Appendix P

Convention and Event Center Project Surface Water Quality System Technical Report

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1.0 INTRODUCTION

1.1 Project Description

The Convention and Event Center Project (hereafter referred to as the "Proposed Project") consists of the following three components: (1) expansion and modernization of the Los Angeles Convention Center (hereafter referred to as the "Convention Center"), (2) the construction of a new multi-use entertainment and sports facility (hereafter referred to as the "Event Center"), and (3) related parking and support facilities. The Proposed Project is located within an approximately 68-acre site that includes all of the existing Convention Center property, including the Bond Street Parking Lot and the Cherry Street Parking Garage, STAPLES Center, as well as the air space over Pico Boulevard and L A LIVE Way (hereafter referred to as the "Project Site"). The Project Site is generally bounded by the following major roadways: the I-110 Harbor Freeway to the west; Chick Hearn Court to the north; Figueroa Street to the east; and Venice Boulevard to the south.

With the implementation of the Proposed Project, the Project Site would function as a unified center for convention, sports and entertainment uses. The Proposed Project is proposed to be implemented through adoption of a new Specific Plan and Community Plan Amendment. Although the Specific Plan encompasses the entire Project Site, its primary focus would be on the regulation of the proposed buildings and related features, including signage, as well as the regulation of transportation and parking. In addition, notable elements of environmental sustainability would be comprehensively integrated into the Proposed Project and would be one of the key elements that would guide the design of the Proposed Project. Total building square footage to be constructed under the Proposed Project would be approximately 1.74 million square feet of net new gross floor area. A brief overview of each of the Proposed Project's three components is provided below.

The Proposed Project's first component would involve the demolition and replacement of the Convention Center's existing West and Petree Halls. The new structure (hereafter referred to as "New Hall"), would bridge over a portion of Pico Boulevard such that it would adjoin the Convention Center's existing South Hall and would consist of roughly the same amount of square footage as the former West and Petree Halls. While the total square footage would be comparable, the amount of functional space would substantially increase through a more efficient building design that among other benefits results in a substantial increase in contiguous floor space for the Convention Center.

The Proposed Project's second component is the development of the Event Center, a multi-purpose, entertainment and sports facility with a potentially retractable roof on the site of the former West and Petree Halls. The approximately 1,750,000 square-foot structure would include approximately 72,000 permanent seats with expandable seating capacity to approximately 76,250 seats for major marquee events, such as a Super Bowl. The Event Center would also be available for use as Convention

Center exhibit and meeting room space, when not used for spectator events, providing roughly 245,650 square feet of rentable exhibition and meeting room space.

The Proposed Project's third component would involve the construction of new larger, more efficient parking facilities on the existing Bond Street Parking Lot and Cherry Street Garage sites. As the West Hall would be demolished, the existing 1,625 parking spaces under the West Hall would be removed by the Proposed Project. The existing Cherry Street Garage would be rebuilt and expanded from the existing 858 spaces to approximately 2,950 parking spaces. A new parking garage would be constructed on the existing Bond Street Parking Lot, which would increase parking on that site from approximately 283 to approximately 928 parking spaces. These improvements would result in a net increase of approximately 1,121 parking spaces. Additionally, above-ground pedestrian bridges would provide connectivity between these parking structures and the Event Center and New Hall, as well as to L A LIVE Way.

In addition to the above improvements, the Proposed Project includes up to approximately 100,000 square feet of renovations to the existing Concourse building. Changes to the Convention Center's existing South Hall would be limited to its interface with the proposed New Hall. Existing parking under the South Hall and in the Convention Center's Venice Garage would not be affected by the Proposed Project. Street vacations involving portions of Pico Boulevard, L A LIVE Way, Bond Street and 12th Street would also occur under the Proposed Project.

The Proposed Project also includes approximately 4,317 square feet of landscape areas associated with the Event Center Plaza, approximately 69,485 square feet of landscape areas for the Gil Lindsay Plaza, and approximately 40,656 square feet of landscape areas along L A LIVE Way.

1.2 Scope of Work

This report provides a description of the impact of the Proposed Project on surface water quality.

2.0 REGULATORY FRAMEWORK AND ENVIRONMENTAL SETTING

2.1 Regulatory Framework

Clean Water Act

The Clean Water Act (CWA) was first introduced in 1948 as the Water Pollution Control Act. The CWA authorizes Federal, state, and local entities to cooperatively create comprehensive programs for eliminating or reducing the pollution of state waters and tributaries. The primary goals of the CWA are to restore and maintain the chemical, physical, and biological integrity of the nation's waters and to make all surface waters fishable and swimmable. As such, the CWA forms the basic national framework for the management of water quality and the control of pollutant discharges. The CWA also sets forth a number of objectives in order to achieve the above-mentioned goals. These objectives include regulating pollutant and toxic pollutant discharges; providing for water quality that protects and fosters the propagation of fish, shellfish and wildlife; developing waste treatment management plans; and developing and implementing programs for the control of non-point sources of pollution.[1]

Since its introduction, major amendments to the CWA have been enacted (e.g., 1961, 1966, 1970, 1972, 1977, and 1987). Amendments enacted in 1970 created the U.S. Environmental Protection Agency (USEPA), while amendments enacted in 1972 deemed the discharge of pollutants into waters of the United States from any point source unlawful unless authorized by a USEPA National Pollutant Discharge Elimination System (NPDES) permit. Amendments enacted in 1977 mandated development of a "Best Management Practices" Program at the state level and provided the Water Pollution Control Act with the common name of "Clean Water Act," which is universally used today. Amendments enacted in 1987 required the USEPA to create specific requirements for discharges.

In response to the 1987 amendments to the CWA and as part of Phase I of its NPDES permit program, the USEPA began requiring NPDES permits for: (1) municipal separate storm sewer systems (MS4) generally serving, or located in, incorporated cities with 100,000 or more people (referred to as municipal permits); (2) 11 specific categories of industrial activity (including landfills); and (3) construction activity that disturbs five acres or more of land. Phase II of the USEPA's NPDES permit program, which went into effect in early 2003, extended the requirements for NPDES permits to: (1) numerous small municipal separate storm sewer systems,[2] (2) construction sites of one to five acres, and (3) industrial facilities owned or operated by small municipal separate storm sewer systems. The NPDES permit program is typically administered by individual authorized states.

In 2008, the USEPA published draft Effluent Limitation Guidelines (ELGs) for the construction and development industry. On December 1, 2009 the EPA finalized its 2008 Effluent Guidelines Program Plan.

In California, the NPDES stormwater permitting program is administered by the State Water Resources Control Board (SWRCB). The SWRCB was created by the Legislature in 1967. The joint authority of water distribution and water quality protection allows the Board to provide protection for the State's waters, through its nine Regional Water Quality Control Boards (RWQCBs). The RWQCBs develop

1 Non-point sources of pollution are carried through the environment via elements such as wind, rain, or stormwater and are generated by diffuse land use activities (such as runoff from streets and sidewalks or agricultural activities) rather than from an identifiable or discrete facility.

2 A small municipal separate storm sewer system (MS4) is any MS4 not already covered by the Phase I program as a medium or large MS4. The Phase II Rule automatically covers on a nationwide basis all small MS4s located in "urbanized areas" as defined by the Bureau of the Census (unless waived by the NPDES permitting authority), and on a case-by-case basis those small MS4s located outside of urbanized areas that the NPDES permitting authority designates.

and enforce water quality objectives and implement plans that will best protect California's waters, acknowledging areas of different climate, topography, geology, and hydrology. The RWQCBs develop "basin plans" for their hydrologic areas, issue waste discharge requirements, enforce action against stormwater discharge violators, and monitor water quality. [3]

In addition to regulating non-stormwater discharges, the CWA sets for the water quality standards and criteria based on a water body's designated beneficial uses. Section 305(b) of the CWA requires preparation of a 303(d) list (list of water quality limited or impaired water bodies). This list identifies those water bodies that are not achieving water quality standards or receiving beneficial uses and for what pollutants. Once a water body is identified as impaired, a Total Maximum Daily Load (TMDL) for the constituent of concern (pollutant) must be developed for that water body. A TMDL specifies the maximum amount of a pollutant that a water body can receive and still meet water quality standards. Those facilities and activities that are discharging into the water body, collectively, must not exceed the TMDL. The USEPA oversees the 303(d) program and either the USEPA or the State Water Board establishes the TMDL schedule for the individual constituents.

Federal Anti-Degradation Policy

The Federal Antidegradation Policy (40 Code of Federal Regulations 131.12) requires states to develop statewide antidegradation policies and identify methods for implementing them. Pursuant to the Code of Federal Regulations (CFR), state antidegradation policies and implementation methods shall, at a minimum, protect and maintain (1) existing in-stream water uses; (2) existing water quality, where the quality of the waters exceeds levels necessary to support existing beneficial uses, unless the state finds that allowing lower water quality is necessary to accommodate economic and social development in the area; and (3) water quality in waters considered an outstanding national resource.

California Porter-Cologne Act

The Porter-Cologne Water Quality Control Act established the legal and regulatory framework for California's water quality control. The California Water Code authorizes the SWRCB to implement the provisions of the CWA, including the authority to regulate waste disposal and require cleanup of discharges of hazardous materials and other pollutants.

As discussed above, under the California Water Code (CWC), the State of California is divided into nine RWQCBs, governing the implementation and enforcement of the CWC and CWA. The Project Site is located within Region 4, also known as the Los Angeles Region. Each RWQCB is required to formulate and adopt a Basin Plan for its region. This Plan must adhere to the policies set forth in the CWC and established by the SWRCB. The RWQCB is also given authority to include within its regional plan water discharge prohibitions applicable to particular conditions, areas, or types of waste.

[3] USEPA. U.S. Environmental Protection Agency - Clean Water Act. July 2011 <http://www.epa.gov/lawsregs/laws/cwa.html>.

California Anti-Degradation Policy

The California Antidegradation Policy, otherwise known as the *Statement of Policy with Respect to Maintaining High Quality Water in California* was adopted by the SWRCB (State Board Resolution No. 68-16) in 1968. Unlike the Federal Antidegradation Policy, the California Antidegradation Policy applies to all waters of the State, not just surface waters. The policy states that whenever the existing quality of a water body is better than the quality established in individual Basin Plans, such high quality shall be maintained and discharges to that water body shall not unreasonably affect present or anticipated beneficial use of such water resource.

California Toxic Rule

In 2000, the EPA promulgated the California Toxic Rule, which establishes water quality criteria for certain toxic substances to be applied to waters in the State. The EPA promulgated this rule based on the EPA's determination that the numeric criteria are necessary in the State to protect human health and the environment. The California Toxic Rule establishes acute (i.e., short-term) and chronic (i.e., long-term) standards for bodies of water such as inland surface waters and enclosed bays and estuaries that are designated by the LARWQCB as having beneficial uses protective of aquatic life or human health such as the Ballona Creek.

Board Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties

As required by the California Water Code, the LARWQCB has adopted a plan entitled "Water Quality Control Plan, Los Angeles Region: Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties" (Basin Plan). Specifically, the Basin Plan designates beneficial uses for surface and groundwaters, sets narrative and numerical objectives that must be attained or maintained to protect the designated beneficial uses and conform to the State's antidegradation policy, and describes implementation programs to protect all waters in the Los Angeles Region. In addition, the Basin Plan incorporates (by reference) all applicable State and Regional Board plans and policies and other pertinent water quality policies and regulations. Those of other agencies are referenced in appropriate sections throughout the Basin Plan.[4]

The Basin Plan is a resource for the RWQCB and others who use water and/or discharge wastewater in the Los Angeles Region. Other agencies and organizations involved in environmental permitting and resource management activities also use the Basin Plan. Finally, the Basin Plan provides valuable information to the public about local water quality issues.

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[4] Los Angeles Regional Water Quality Control Board. LARWQCB Basin Plan <http://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/> accessed October 21, 2011.

NPDES Permit Program

The NPDES permit program was first established under authority of the CWA to control the discharge of pollutants from any point source into the waters of the United States. As indicated above, in California, the NPDES stormwater permitting program is administered by the SWRCB through its nine RWQCBs.

The General Permit

SWRCB Order No. 2009-0009-DWQ known as "The General Permit" was adopted on September 2, 2009. This NPDES permit establishes a risk-based approach to stormwater control requirements for construction projects by identifying three project risk levels. The main objectives of the General Permit are to:

1. Reduce erosion
2. Minimize or eliminate sediment in stormwater discharges
3. Prevent materials used at a construction site from contacting stormwater
4. Implement a sampling and analysis program
5. Eliminate unauthorized non-stormwater discharges from construction sites
6. Implement appropriate measures to reduce potential impacts on waterways both during and after construction of projects
7. Establish maintenance commitments on post-construction pollution control measures

California mandates requirements for all construction activities disturbing more than one acre of land to develop and implement Stormwater Pollution Prevention Plans (SWPPP). The SWPPP documents the selection and implementation of Best Management Practices for a specific construction project, charging Owners with stormwater quality management responsibilities. A construction site subject to the General Permit must prepare and implement a SWPPP that meets the requirements of the General Permit.[5] [6]

Los Angeles County Municipal Storm Water System (MS4) Permit

As described above, USEPA regulations require that MS4 permittees implement a program to monitor and control pollutants being discharged to the municipal system from both industrial and commercial projects that contribute a substantial pollutant load to the MS4.

On December 13, 2001, the LARWQCB adopted Order No. 01-182 under the CWA and the Porter-Cologne Act. This Order is the NPDES Permit or MS4 permit for municipal stormwater and urban runoff discharges within Los Angeles County. The requirements of this Order (the "Permit") cover 84 cities and most of the unincorporated areas of Los Angeles County. Under the Permit, the Los Angeles County Flood Control District (LACFCD) is designated as the Principal Permittee. The Permittees are the 84 Los Angeles County cities (including the City of Los

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[5] State Water Resources Control Board. State Water Resources Control Board. July 2011 <http://www.swrcb.ca.gov/water_issues/programs/npdes/>.
[6] USEPA. U.S. Environmental Protection Agency - NPDES. July 2011 <http://cfpub.epa.gov/npdes/>.

Angeles) and Los Angeles County. Collectively, these are the "Co-Permittees". The Principal Permittee helps to facilitate activities necessary to comply with the requirements outlined in the Permit but is not responsible for ensuring compliance of any of the Permittees.

Stormwater Quality Management Program (SQMP)

In compliance with the Los Angeles County MS4 Permit, the Co-Permittees are required to implement a stormwater quality management program (SQMP) with the goal of accomplishing the requirements of the Permit and reducing the amount of pollutants in stormwater runoff. The SWMP requires the County of Los Angeles and the 84 incorporated cities to:

- Implement a public information and participation program to conduct outreach on storm water pollution;
- Control discharges at commercial/industrial facilities through tracking, inspecting, and ensuring compliance at facilities that are critical sources of pollutants;
- Implement a development planning program for specified development projects;
- Implement a program to control construction runoff from construction activity at all construction sites within the relevant jurisdictions;
- Implement a public agency activities program to minimize storm water pollution impacts from public agency activities; and
- Implement a program to document, track, and report illicit connections and discharges to the storm drain system.

The MS4 Permit contains the following provisions for implementation of the SQMP by the Co-Permittees:

1. General Requirements:

    - Each permittee is required to implement the SQMP in order to comply with applicable stormwater program requirements.
    - The SQMP shall be implemented and each permittee shall implement additional controls so that discharge of pollutants is reduced.

2. Best Management Practice Implementation:

    - Permittees are required to implement the most effective combination of BMPs for stormwater/urban runoff pollution control. This should result in the reduction of storm water runoff.

3. Revision of the SQMP:

    - Permittees are required to revise the SQMP in order to comply with requirements of the RWQCB while complying with regional watershed requirements and/or waste load allocations for implementation of TMDLs for impaired waterbodies.

4. Designation and Responsibilities of the Principal Permittee:

    The Los Angeles County Flood Control District is designated as the Principal Permittee who is responsible for:

    - Coordinating activities that comply with requirements outlined in the NPDES Permit;
    - Coordinating activities among Permittees;
    - Providing personnel and fiscal resources for necessary updates to the SQMP;
    - Providing technical support for committees required to implement the SQMP; and
    - Implementing the Countywide Monitoring Program required under this Order and assessing the results of the monitoring program.

5. Responsibilities of Co-Permittees:

    Each co-permittee is required to comply with the requirements of the SQMP as applicable to the discharges within its geographical boundaries. These requirements include:

    - Coordinating among internal departments to facilitate the implementation of the SQMP requirements in an efficient way;
    - Participating in coordination with other internal agencies as necessary to successfully implement the requirements of the SQMP; and
    - Preparing an annual Budget Summary of expenditures for the storm water management program by providing an estimated breakdown of expenditures for different areas of concern, including budget projections for the following year.

6. Watershed Management Committees (WMCs):

    - Each WMC shall be comprised of a voting representative from each Permittee in the Watershed Management Area (WMA).
    - Each WMCs is required to facilitate exchange of information between co-permittees, establish goals and deadlines for WMAs, prioritize pollution control measures, develop and update adequate information, and recommend appropriate revisions to the SQMP.

7. Legal Authority:

   - Co-permittees are granted the legal authority to prohibit non-storm water discharges to the storm drain system including discharge to the MS4 from various development types.

Standard Urban Stormwater Mitigation Plan (SUSMP)

Under the Los Angeles County Municipal NPDES Permit, permittees are required to implement a development planning program to address storm water pollution. These programs require project applicants for certain types of projects to implement Standard Urban Stormwater Mitigation Plans (SUSMP) throughout the operational life of their projects. The purpose of SUSMP is to reduce the discharge of pollutants in storm water by outlining BMPs which must be incorporated into the design plans of new development and redevelopment. A project is subject to SUSMP if it falls under one of the categories listed below:

1. Single-family hillside homes
2. Ten or more unit homes (including single family homes, multifamily homes, condominiums, and apartments).
3. Automotive service facilities
4. Restaurants
5. 100,000 or more square-feet of impervious surface in industrial/commercial development.
6. Retail gasoline outlet
7. Parking lots with 5,000 square feet or more of surface area or with 25 or more parking spaces
8. Redevelopment projects in subject categories that meet redevelopment thresholds
9. Location within or directly adjacent to or discharging directly to an environmentally sensitive area if the discharge is likely to impact a sensitive biological species or habitat and the development creates 2,500 square feet or more of impervious surface.

Permittees are required to adopt the requirements set herein in their own SUSMP. Additional BMPs may be required by ordinance or code adopted by the Permittee and applied in a general way to all projects or on a case by case basis.

City of Los Angeles Water Quality Compliance Master Plan for Urban Runoff

On March 2, 2007, City Council Motion 07-0663 was introduced by the City of Los Angeles City Council to develop a water quality master plan with strategic directions for planning, budgeting and funding to reduce pollution from urban runoff in the City of Los Angeles. The Water Quality Compliance Master Plan for Urban Runoff was developed by the Bureau of Sanitation, Watershed Protection Division in collaboration with stakeholders to address the requirements of this Council Motion. The primary goal of the Water Quality Compliance Master Plan for Urban Runoff is to help meet water quality regulations. Implementation of the Water

Quality Compliance Master Plan for Urban Runoff is intended over the next 20 to 30 years to result in cleaner neighborhoods, rivers, lakes and bays, augmented local water supply, reduced flood risk, more open space, and beaches that are safe for swimming.

The Water Quality Compliance Master Plan for Urban Runoff identifies and describes the various watersheds in the City, summarizes the water quality conditions of the City's waters, identifies known sources of pollutants, describes the governing regulations for water quality, describes the BMPs that are being implemented by the City, discusses existing TMDL Implementation Plans and Watershed Management Plans. Additionally, the Water Quality Compliance Master Plan for Urban Runoff provides an implementation strategy that includes the following three initiatives to achieve water quality goals:

- Water Quality Management Initiative, which describes how Water Quality Management Plans for each of the City's watershed and TMDL-specific Implementation Plans will be developed to ensure compliance with water quality regulations.

- The Citywide Collaboration Initiative, which recognizes that urban runoff management and urban (re)development are closely linked, requiring collaborations of many City agencies. This initiative requires the development of City policies, guidelines, and ordinances for green and sustainable approaches for urban runoff management.

- The Outreach Initiative, which promotes public education and community engagement with a focus on preventing urban runoff pollution.

The Water Quality Compliance Master Plan for Urban Runoff includes a financial plan that provides a review of current sources of revenue, estimates costs for water quality compliance, and identifies new potential sources of revenue.

City of Los Angeles Proposition O

On November 2, 2004, City of Los Angeles voters passed Proposition O. The $500 million bond authorizes the City to fund projects that protect public health, capture stormwater for reuse and meet CWA requirements through removal and prevention of pollutants entering regional waterways. A number of projects targeted at improving water quality have been authorized using Proposition O funds, including but not limited to: the Temescal Canyon Park Stormwater BMP, Los Angeles Zoo Parking Lot, the Westchester Stormwater BMP, Echo Park Lake Rehabilitation Project, and the Hansen Dam Recreational Area Parking Lot and Wetlands Restoration.[7]

In addition, Proposition O funds were used for the Catch Basin Screen Cover and Insert Project, which provided for the installation of catch basin inserts and screen covers throughout the City beginning in 2005 with completion on September 30,

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[7] City of Los Angeles Stormwater Program, Proposition O, website - http://www.lapropo.org/index.htm; accessed October 21, 2011.

2007 (Phase I and Phase II). Phase III began in the spring of 2008 and will retrofit approximately 34,000 remaining catch basins with opening screen covers.[8]

City of Los Angeles Stormwater Program

The City of Los Angeles supports the policies of the Construction General Permit through the *Development Best Management Practices Handbook, Part A Construction Activities*, 3rd Edition, and associated ordinances which the City of Los Angeles adopted in September 2004. The handbook and ordinances also have specific minimum BMP requirements for all construction activities and require dischargers whose construction projects disturb one acre or more of soil to prepare a SWPPP and file a Notice of Intent (NOI) with the SWRCB. The NOI informs the SWRCB of a particular project and results in the issuance of a Waste Discharger Identification (WDID) number, which is needed to demonstrate compliance with the Genereral Permit.

The City of Los Angeles supports the requirements of the Los Angeles County Municipal NPDES permit through the City of Los Angeles's *Development Best Management Practices Handbook, Part B Planning Activities*, 3rd Edition, which the City of Los Angeles Department of Public Works adopted in June 2004. The Handbook provides guidance for developers in complying with the requirements of the Development Planning Program regulations of the City's Stormwater Program. Compliance with the requirements of this manual is required by City of Los Angeles Ordinance No. 173,494.

The City of Los Angeles implements the requirement to incorporate stormwater BMPs into the SUSMP through the City's plan review and approval process. During the review process, project plans are reviewed for compliance with the City's General Plans, zoning ordinances, and other applicable local ordinances and codes, including storm water requirements. Plans and specifications are reviewed to ensure that the appropriate BMPs are incorporated to address storm water pollution prevention goals. The SUSMP provisions that are applicable to new residential and commercial developments include, but are not limited to, the following:[9]

- Peak Storm Water Runoff Discharge Rate: Post-development peak storm water runoff discharge rates shall not exceed the estimated pre-development rate for developments where the increased peak storm water discharge rate will result in increased potential for downstream erosion;

- Provide storm drain system Stenciling and Signage (only applicable if a catch basin is built on-site);

- Properly design outdoor material storage areas to provide secondary containment to prevent spills;

[8] City of Los Angeles Stormwater Program, What's New, website - http://www.lastormwater.org/siteorg/events/PropO/121307.htm; accessed October 21, 2011.
[9] City of Los Angeles Stormwater Program website, http://www.lastormwater.org/siteorg/businesses/susmp/industrial.htm; http://www.lastormwater.org/siteorg/businesses/susmp/housing.htm; accessed October 21, 2011.

- Properly design trash storage areas to prevent off-site transport of trash;
- Provide proof of ongoing BMP Maintenance of any structural BMPs installed;
- Design Standards for Structural or Treatment control BMPs:
  - Conserve natural and landscaped areas;
  - Provide planter boxes and/or landscaped areas in yard/courtyard spaces;
  - Properly design trash storage areas to provide screens or walls to prevent off-site transport of trash;
  - Provide proof on ongoing BMP maintenance of any structural BMPs installed;
  - Post-construction treatment control BMPs are required to incorporate, at minimum, either a volumetric or flow based treatment control design or both, to mitigate (infiltrate, filter or treat) storm water runoff.

In addition, project applicants subject to the SUSMP requirements must select source control and, in most cases, treatment control BMPs from the list approved by the RWQCB. The BMPs must control peak flow discharge to provide stream channel and over bank flood protection, based on flow design criteria selected by the local agency. Further, the source and treatment control BMPs must be sufficiently designed and constructed to collectively treat, infiltrate, or filter stormwater runoff from one of the following:

- The 85th percentile 24-hour runoff event determined as the maximized capture stormwater volume for the area, from the formula recommended in *Urban Runoff Quality Management, WEF Manual of Practice No. 23/ASCE Manual of Practice No. 87, (1998)*;
- The volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment by the method recommended in *California Stormwater Best Management Practices Handbook—Industrial/ Commercial, (1993)*;
- The volume of runoff produced from a 0.75-inch storm event, prior to its discharge to a stormwater conveyance system; or
- The volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for “treatment” (0.75-inch average for the Los Angeles County area) that achieves approximately the same reduction in pollutant loads achieved by the 85th percentile 24-hour runoff event.

Per the City’s *SUSMP Infiltration Requirements and Guidelines*, the order of preference specified below shall be followed in determining the appropriate type of SUSMP improvement for the Project Site:

1. Infiltration Systems (Design based on the volume of storm water)

2. Bio-Filtration/Retention Systems (Design based on flow of storm water)

3. Storm Water Capture and Re-Use (Optional. Subject to County Health Dept approval)

4. Mechanical/Hydrodynamic Units

5. Combination of Any of the Above

Los Angeles Municipal Code

Section 64.70 of the LAMC sets forth the City's Stormwater and Urban Runoff Pollution Control Ordinance. The ordinance prohibits the discharge of the following into any storm drain system:

- Any liquids, solids, or gases which by reason of their nature or quantity are flammable, reactive, explosive, corrosive, or radioactive, or by interaction with other materials could result in fire, explosion or injury.

- Any solid or viscous materials, which could cause obstruction to the flow or operation of the storm drain system.

- Any pollutant that injures or constitutes a hazard to human, animal, plant, or fish life, or creates a public nuisance.

- Any noxious or malodorous liquid, gas, or solid in sufficient quantity, either singly or by interaction with other materials, which creates a public nuisance, hazard to life, or inhibits authorized entry of any person into the storm drain system.

- Any medical, infectious, toxic or hazardous material or waste.

Additionally, unless otherwise permitted by a NPDES permit, the ordinance prohibits industrial and commercial developments from discharging untreated wastewater or untreated runoff into the storm drain system. Furthermore, the ordinance prohibits trash or any other abandoned objects/materials from being deposited such that they could be carried into the storm drains. Lastly, the ordinance not only makes it a crime to discharge pollutants into the storm drain system and imposes fines on violators, but also gives City public officers the authority to issue citations or arrest business owners or residents who deliberately and knowingly dump or discharge hazardous chemicals or debris into the storm drain system.

Earthwork activities, including grading, are governed by the Los Angeles Building Code, which is contained in Los Angeles Municipal Code (LAMC), Chapter IX, Article 1. Specifically, Section 91.7013 includes regulations pertaining to erosion control and drainage devices, and Section 91.7014 includes general construction requirements, as well as requirements regarding flood and mudflow protection.

Low Impact Development (LID)

In October 2011, the City of Los Angeles passed an ordinance amending City of Los Angeles Municipal Code Chapter VI, Article 4.4, Sections 64.70.01 and 64.72 to expand the applicability of the existing Standard Urban Stormwater Mitigation Plan requirements by imposing rainwater Low Impact Development (LID) strategies on projects that require building permits. LID is a stormwater management strategy with goals to mitigate the impacts of increased runoff and stormwater pollution as close to its source as possible. LID promotes the use of natural infiltration systems, evapotranspiration, and the reuse of stormwater. The goal of these LID practices is to remove nutrients, bacteria, and metals from stormwater while also reducing the quantity and intensity of stormwater flows. Through the use of various infiltration strategies, LID is aimed at minimizing impervious surface area. Where infiltration is not feasible, the use of bioretention, rain gardens, green roofs, and rain barrels that will store, evaporate, detain, and/or treat runoff may be used. [10]

The intent of the City of Los Angeles LID standards is to:

- Require the use of LID practices in future developments and redevelopments to encourage the beneficial use of rainwater and urban runoff;
- Reduce stormwater/urban runoff while improving water quality;
- Promote rainwater harvesting;
- Reduce offsite runoff while provide increased groundwater recharge;
- Reduce erosion and hydrologic impacts downstream; and
- Enhance the recreational and aesthetic values in our communities.

The City of Los Angeles Bureau of Sanitation, Watershed Protection Division will adopt the Low Impact Development (LID) standards as issued by the LARWQCB and the City of Los Angeles Department of Public Works. The LID Ordinance will conform to the regulations outlined in the NPDES Permit and SUSMP.

2.2 Regional Conditions

The Project Site lies within the Los Angeles Basin as designated by the RWQCB. The Los Angeles Basin (Basin) consists of the coastal areas of Los Angeles County, south of the divide of the San Gabriel Mountains and Santa Susana Mountains, plus a small part of the coastal portion of Ventura County, south of the divide of the Santa Monica Mountains.[11] This Basin is drained by four watersheds: the Los Angeles River, the Rio Hondo River, Ballona Creek, and the San Gabriel River. Numerous tributaries discharge into these major drainages, most of which have intermittent flow. Except for a few rivers in the mountainous areas, most have been converted to flood control channels lined with concrete and stone rip-rap.

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[10] City of Los Angeles. "Low Impact Development Best Management Practices Handbook." June, 2011

[11] Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties, Regional Water Quality Control Board – Los Angeles; accessed online on October 21, 2011 at http://www.swrcb.ca.gov/rwqcb4/water_issues/programs/basin_plan/electronics_documents/bp1_introduction.pdf.

The Project Site is located within the Santa Monica Bay Watershed Management Area (WMA) of the Basin. The WMA includes several watersheds, with Malibu Creek and Ballona Creek being the two largest watersheds.

The Project is located within the Ballona Creek watershed. Ballona Creek is a nine-mile long flood protection channel that drains the Los Angeles Basin, from the Santa Monica Mountains on the north, roughly the Harbor Freeway (110) on the east, and the Baldwin Hills on the south. The Ballona Creek Watershed totals about 130 square miles. Its land use consists of 64% residential, 8% commercial, 4% industrial, and 17% open space. The major tributaries to the Ballona Creek include Centinela Creek, Sepulveda Canyon Channel, Benedict Canyon Channel, and numerous storm drains. Ballona Creek is designed to discharge to Santa Monica Bay. The watershed is comprised of all or parts of the Cities of Beverly Hills, Culver City, Inglewood, Los Angeles, Santa Monica, West Hollywood, and unincorporated Los Angeles County.[12]

As described above, the Clean Water Act sets forth water quality standards and criteria based on a water body's designated beneficial uses through preparation of a 303(d) list (list of water quality limited or impaired water bodies). This list identifies those water bodies that are not achieving water quality standards or receiving beneficial uses and for what pollutants. Once a water body is identified as impaired, a Total Maximum Daily Load for the constituent of concern (pollutant)O must be developed for that water body. A TMDL specifies the maximum amount of a pollutant that a water body can receive and still meet water quality standards. Those facilities and activities that are discharging into the water body, collectively, must not exceed the TMDL. Ballona Creek is listed on the 2010 CWA Section 303(d) List for the following pollutants: Cadmium (sediment), coliform bacteria, dissolved copper, cyanide, lead, selenium, toxicity, trash, and viruses.

2.3 Existing Site Conditions

The Project Site is located in downtown Los Angeles and is bounded on the west by Harbor Freeway (110), on the north by Chick Hearn Court, on the east by Figueroa Street and on the south by Venice Boulevard. As shown in Figure 1 (Existing Project Site Tributary Areas), storm water runoff from on and off of the Project Site is conveyed through and within the Project Site by three existing storm drain mains, which are tributary to Ballona Creek. These include a 54-inch storm drain located near the intersection of Venice Boulevard and the I-10 off-ramp, a 42-inch storm drain main located adjacent to the Cherry Street Parking Garage, and a 33-inch storm drain main located adjacent to the Bond Street Parking Lot. Tributary areas that drain into these storm drains include off-site tributary area T-1 encompassing an area of 246.06 acres including most of the eastern half of the Project Site and extending off-site; tributary area T-2 encompassing an area of 21.61 acres including a portion of West Hall and extending off-site; and tributary area T-3 encompassing an area of 24.45 acres including most of the western portion of the Project Site including the Bond Street Parking Lot and the Cherry Street Parking Garage and extending off-site. The 54-inch storm drain main collects surface water runoff from tributary area T-1 (42.79 acres of the Project Site). The 42-inch storm drain main

[12] Los Angeles County Department of Public Works. LACDPW: Ballona Creek Watershed. 5 July 2011 <http://ladpw.org/wmd/watershed/bc/>.

collects surface water runoff from tributary area T-2 (10.98 acres of the Project Site). The 33-inch storm drain main collects surface water runoff from tributary are T-3 (17.96 acres of the Project Site).

Storm drain inlets within the site boundaries currently collect surface runoff from the existing site. Catch basin inlets in L A LIVE Way, Pico Blvd. and Figueroa Street capture any off-site runoff. Stormwater runoff is conveyed from the site to the storm drain system by a network of storm drain pipes, ultimately discharging to the public storm drain system owned and maintained by the City of Los Angeles.

The Project Site consists predominantly of impervious surfaces and structures. Stormwater runoff from impervious surfaces contains numerous natural constituents. Pollutants of concern for the Proposed Project associated with stormwater include sediment, nutrients, oils and grease, metals, organics, pesticides, and gross pollutants.

1. Sediment is a common component of stormwater and can also be a pollutant. Sediment can also transport other pollutants that are attached to it including nutrients, trace metals, and hydrocarbons. Sediment is the primary component of turbidity, total suspended solids (TSS), and suspended sediment concentration (SSC).

2. Nutrients, including nitrogen and phosphorus, are the major plant nutrients when fertilizing landscape areas and can often be found in stormwater. These nutrients can result in excessive growth of vegetation and algae, creating an impaired use of water in lakes and other sources of water supply.

3. Oil and grease include a wide variety of hydrocarbon compounds, some of which are toxic to aquatic organisms. Sources of oil and grease include leakage and spills associated with vehicle engines, restaurants, and waste oil disposal.

4. Metals including lead, zinc, cadmium, copper, chromnium, and nickel are commonly found in stormwater. Many artificial surfaces contain metals, which enter stormwater as the surfaces corrode, flake, dissolve, etc. Over half the trace metal load carried in stormwater is associated with sediments. Metals are of concern because some are toxic to aquatic organisms and have the potential to contaminate drinking water supplies.

5. Synthetic organics can be found in stormwater in low concentrations. Synthetic organic compounds are often widely applied and have the potential for being improperly stored and disposed of. Additionally, deliberate dumping of these chemicals into the storm drains and inlets causes environmental harm to waterways.

6. Pesticides have been detected repeatedly in stormwater at levels toxic to certain organisms. Stormwater can transport pesticides from target areas into receiving waters where they may impact non-target animals such as invertebrates and fish.

7. Gross pollutants, also referred to as floatables, typically result from industrial and construction sites, creating an aesthetic "eye sore" in waterways. Gross pollutants also include plant debris, street litter, animal excrement, and other

organic matter. Such of these substances may harbor bacteria and viruses, causing fish kills.[13]

Consistent with typical projects developed prior to implementation of SUSMP requirements in the City of Los Angeles, stormwater run-off from much of the existing site is not treated and is conveyed to the storm drain system through direct connections. In addition, the site is fully developed with buildings and pavements that virtually cover the entire site footprint with impervious surfaces that eliminate the potential of natural soils and vegetation to absorb pollutants and promote infiltration. The total Project Site is approximately 68 acres and is approximately 94% impervious.

3.0 SIGNIFICANCE THRESHOLDS

The City of Los Angeles *CEQA Thresholds Guide* states that a project would normally have a significant impact on surface water quality if discharges associated with the project would create pollution, contamination or nuisance, as defined in Section 13050 of the California Water Code (CWC) or that cause regulatory standards to be violated, as defined in the applicable NPDES stormwater permit or Water Quality Control Plan for the receiving water body. The CEQA Thresholds Guide and CWC include the following definitions:

"Pollution" means an alteration of the quality of the waters of the state to a degree which unreasonably affects either of the following: 1) the waters for beneficial uses or 2) facilities which serve these beneficial uses. "Pollution" may include "Contamination".

"Contamination" means an impairment of the quality of the waters of the state by waste to a degree, which creates a hazard to the public health through poisoning or though the spread of disease. "Contamination" includes any equivalent effect resulting from the disposal of waste, whether or not waters of the state are affected.

"Nuisance" means anything which meets all of the following requirements: 1) is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property; 2) affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal; and 3) occurs during, or as a result of, the treatment or disposal of wastes.[14]

[13] California Stormwater Quality Association (CASQA). Stormwater Best Management Practice Handbook: Construction. Fresno: California Stormwater Quality Association (CASQA), 2009

[14] City of Los Angles. LA. CEQA Thresholds Guides. 2006 http://www.ci.la.ca.us/ead/programs/Thresholds/G-Water%20Resources.pdf

4.0 PROJECT DESIGN FEATURES

The Project's stormwater management features will focus on meeting or exceeding the goals of the General Permit, as well as, SUSMP and LID.

Construction Stormwater Management Features

Provisions to manage construction stormwater run-off are based on BMP objectives outlined by the SWPPP that identify the category of BMP fit to meet each goal. The BMPs selected for each site depend on site conditions, construction activities, and cost considerations. All of the following BMPs will be included as part of the Project to manage construction stormwater run-off:

1. <u>Erosion Control BMPs</u> protect the soil surface and prevents soil particles from detaching. Selection of the appropriate erosion control BMP shall be based on minimizing areas of disturbance, stabilizing disturbed areas, and protecting slopes/channels. These BMP's would include: scheduling, geotextiles and mats, earth dikes and drainage swales, and slope drains.

2. <u>Sediment Control BMPs</u> are treatment controls that trap soil particles that have been detached by water or wind. Selection of the appropriate sediment control BMP shall be based on keeping sediments on site and controlling the site boundaries. These BMP's would include: silt fence, sediment trap, street sweeping and vacuuming, sandbag barrier, and storm drain inlet protection.

3. <u>Wind Erosion Control BMPs</u> consists of applying water to prevent or minimize dust nuisance.

4. <u>Tracking Control BMPs</u> consists of preventing or reducing the tracking of sediment off-site by vehicles leaving the construction area. These BMPs include street sweeping and vacuuming. All sites must have a stabilized construction entrance to prevent off-site tracking of sediment and debris.

5. <u>Non-Stormwater Mangement BMPs</u> are also referred to as "good housekeeping practices," which involve keeping a clean, orderly construction site.

6. <u>Waste Management and Materials Pollution Control BMPs</u> consist of implementing procedural and structural BMPs for handling, storing, and disposing of wastes generated by a construction project to prevent the release of waste materials into stormwater runoff or discharges through the proper management of construction waste.

Post Construction Stormwater Management Features

The following BMPs will be included as part of the SUSMP for the Project to manage post-construction stormwater run-off:

- Promote evapotranspiration and infiltration by increasing the overall footprint of landscaped areas and promoting the use of native and/or drought tolerant plants. The Proposed Project site would slightly increase the overall amount of pervious surface.

- Provide storm drain system stenciling and signage to discourage illegal dumping.

- Design material storage areas and loading docks within structures or enclosures to prevent leaks or spills of pollutants from entering the storm drain system.

- Provide evidence of ongoing BMP maintenance as part of a legal agreement with the City of Los Angeles. Recorded covenant and agreements for BMP maintenance are part of standard building permit approval processing.

- Design post-construction structural or treatment control BMPs to either treat or infiltrate stormwater runoff. Storm water treatment facilities and systems shall be designed to meet the requirements of the SUSMP manual.
  - Volumetric Treatment Control BMPs shall be designed to capture the volume of runoff from a 0.75-inch storm event, prior to discharging to the public storm drain system.
  - Flow based Treatment Control BMPs shall be designed to the same standards as the volume-based control BMPs. The flow of runoff produced from the storm event shall be equal to or at least 0.2 inches per hour.
  - Treatment devices shall be sized and designed to meet the above requirements outlined in the SUSMP manual.

The Project will also comply with the Low Impact Development Standards which are intended to promote the use of natural infiltration systems, evapotranspiration, and the reuse of stormwater. The goal of these LID practices is to remove nutrients, bacteria, and metals from stormwater, while also reducing the quantity and intensity of stormwater flows. Through the use of various infiltration strategies, LID is aimed at minimizing impervious surface area. Where infiltration is not feasible, the use of capture and reuse BMPs or biofiltration BMPs that will store, evaporate, detain, and/or treat runoff may be used. [15]

- Infiltration refers to the physical process of percolation, or downward seepage, of water through a soil's pore space. As water infiltrates, the natural filtration, adsorption, and biological decomposition properties of soils, plant roots, and micro-organisms work to remove pollutants prior to the water recharging the underlying groundwater. Infiltration BMPs include infiltration basins, infiltration trenches, infiltration galleries, bioretention without an underdrain, dry wells, and permeable pavement. Infiltration can provide multiple benefits, including pollutant removal, peak flow control, groundwater recharge, and flood control. However, conditions that can limit the use of infiltration include soil properties, proximity to building foundations and other infrastructure, geotechnical hazards (e.g. liquefaction, landslides), and potential adverse impacts on groundwater quality (e.g. industrial pollutant source areas, contaminated soils, groundwater plumes). To ensure that infiltration would be physically feasible and desirable (i.e., not have adverse impacts), a categorical screening of site feasibility criteria must be completed prior to the use of infiltration BMPs.

[15] City of Los Angeles. "Low Impact Development Best Management Practices Handbook." June, 2011

- Capture and Use refers to a specific type of BMP that operates by capturing stormwater runoff and holding it for efficient use at a later time. On a commercial or industrial scale, capture and use BMPs are typically synonymous with cisterns, which can be implemented both above and below ground. Cisterns are sized to store a specified volume of water with no surface discharge until this volume is exceeded. The primary use of captured runoff is for subsurface drip irrigation purposes. The temporary storage of roof runoff reduces the runoff volume from a property and may reduce the peak runoff velocity for small, frequently occurring storms. In addition, by reducing the amount of stormwater runoff that flows overland into a stormwater conveyance system, less pollutants are transported through the conveyance system into local streams and the ocean.

- Biofiltration BMPs are landscaped facilities that capture and treat stormwater runoff through a variety of physical and biological treatment processes. Facilities normally consist of a ponding area, mulch layer, planting soils, plants, and in some cases, an underdrain. Runoff that passes through a biofiltration system is treated by the natural adsorption and filtration characteristics of the plants, soils, and microbes with which the water contacts. Biofiltration BMPs include vegetated swales, filter strips, planter boxes, high flow biotreatment units, bio-infiltration facilities, and bioretention facilities with underdrains. Biofiltration can provide multiple benefits, including pollutant removal, peak flow control, and low amounts of volume reduction through infiltration and evapotranspiration.

Refer to Exhibit 5 for possible LID BMPs to be implemented by the Project.

5.0 PROJECT IMPACTS

5.1 Construction

Construction activities such as earth moving, maintenance/operation of construction equipment, and handling/storage/disposal of materials could contribute to pollutant loading in stormwater runoff. However, as previously discussed, construction contractors disturbing greater than one acre of soil would be required to obtain coverage under the NPDES General Construction Activity Permit (Order No. 2009-0009-SWQ). In accordance with the requirements of the permit, the Project Applicant would prepare and implement a site-specific SWPPP adhering to the California Stormwater Quality Association (CASQA) BMP Handbook. The SWPPP would specify BMPs to be used during construction. BMPs would include but not be limited to: erosion control, sediment control, and non-stormwater management and materials management BMPs. Refer to Exhibit 6 for typical SWPPP BMPs to be implemented during construction of the Project.

With implementation of these BMPs included as part of the SWPPP, the Proposed Project would reduce or eliminate the discharge of potential pollutants from the storm water runoff to the maximum extent practicable. In addition, the Project Applicant would be required to comply with City grading permit regulations, which require necessary measures, plans (including a wet weather erosion control plan if construction occurs during the rainy season), and inspections to reduce sedimentation and erosion. Therefore, with compliance with NPDES requirements and City grading regulations, construction of the Proposed Project would not result in discharges that would cause: (1) pollution which would alter the quality of the waters of the State (i.e., Ballona Creek) to a degree which unreasonably affects beneficial uses of the waters; (2) contamination of the quality of the waters of the State by waste to a degree which creates a hazard to the public health through poisoning or through the spread of diseases; or (3) nuisance that would be injurious to health; affect an entire community or neighborhood, or any considerable number of persons; and occurs during or as a result of the treatment or disposal of wastes. Furthermore, construction of the Proposed Project would not result in discharges that would cause regulatory standards to be violated in Ballona Creek. Therefore, construction-related short term impacts on surface water quality would be less than significant.

5.2 Operation

The Project will increase the amount of pervious landscaped area by nearly an acre. Thus, the impervious area of the Project Site will decrease slightly from approximately 94% to approximately 93% after implementation of this Project. Utilizing the natural adsorption and filtration characteristics of vegetated swales and pervious surfaces, the quality of stormwater runoff from the Project Site will be marginally improved.

In addition, BMPs will be implemented to address pollutants of concern and comply with post construction stormwater management regulations. Refer to Table 1 for anticipated and potential pollutants generated by on-site land uses that are similar to the Proposed Project.

Table 1
Anticipated and Potential Pollutants Generated by On-site Land Uses

	Pathogens	Metals	Nutrients	Pesticides	Organic Compounds	Sediments	Trash & Debris	Oxygen Demanding Substances	Oil and Grease
Commercial/Industrial Development	P		P	P	P	P	A	P	A
Restaurants	A						A	A	A
Parking Lots		A	P	P		P	A	P	A
Streets, Highways, Freeways		A	P		A	A	A	P	A

Note: A = Anticipated and P = Potential

With the implementation of the source control and treatment BMPs described in Table 2, which would be included as part of the SUSMP requirements to reduce the quantity and improve the quality of rainfall runoff that leaves the site, the Proposed Project would reduce or eliminate the discharge of potential pollutants from stormwater runoff to the maximum extent practicable.

Table 2
Efficiency of Treatment Control BMPs and by Target Pollutants [a]

	Sediments	Nutrients	Trash	Metals	Bacteria	Oil/Grease	Organics
Vegetated Swale	Medium	Low	Low	Medium	Low	Medium	Medium
Vegetated Buffer Strip	High	Low	Medium	High	Low	High	Medium
Vortex/Hydrodynamic System [b]	Medium	Low	Unknown	Low	Unknown	Unknown	Unknown
Catch Basins System [b]	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Infiltration/Retention	High	High	High	High	High	High	High
Media Filtration	High	Low	High	High	Medium	High	High

[a] *Low, Medium, and High are used to indicate how efficient a particular type of BMP is at reducing pollutants.*
[b] *Performance of system varies per manufacturer and model.*

In addition, the implementation of the LID BMPs (Refer to Exhibit 5), intended to promote the use of natural infiltration systems, evapotranspiration, and the reuse of stormwater, the Proposed Project would reduce or eliminate the discharge of potential pollutants from stormwater runoff to the maximum extent practicable.

Therefore, operation of the Proposed Project would not result in discharges that would cause: (1) pollution which would alter the quality of the waters of the State (i.e., Ballona Creek) to a degree which unreasonably affects beneficial uses of the waters; (2) contamination of the quality of the waters of the State by waste to a degree which creates a hazard to the public health through poisoning or through the spread of diseases; or (3) nuisance that would be injurious to health; affect an entire community or neighborhood, or any considerable number of persons; and occurs during or as a result of the treatment or disposal of wastes. Furthermore, operation of the Proposed Project would not result in discharges that would cause regulatory standards to be violated in Ballona Creek.

The Proposed Project will implement BMPs for managing stormwater runoff in accordance with current SUSMP and LID requirements. Since the existing onsite BMPs for managing stormwater runoff are consistent with typical projects developed prior to implementation of current practices, stormwater run-off from the Proposed Project will be will result in improved surface water quality.

In addition, the existing site footprint is approximately 94% covered by impervious surfaces including buildings such as the South and West Halls of the Convention Center, STAPLES Center, as well as impervious pavements for pedestrian and vehicular circulation. The Project will decrease the percentage of impervious surfaces slightly through the installation of additional landscaped areas (the Proposed Project includes approximately 4,317 square feet of landscape areas associated with the Event Center Plaza, approximately 69,485 square feet of landscape areas for the Gil Lindsay Plaza, and approximately 40,656 square feet of landscape areas along L A LIVE Way). As a result, the Proposed Project will be covered by approximately 93% impervious surfaces. The additional landscape areas provided by the Project will allow for more opportunities to direct stormwater to flow through the planting media where pollutants are filtered, absorbed, and biodegraded by the soil and plants, prior to infiltrating to the ground below.

As a result of the implementation of SWPPP, SUSMP, and LID BMPs by the Project and the decrease in impervious surfaces, operational impacts on surface water quality would be less than significant.

5.3 Cumulative Impacts

The geographic context for the cumulative impact analysis on surface water quality is the Ballona Creek watershed. Like the Proposed Project, forecasted growth in the Ballona Creek watershed would be subject to NPDES requirements regarding water quality for both construction and operation.

In addition, since the Project Site is located in an already highly urbanized area, future land use changes or development are not likely to cause substantial changes in regional surface water quality.

Furthermore, it is anticipated that the Project and other future development projects would also be subject to SUSMP and LID requirements and implementation of measures to comply with total maximum daily loads. In addition, increases in regional controls associated with other elements of the MS4 Permit would improve regional water quality over time. Therefore, with compliance with all applicable laws, rules and regulations, cumulative impacts to surface water quality would be less than significant.

6.0 LEVEL OF SIGNIFICANCE

Based on the analysis contained in this report no significant impacts on surface water quality have been identified for the Proposed Project.

REFERENCES

Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties, Regional Water Quality Control Board – Los Angeles; accessed online on October 21, 2011 at http://www.swrcb.ca.gov/rwqcb4/water_issues/ programs/basin_plan/electronics_documents/bp1_introduction.pdf.

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City of Los Angles. LA. CEQA Thresholds Guides. 2006 <http://www.ci.la.ca.us/ead/programs/Thresholds/G-Water%20Resources.pdf>

City of Los Angeles. "Low Impact Development Best Management Practices Handbook." June, 2011

City of Los Angeles Stormwater Program, Proposition O, website - http://www.lapropo.org/index.htm; accessed October 21, 2011.

City of Los Angeles Stormwater Program website, http://www.lastormwater.org/siteorg/businesses/susmp/ industrial.htm; http://www.lastormwater.org/siteorg/businesses/susmp/housing.htm; accessed October 21, 2011

City of Los Angeles Stormwater Program, What's New, website - http://www.lastormwater.org/siteorg/ events/PropO/121307.htm; accessed October 21, 2011.

Los Angeles County Department of Public Works. LACDPW: Ballona Creek Watershed. 5 July 2011 <http://ladpw.org/wmd/watershed/bc/>.

Los Angeles Regional Water Quality Control Board. LARWQCB Basin Plan <http://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/> accessed October 21, 2011.

State Water Resources Control Board. State Water Resources Control Board. July 2011 <http://www.swrcb.ca.gov/water_issues/programs/npdes/>.

USEPA. U.S. Environmental Protection Agency - Clean Water Act. July 2011 <http://www.epa.gov/lawsregs/laws/cwa.html>.

USEPA. U.S. Environmental Protection Agency - NPDES. July 2011 <http://cfpub.epa.gov/npdes/>.

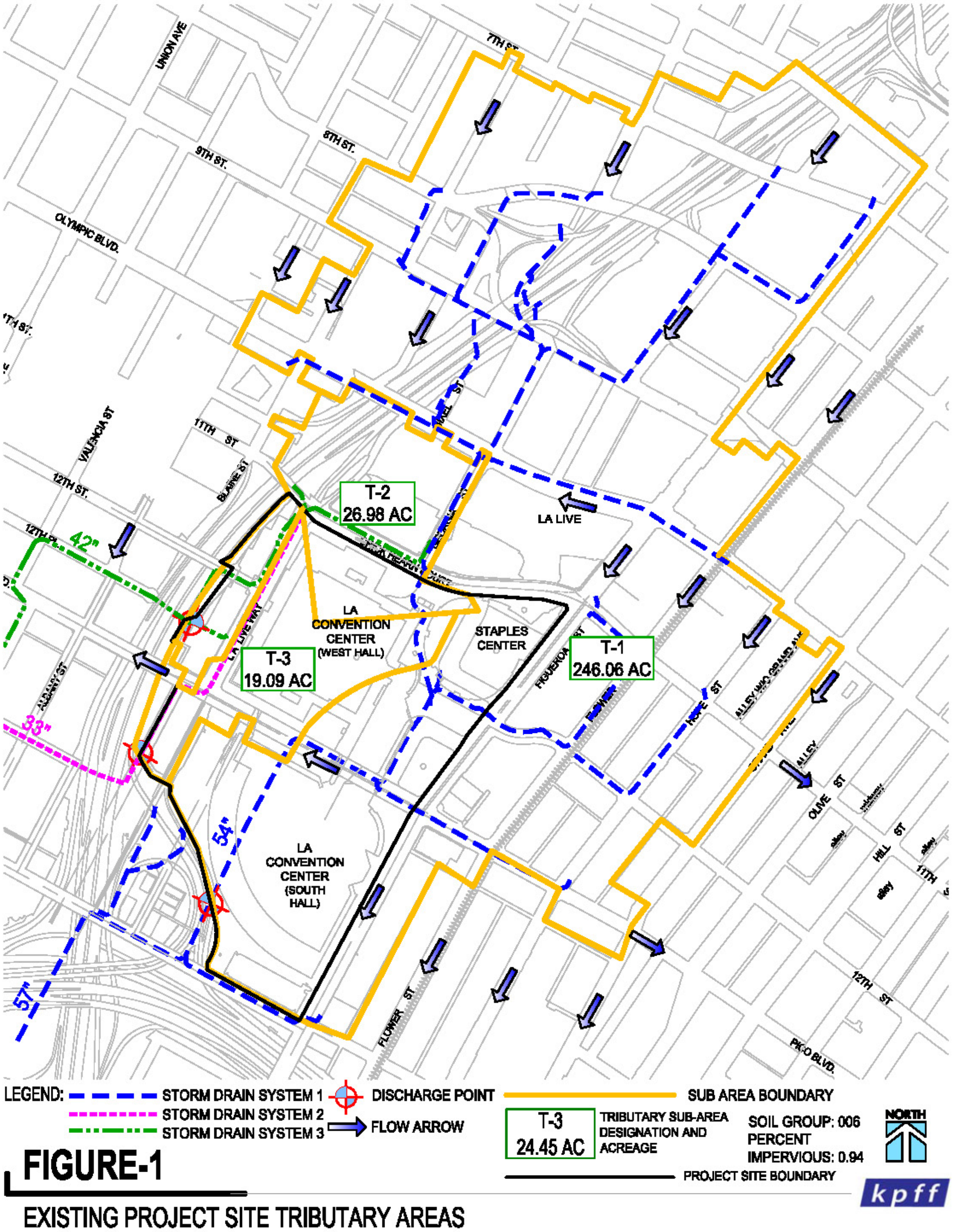

FIGURE-1

EXISTING PROJECT SITE TRIBUTARY AREAS

Exhibit 1

Typical Post-Construction BMPs

Stormwater Management Goal	Description	Suggested BMPs
Peak Storm Water Runoff Discharge Rates	Reduce Post-development peak storm water runoff discharge rates to prevent downstream erosion.	Detention or Retention Systems such as Infiltration, Capture and Reuse, or Biofiltration.
Conserve Natural Areas	Maximize trees and other vegetation by planting additional vegetation, clustering trees areas, and promoting the use of native and/or drought tolerant plants.	Proposed landscaped areas and planters to reduce the footprint of impervious areas.
Minimize Storm Water Pollutants of Concern	Stormwater runoff from a site has the potential to contribute oils, greases, solids, pesticides, etc. to the storm drain system. New developments shall be designed in order to minimize the introduction of pollutants of concern which could result in impacts to the storm drain system. Pollutants of concern consist of any pollutants that exhibit one or more of the following characteristics: current loadings or historic deposits of the pollutant are impacting the beneficial use of a receiving water body, elevated levels of the pollutant are found in sediments of a receiving water body, or the inputs of the pollutant are at concentrations considered potentially toxic to humans and/or animals.	▪ Infiltration ▪ Capture and Reuse ▪ Biofiltration ▪ Structural Treatment BMPs
Protect Slopes and Channels	Project must implement BMPs in accordance with local codes and ordinance. Ways to decrease the potential for erosion in slopes or channels are: The Project Contractor will be required to implement a SWPPP at the time of construction indicating all BMPs that will be used to prevent erosion and runoff of any silt and debris off –site that could potentially impact storm drain conveyance systems.	▪ Convey runoff safely from tops of slopes and stabilize disturbed slopes ▪ Reduce flow to natural drainage systems to the maximum extent practicable ▪ Vegetate slopes with native or drought tolerant vegetation ▪ Install energy dissipaters including riprap at the outlets to new storm drains, culverts, conduits, or channels.

Provide Storm Drain System Stenciling and Signage	Project plans must include BMPs consistent with local codes and ordinances and the SUSMP to decrease potential for slopes and/or channels to erode and impact storm water runoff. The Project Contractor is responsible for protecting all catch basin and storm drain inlets within the site area during construction.	▪ Storm drain inlets and catch basins must be stenciled with “NO DUMPING – DRAINS TO OCEAN” ▪ Signs and/or graphical icons prohibiting legal dumping must be posted publicly along channels and creeks within the project area. ▪ Stencils and signs must be legible
Properly Design Outdoor Material Storage Areas	Outdoor material storage areas are facilities used for storage of materials. Improper storage of materials outdoors can cause pollutants to enter the storm drain system.	▪ Materials that can potentially contaminate storm water must be (1) placed in an enclosure, (2) protected by containment structures including berms, dikes, or curbs ▪ Storage area must be paved to prevent any leaks and spills ▪ Storage area must have a roof to minimize amount of storm water runoff
Provide Proof of Ongoing BMP Maintenance	Improper maintenance of BMP devices can lead to failure of the system or maintenance problems. It is important to consider who will perform the BMP maintenance as well as what equipment is required to maintain the BMP. Project applicant is required to provide verification of maintenance provisions through such means as may be appropriate, including, but not limited to legal agreements, covenants, CEQA mitigation, and/or Conditional Use Permits.	If Structural or Treatment control BMPs are located within a public area proposed for transfer, they will be the responsibility of the developer until they are accepted for transfer by the County or other public agency. Structural or Treatment Control BMPs must meet design standards adopted by the public agency for the BMP installed and shall be approved by the public reviewing agency prior to installation.

<table>
<tr>
<td>Design Standards for Structural or Treatment Control BMPs</td>
<td>Structural or Treatment control BMPs selected for use at any of the planning development categories shall meet the design standards of the SUSMP manual unless specifically exempted. Post-construction Structural or Treatment Control BMPs shall be designed to mitigate (infiltrate or treat) storm water runoff from either:
▪ Volumetric treatment control BMP
▪ Flow based treatment control BMP

And control peak flow discharge rates to provide stream channel and over bank flood protection, based on design standards enforced by the local agency.</td>
<td>Storm water treatment facilities and systems shall be designed to meet the requirements of the SUSMP manual.

Volumetric Treatment Control BMPs shall be designed to capture the volume of runoff from a 0.75-inch storm event, prior to discharging to the public storm drain system.

Flow based Treatment Control BMPs shall be designed to the same standards as the volume-based control BMPs. The flow of runoff produced from the storm event shall be equal to or at least 0.2 inches per hour.

Treatment devices shall be sized and designed to meet the above requirements outlined in the SUSMP manual. The Project engineer will be responsible for selecting a BMP for the project based on a hydrology study of the area.</td>
</tr>
</table>

Exhibit 2

Construction General Permit
(SWRCB Order No. 2009-0009-DWQ)

Linda S. Adams
Secretary for Environmental Protection

State Water Resources Control Board

Division of Water Quality
1001 I Street • Sacramento, California 95814 • (916) 341-5455
Mailing Address: P.O. Box 100 • Sacramento, California • 95812-0100
Fax (916) 341-5463 • http://www.waterboards.ca.gov

Arnold Schwarzenegger
Governor

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES)
GENERAL PERMIT FOR
STORM WATER DISCHARGES
ASSOCIATED WITH CONSTRUCTION AND LAND DISTURBANCE
ACTIVITIES

ORDER NO. 2009-0009-DWQ
NPDES NO**. CAS000002**

This Order was adopted by the State Water Resources Control Board on:	**September 2, 2009**
This Order shall become effective on:	**July 1, 2010**
This Order shall expire on:	**September 2, 2014**

IT IS HEREBY ORDERED, that this Order supersedes Order No. 99-08-DWQ [as amended by Order No. 2010-0014-DWQ] except for enforcement purposes. The Discharger shall comply with the requirements in this Order to meet the provisions contained in Division 7 of the California Water Code (commencing with section 13000) and regulations adopted thereunder, and the provisions of the federal Clean Water Act and regulations and guidelines adopted thereunder.

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this Order with all attachments is a full, true, and correct copy of an Order adopted by the State Water Resources Control Board, on September 2, 2009.

AYE: Vice Chair Frances Spivy-Weber
Board Member Arthur G. Baggett, Jr.
Board Member Tam M. Doduc

NAY: Chairman Charles R. Hoppin

ABSENT: None

ABSTAIN: None

Jeanine Townsend

Jeanine Townsend
Clerk to the Board

Linda S. Adams
Secretary for Environmental Protection

State Water Resources Control Board

Arnold Schwarzenegger
Governor

Division of Water Quality
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NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) GENERAL PERMIT FOR STORM WATER DISCHARGES ASSOCIATED WITH CONSTRUCTION AND LAND DISTURBANCE ACTIVITIES

ORDER NO. 2010-0014-DWQ
NPDES NO. CAS000002

Order No. 2009-0009-DWQ was adopted by the State Water Resources Control Board on:	**September 2, 2009**
Order No. 2009-0009-DWQ became effective on:	**July 1, 2010**
Order No. 2009-0009-DWQ shall expire on:	**September 2, 2014**
This Order, which amends Order No. 2009-0009-DWQ, was adopted by the State Water Resources Control Board on:	**November 16, 2010**
This Order shall become effective on:	**February 14, 2011**

IT IS HEREBY ORDERED that this Order amends Order No. 2009-0009-DWQ. Additions to Order No. 2009-0009-DWQ are reflected in blue-underline text and deletions are reflected in red-strikeout text.

IT IS FURTHER ORDERED that staff are directed to prepare and post a conformed copy of Order No. 2009-0009-DWQ incorporating the revisions made by this Order.

I, Jeanine Townsend, Clerk to the Board, do hereby certify that this Order with all attachments is a full, true, and correct copy of an Order adopted by the State Water Resources Control Board, on **November 16, 2010.**

AYE: Chairman Charles R. Hoppin
Vice Chair Frances Spivy-Weber
Board Member Arthur G. Baggett, Jr.
Board Member Tam M. Doduc

NAY: None

ABSENT: None

ABSTAIN: None

Jeanine Townsend

Jeanine Townsend
Clerk to the Board

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LIST OF APPENDICES

STATE WATER RESOURCES CONTROL BOARD
ORDER NO. 2009-0009-DWQ
[AS AMENDED BY ORDER NO. 2010-0014-DWQ]
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM
GENERAL PERMIT NO. CAS000002

WASTE DISCHARGE REQUIREMENTS
FOR
DISCHARGES OF STORM WATER RUNOFF ASSOCIATED WITH CONSTRUCTION AND LAND DISTURBANCE ACTIVITIES

I. FINDINGS

A. General Findings

The State Water Resources Control Board (State Water Board) finds that:

1. The federal Clean Water Act (CWA) prohibits certain discharges of storm water containing pollutants except in compliance with a National Pollutant Discharge Elimination System (NPDES) permit (Title 33 United States Code (U.S.C.) §§ 1311 and 1342(p); also referred to as Clean Water Act (CWA) §§ 301 and 402(p)). The U.S. Environmental Protection Agency (U.S. EPA) promulgates federal regulations to implement the CWA's mandate to control pollutants in storm water runoff discharges. (Title 40 Code of Federal Regulations (C.F.R.) Parts 122, 123, and 124). The federal statutes and regulations require discharges to surface waters comprised of storm water associated with construction activity, including demolition, clearing, grading, and excavation, and other land disturbance activities (except operations that result in disturbance of less than one acre of total land area and which are not part of a larger common plan of development or sale), to obtain coverage under an NPDES permit. The NPDES permit must require implementation of Best Available Technology Economically Achievable (BAT) and Best Conventional Pollutant Control Technology (BCT) to reduce or eliminate pollutants in storm water runoff. The NPDES permit must also include additional requirements necessary to implement applicable water quality standards.

2. This General Permit authorizes discharges of storm water associated with construction activity so long as the dischargers comply with all requirements, provisions, limitations and prohibitions in the permit. In addition, this General Permit regulates the discharges of storm water associated with construction activities from all Linear

Underground/Overhead Projects resulting in the disturbance of greater than or equal to one acre (Attachment A).

3. This General Permit regulates discharges of pollutants in storm water associated with construction activity (storm water discharges) to waters of the United States from construction sites that disturb one or more acres of land surface, or that are part of a common plan of development or sale that disturbs more than one acre of land surface.

4. This General Permit does not preempt or supersede the authority of local storm water management agencies to prohibit, restrict, or control storm water discharges to municipal separate storm sewer systems or other watercourses within their jurisdictions.

5. This action to adopt a general NPDES permit is exempt from the provisions of Chapter 3 of the California Environmental Quality Act (CEQA) (Public Resources Code Section 21100, et seq.), pursuant to Section 13389 of the California Water Code.

6. Pursuant to 40 C.F.R. § 131.12 and State Water Board Resolution No. 68-16,[1] which incorporates the requirements of § 131.12 where applicable, the State Water Board finds that discharges in compliance with this General Permit will not result in the lowering of water quality standards, and are therefore consistent with those provisions. Compliance with this General Permit will result in improvements in water quality.

7. This General Permit serves as an NPDES permit in compliance with CWA § 402 and will take effect on July 1, 2010 by the State Water Board provided the Regional Administrator of the U.S. EPA has no objection. If the U.S. EPA Regional Administrator objects to its issuance, the General Permit will not become effective until such objection is withdrawn.

8. Following adoption and upon the effective date of this General Permit, the Regional Water Quality Control Boards (Regional Water Boards) shall enforce the provisions herein.

9. Regional Water Boards establish water quality standards in Basin Plans. The State Water Board establishes water quality standards in various statewide plans, including the California Ocean Plan. U.S. EPA establishes water quality standards in the National Toxic Rule (NTR) and the California Toxic Rule (CTR).

[1] Resolution No. 68-16 generally requires that existing water quality be maintained unless degradation is justified based on specific findings.

10. This General Permit does not authorize discharges of fill or dredged material regulated by the U.S. Army Corps of Engineers under CWA § 404 and does not constitute a waiver of water quality certification under CWA § 401.

11. The primary storm water pollutant at construction sites is excess sediment. Excess sediment can cloud the water, which reduces the amount of sunlight reaching aquatic plants, clog fish gills, smother aquatic habitat and spawning areas, and impede navigation in our waterways. Sediment also transports other pollutants such as nutrients, metals, and oils and greases.

12. Construction activities can impact a construction site's runoff sediment supply and transport characteristics. These modifications, which can occur both during and after the construction phase, are a significant cause of degradation of the beneficial uses established for water bodies in California. Dischargers can avoid these effects through better construction site design and activity practices.

13. This General Permit recognizes four distinct phases of construction activities. The phases are Grading and Land Development Phase, Streets and Utilities Phase, Vertical Construction Phase, and Final Landscaping and Site Stabilization Phase. Each phase has activities that can result in different water quality effects from different water quality pollutants. This General Permit also recognizes inactive construction as a category of construction site type.

14. Compliance with any specific limits or requirements contained in this General Permit does not constitute compliance with any other applicable requirements.

15. Following public notice in accordance with State and Federal laws and regulations, the State Water Board heard and considered all comments and testimony in a public hearing on 06/03/2009. The State Water Board has prepared written responses to all significant comments.

16. Construction activities obtaining coverage under the General Permit may have multiple discharges subject to requirements that are specific to general, linear, and/or active treatment system discharge types.

17. The State Water Board may reopen the permit if the U.S. EPA adopts a final effluent limitation guideline for construction activities.

B. Activities Covered Under the General Permit

18. Any construction or demolition activity, including, but not limited to, clearing, grading, grubbing, or excavation, or any other activity that results in a land disturbance of equal to or greater than one acre.

19. Construction activity that results in land surface disturbances of less than one acre if the construction activity is part of a larger common plan of development or the sale of one or more acres of disturbed land surface.

20. Construction activity related to residential, commercial, or industrial development on lands currently used for agriculture including, but not limited to, the construction of buildings related to agriculture that are considered industrial pursuant to U.S. EPA regulations, such as dairy barns or food processing facilities.

21. Construction activity associated with Linear Underground/Overhead Utility Projects (LUPs) including, but not limited to, those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment and associated ancillary facilities) and include, but are not limited to, underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/or pavement repair or replacement, and stockpile/borrow locations.

22. Discharges of sediment from construction activities associated with oil and gas exploration, production, processing, or treatment operations or transmission facilities.[2]

23. Storm water discharges from dredge spoil placement that occur outside of U.S. Army Corps of Engineers jurisdiction (upland sites) and that disturb one or more acres of land surface from construction activity are covered by this General Permit. Construction sites that intend to disturb one or more acres of land within the jurisdictional boundaries of

[2] Pursuant to the Ninth Circuit Court of Appeals' decision in *NRDC v. EPA* (9th Cir. 2008) 526 F.3d 591, and subsequent denial of the U.S. EPA's petition for reconsideration in November 2008, oil and gas construction activities discharging storm water contaminated only with sediment are no longer exempt from the NPDES program.

a CWA § 404 permit should contact the appropriate Regional Water Board to determine whether this permit applies to the site.

C. Activities Not Covered Under the General Permit

24. Routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of the facility.

25. Disturbances to land surfaces solely related to agricultural operations such as disking, harrowing, terracing and leveling, and soil preparation.

26. Discharges of storm water from areas on tribal lands; construction on tribal lands is regulated by a federal permit.

27. Construction activity and land disturbance involving discharges of storm water within the Lake Tahoe Hydrologic Unit. The Lahontan Regional Water Board has adopted its own permit to regulate storm water discharges from construction activity in the Lake Tahoe Hydrologic Unit (Regional Water Board 6SLT). Owners of construction sites in this watershed must apply for the Lahontan Regional Water Board permit rather than the statewide Construction General Permit.

28. Construction activity that disturbs less than one acre of land surface, and that is not part of a larger common plan of development or the sale of one or more acres of disturbed land surface.

29. Construction activity covered by an individual NPDES Permit for storm water discharges.

30. Discharges from small (1 to 5 acre) construction activities with an approved Rainfall Erosivity Waiver authorized by U.S. EPA Phase II regulations certifying to the State Board that small construction activity will occur only when the Rainfall Erosivity Factor is less than 5 (“R” in the Revised Universal Soil Loss Equation).

31. Landfill construction activity that is subject to the Industrial General Permit.

32. Construction activity that discharges to Combined Sewer Systems.

33. Conveyances that discharge storm water runoff combined with municipal sewage.

34. Discharges of storm water identified in CWA § 402(*l*)(2), 33 U.S.C. § 1342(*l*)(2).

35. Discharges occurring in basins that are not tributary or hydrologically connected to waters of the United States (for more information contact your Regional Water Board).

D. Obtaining and Modifying General Permit Coverage

36. This General Permit requires all dischargers to electronically file all Permit Registration Documents (PRDs), Notices of Termination (NOT), changes of information, annual reporting, and other compliance documents required by this General Permit through the State Water Board's Storm water Multi-Application and Report Tracking System (SMARTS) website.

37. Any information provided to the Regional Water Board shall comply with the Homeland Security Act and any other federal law that concerns security in the United States; any information that does not comply should not be submitted.

38. This General Permit grants an exception from the Risk Determination requirements for existing sites covered under Water Quality Orders No. 99-08-DWQ, and No. 2003-0007-DWQ. For certain sites, adding additional requirements may not be cost effective. Construction sites covered under Water Quality Order No. 99-08-DWQ shall obtain permit coverage at the Risk Level 1. LUPs covered under Water Quality Order No. 2003-0007-DWQ shall obtain permit coverage as a Type 1 LUP. The Regional Water Boards have the authority to require Risk Determination to be performed on sites currently covered under Water Quality Orders No. 99-08-DWQ and No. 2003-0007-DWQ where they deem it necessary. The State Water Board finds that there are two circumstances when it may be appropriate for the Regional Water Boards to require a discharger that had filed an NOI under State Water Board Order No. 99-08-DWQ to recalculate the site's risk level. These circumstances are: (1) when the discharger has a demonstrated history of noncompliance with State Water Board Order No. 99-08-DWQ or; (2) when the discharger's site poses a significant risk of causing or contributing to an exceedance of a water quality standard without the implementation of the additional Risk Level 2 or 3 requirements.

E. Prohibitions

39. All discharges are prohibited except for the storm water and non-storm water discharges specifically authorized by this General Permit or another NPDES permit. Non-storm water discharges include a wide variety of sources, including improper dumping, spills, or leakage from storage tanks or transfer areas. Non-storm water discharges may

contribute significant pollutant loads to receiving waters. Measures to control spills, leakage, and dumping, and to prevent illicit connections during construction must be addressed through structural as well as non-structural Best Management Practices (BMPs)[3]. The State Water Board recognizes, however, that certain non-storm water discharges may be necessary for the completion of construction.

40. This General Permit prohibits all discharges which contain a hazardous substance in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

41. This General Permit incorporates discharge prohibitions contained in water quality control plans, as implemented by the State Water Board and the nine Regional Water Boards.

42. Pursuant to the Ocean Plan, discharges to Areas of Special Biological Significance (ASBS) are prohibited unless covered by an exception that the State Water Board has approved.

43. This General Permit prohibits the discharge of any debris[4] from construction sites. Plastic and other trash materials can cause negative impacts to receiving water beneficial uses. The State Water Board encourages the use of more environmentally safe, biodegradable materials on construction sites to minimize the potential risk to water quality.

F. Training

44. In order to improve compliance with and to maintain consistent enforcement of this General Permit, all dischargers are required to appoint two positions - the Qualified SWPPP Developer (QSD) and the Qualified SWPPP Practitioner (QSP) - who must obtain appropriate training. Together with the key stakeholders, the State and Regional Water Boards are leading the development of this curriculum through a collaborative organization called The Construction General Permit (CGP) Training Team.

45. The Professional Engineers Act (Bus. & Prof. Code section 6700, et seq.) requires that all engineering work must be performed by a California licensed engineer.

[3] BMPs are scheduling of activities, prohibitions of practices, maintenance procedures, and other management practices to prevent or reduce the discharge of pollutants to waters of the United States. BMPs also include treatment requirements, operating procedures, and practice to control site runoff, spillage or leaks, sludge or waste disposal, or drainage from raw material storage.

[4] Litter, rubble, discarded refuse, and remains of destroyed inorganic anthropogenic waste.

G. Determining and Reducing Risk

46. The risk of accelerated erosion and sedimentation from wind and water depends on a number of factors, including proximity to receiving water bodies, climate, topography, and soil type.

47. This General Permit requires dischargers to assess the risk level of a site based on both sediment transport and receiving water risk. This General Permit contains requirements for Risk Levels 1, 2 and 3, and LUP Risk Type 1, 2, and 3 (Attachment A). Risk levels are established by determining two factors: first, calculating the site's sediment risk; and second, receiving water risk during periods of soil exposure (i.e. grading and site stabilization). Both factors are used to determine the site-specific Risk Level(s). LUPs can be determined to be Type 1 based on the flowchart in Attachment A.1.

48. Although this General Permit does not mandate specific setback distances, dischargers are encouraged to set back their construction activities from streams and wetlands whenever feasible to reduce the risk of impacting water quality (e.g., natural stream stability and habitat function). Because there is a reduced risk to receiving waters when setbacks are used, this General Permit gives credit to setbacks in the risk determination and post-construction storm water performance standards. The risk calculation and runoff reduction mechanisms in this General Permit are expected to facilitate compliance with any Regional Water Board and local agency setback requirements, and to encourage voluntary setbacks wherever practicable.

49. Rain events can occur at any time of the year in California. Therefore, a Rain Event Action Plan (REAP) is necessary for Risk Level 2 and 3 traditional construction projects (LUPs exempt) to ensure that active construction sites have adequate erosion and sediment controls implemented prior to the onset of a storm event, even if construction is planned only during the dry season.

50. Soil particles smaller than 0.02 millimeters (mm) (i.e., finer than medium silt) do not settle easily using conventional measures for sediment control (i.e., sediment basins). Given their long settling time, dislodging these soils results in a significant risk that fine particles will be released into surface waters and cause unacceptable downstream impacts. If operated correctly, an Active Treatment System (ATS[5]) can prevent or reduce the release of fine particles from construction sites.

[5] An ATS is a treatment system that employs chemical coagulation, chemical flocculation, or electro coagulation in order to reduce turbidity caused by fine suspended sediment.

Use of an ATS can effectively reduce a site's risk of impacting receiving waters.

51. Dischargers located in a watershed area where a Total Maximum Daily Load (TMDL) has been adopted or approved by the Regional Water Board or U.S. EPA may be required by a separate Regional Water Board action to implement additional BMPs, conduct additional monitoring activities, and/or comply with an applicable waste load allocation and implementation schedule. Such dischargers may also be required to obtain an individual Regional Water Board permit specific to the area.

H. Effluent Standards

52. The State Water Board convened a blue ribbon panel of storm water experts that submitted a report entitled, “The Feasibility of Numeric Effluent Limits Applicable to Discharges of Storm Water Associated with Municipal, Industrial and Construction Activities,” dated June 19, 2006. The panel concluded that numeric limits or action levels are technically feasible to control construction storm water discharges, provided that certain conditions are considered. The panel also concluded that numeric effluent limitations (NELs) are feasible for discharges from construction sites that utilize an ATS. The State Water Board has incorporated the expert panel’s suggestions into this General Permit, which includes both numeric action levels (NALs) and NELs for pH and turbidity, and special numeric limits for ATS discharges.

Numeric Effluent Limitations

53. Discharges of storm water from construction activities may become contaminated from alkaline construction materials resulting in high pH (greater than pH 7). Alkaline construction materials include, but are not limited to, hydrated lime, concrete, mortar, cement kiln dust (CKD), Portland cement treated base (CTB), fly ash, recycled concrete, and masonry work. This General Permit includes an NEL for pH (6.0-9.0) that applies only at sites that exhibit a "high risk of high pH discharge." A "high risk of high pH discharge" can occur during the complete utilities phase, the complete vertical build phase, and any portion of any phase where significant amounts of materials are placed directly on the land at the site in a manner that could result in significant alterations to the background pH of any discharges.

54. For Risk Level 3 discharges, this General Permit establishes technology-based, numeric effluent limitations (NELs) for turbidity of 500 NTU. Exceedances of the turbidity NEL constitutes a violation of this General Permit.

55. This General Permit establishes a 5 year, 24 hour (expressed in inches of rainfall) Compliance Storm Event exemption from the technology-based NELs for Risk Level 3 dischargers.

Determining Compliance with Numeric Limitations

56. This General Permit sets a pH NAL of 6.5 to 8.5, and a turbidity NAL of 250 NTU. The purpose of the NAL and its associated monitoring requirement is to provide operational information regarding the performance of the measures used at the site to minimize the discharge of pollutants and to protect beneficial uses and receiving waters from the adverse effects of construction-related storm water discharges. The NALs in this General Permit for pH and turbidity are not directly enforceable and do not constitute NELs.

57. This General Permit requires dischargers with NAL exceedances to immediately implement additional BMPs and revise their Storm Water Pollution Prevention Plans (SWPPPs) accordingly to either prevent pollutants and authorized non-storm water discharges from contaminating storm water, or to substantially reduce the pollutants to levels consistently below the NALs. NAL exceedances are reported in the State Water Boards SMARTS system, and the discharger is required to provide an NAL Exceedance Report when requested by a Regional Water Board.

58. If run-on is caused by a forest fire or any other natural disaster, then NELs do not apply.

59. Exceedances of the NELs are a violation of this Permit. This General Permit requires dischargers with NEL exceedances to implement additional monitoring, BMPs, and revise their SWPPPs accordingly. Dischargers are required to notify the State and Regional Water Boards of the violation through the State Water Boards SMARTs system, and provide an NEL Violation Report sharing additional information concerning the NEL exceedance.

I. Receiving Water Limitations

60. This General Permit requires all enrolled dischargers to determine the receiving waters potentially affected by their discharges and to comply with all applicable water quality standards, including any more stringent standards applicable to a water body.

J. Sampling, Monitoring, Reporting and Record Keeping

61. Visual monitoring of storm water and non-storm water discharges is required for all sites subject to this General Permit.

62. Records of all visual monitoring inspections are required to remain on-site during the construction period and for a minimum of three years.

63. For all Risk Level 3 and Risk Level 2 sites, this General Permit requires effluent monitoring for pH and turbidity. Sampling, analysis and monitoring requirements for effluent monitoring for pH and turbidity are contained in this General Permit.

64. Risk Level 3 sites in violation of the Numeric Effluent Limitations contained in this General Permit and with direct discharges to receiving water are required to conduct receiving water monitoring.

65. For Risk Level 3 sites larger than 30 acres and with direct discharges to receiving waters, this General Permit requires bioassessment sampling before and after site completion to determine if significant degradation to the receiving water's biota has occurred. Bioassessment sampling guidelines are contained in this General Permit.

66. A summary and evaluation of the sampling and analysis results will be submitted in the Annual Reports.

67. This General Permit contains sampling, analysis and monitoring requirements for non-visible pollutants at all sites subject to this General Permit.

68. Compliance with the General Permit relies upon dischargers to electronically self-report any discharge violations and to comply with any Regional Water Board enforcement actions.

69. This General Permit requires that all dischargers maintain a paper or electronic copy of all required records for three years from the date generated or date submitted, whichever is last. These records must be available at the construction site until construction is completed. For LUPs, these documents may be retained in a crew member's vehicle and made available upon request.

K. Active Treatment System (ATS) Requirements

70. Active treatment systems add chemicals to facilitate flocculation, coagulation and filtration of suspended sediment particles. The uncontrolled release of these chemicals to the environment can negatively affect the beneficial uses of receiving waters and/or degrade water quality (e.g., acute and chronic toxicity). Additionally, the batch storage and treatment of storm water through an ATS' can potentially

cause physical impacts on receiving waters if storage volume is inadequate or due to sudden releases of the ATS batches and improperly designed outfalls.

71. If designed, operated and maintained properly an ATS can achieve very high removal rates of suspended sediment (measured as turbidity), albeit at sometimes significantly higher costs than traditional erosion/sediment control practices. As a result, this General Permit establishes NELs consistent with the expected level of typical ATS performance.

72. This General Permit requires discharges of storm water associated with construction activity that undergo active treatment to comply with special operational and effluent limitations to ensure that these discharges do not adversely affect the beneficial uses of the receiving waters or cause degradation of their water quality.

73. For ATS discharges, this General Permit establishes technology-based NELs for turbidity.

74. This General Permit establishes a 10 year, 24 hour (expressed in inches of rainfall) Compliance Storm Event exemption from the technology-based numeric effluent limitations for ATS discharges. Exceedances of the ATS turbidity NEL constitutes a violation of this General Permit.

L. Post-Construction Requirements

75. This General Permit includes performance standards for post-construction that are consistent with State Water Board Resolution No. 2005-0006, "Resolution Adopting the Concept of Sustainability as a Core Value for State Water Board Programs and Directing Its Incorporation," and 2008-0030, "Requiring Sustainable Water Resources Management." The requirement for all construction sites to match pre-project hydrology will help ensure that the physical and biological integrity of aquatic ecosystems are sustained. This "runoff reduction" approach is analogous in principle to Low Impact Development (LID) and will serve to protect related watersheds and waterbodies from both hydrologic-based and pollution impacts associated with the post-construction landscape.

76. LUP projects are not subject to post-construction requirements due to the nature of their construction to return project sites to pre-construction conditions.

M. Storm Water Pollution Prevention Plan Requirements

77. This General Permit requires the development of a site-specific SWPPP. The SWPPP must include the information needed to demonstrate compliance with all requirements of this General Permit, and must be kept on the construction site and be available for review. The discharger shall ensure that a QSD develops the SWPPP.

78. To ensure proper site oversight, this General Permit requires a Qualified SWPPP Practitioner to oversee implementation of the BMPs required to comply with this General Permit.

N. Regional Water Board Authorities

79. Regional Water Boards are responsible for implementation and enforcement of this General Permit. A general approach to permitting is not always suitable for every construction site and environmental circumstances. Therefore, this General Permit recognizes that Regional Water Boards must have some flexibility and authority to alter, approve, exempt, or rescind permit authority granted under this General Permit in order to protect the beneficial uses of our receiving waters and prevent degradation of water quality.

IT IS HEREBY ORDERED that all dischargers subject to this General Permit shall comply with the following conditions and requirements (including all conditions and requirements as set forth in Attachments A, B, C, D, E and F)[6]:

II. CONDITIONS FOR PERMIT COVERAGE

A. Linear Underground/Overhead Projects (LUPs)

1. Linear Underground/Overhead Projects (LUPs) include, but are not limited to, any conveyance, pipe, or pipeline for the transportation of any gaseous, liquid (including water and wastewater for domestic municipal services), liquescent, or slurry substance; any cable line or wire for the transmission of electrical energy; any cable line or wire for communications (e.g. telephone, telegraph, radio or television messages); and associated ancillary facilities. Construction activities associated with LUPs include, but are not limited to, (a) those activities necessary for the installation of underground and overhead linear facilities (e.g., conduits, substructures, pipelines, towers, poles, cables, wires, connectors, switching, regulating and transforming equipment, and associated ancillary facilities); and include, but are not limited to, (b) underground utility mark-out, potholing, concrete and asphalt cutting and removal, trenching, excavation, boring and drilling, access road and pole/tower pad and cable/wire pull station, substation construction, substructure installation, construction of tower footings and/or foundations, pole and tower installations, pipeline installations, welding, concrete and/ or pavement repair or replacement, and stockpile/borrow locations.

2. The Legally Responsible Person is responsible for obtaining coverage under the General Permit where the construction of pipelines, utility lines, fiber-optic cables, or other linear underground/overhead projects will occur across several properties unless the LUP construction activities are covered under another construction storm water permit.

3. Only LUPs shall comply with the conditions and requirements in Attachment A, A.1 & A.2 of this Order. The balance of this Order is not applicable to LUPs except as indicated in Attachment A.

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[6] These attachments are part of the General Permit itself and are not separate documents that are capable of being updated independently by the State Water Board.

B. Obtaining Permit Coverage Traditional Construction Sites

1. The Legally Responsible Person (LRP) (see Special Provisions, Electronic Signature and Certification Requirements, Section IV.I.1) must obtain coverage under this General Permit.

2. To obtain coverage, the LRP must electronically file Permit Registration Documents (PRDs) prior to the commencement of construction activity. Failure to obtain coverage under this General Permit for storm water discharges to waters of the United States is a violation of the CWA and the California Water Code.

3. PRDs shall consist of:

   a. Notice of Intent (NOI)
   b. Risk Assessment (Section VIII)
   c. Site Map
   d. Storm Water Pollution Prevention Plan (Section XIV)
   e. Annual Fee
   f. Signed Certification Statement

   Any information provided to the Regional Water Board shall comply with the Homeland Security Act and any other federal law that concerns security in the United States; any information that does not comply should not be submitted.

   Attachment B contains additional PRD information. Dischargers must electronically file the PRDs, and mail the appropriate annual fee to the State Water Board.

4. This permit is effective on July 1, 2010.

   a. **Dischargers Obtaining Coverage On or After July 1, 2010:** All dischargers requiring coverage on or after July 1, 2010, shall electronically file their PRDs prior to the commencement of construction activities, and mail the appropriate annual fee no later than seven days prior to the commencement of construction activities. Permit coverage shall not commence until the PRDs and the annual fee are received by the State Water Board, and a WDID number is assigned and sent by SMARTS.

   b. **Dischargers Covered Under 99-08-DWQ and 2003-0007-DWQ:** Existing dischargers subject to State Water Board Order No. 99-08-DWQ (existing dischargers) will continue coverage under 99-08-DWQ until July 1, 2010. After July 1, 2010, all NOIs subject to State Water Board Order No. 99-08-DWQ will be terminated.

Existing dischargers shall electronically file their PRDs no later than July 1, 2010. If an existing discharger's site acreage subject to the annual fee has changed, it shall mail a revised annual fee no less than seven days after receiving the revised annual fee notification, **or else lose permit coverage**. All existing dischargers shall be exempt from the risk determination requirements in Section VIII of this General Permit until two years after permit adoption. All existing dischargers are therefore subject to Risk Level 1 requirements regardless of their site's sediment and receiving water risks. However, a Regional Board retains the authority to require an existing discharger to comply with the Section VIII risk determination requirements.

5. The discharger is only considered covered by this General Permit upon receipt of a Waste Discharger Identification (WDID) number assigned and sent by the State Water Board Storm water Multi-Application and Report Tracking System (SMARTS). In order to demonstrate compliance with this General Permit, the discharger must obtain a WDID number and must present documentation of a valid WDID upon demand.

6. During the period this permit is subject to review by the U.S. EPA, the prior permit (State Water Board Order No. 99-08-DWQ) remains in effect. Existing dischargers under the prior permit will continue to have coverage under State Water Board Order No. 99-08-DWQ until this General Permit takes effect on July 1, 2010. Dischargers who complete their projects and electronically file an NOT prior to July 1, 2010, are not required to obtain coverage under this General Permit.

7. Small Construction Rainfall Erosivity Waiver

   EPA's Small Construction Erosivity Waiver applies to sites between one and five acres demonstrating that there are no adverse water quality impacts.

   Dischargers eligible for a Rainfall Erosivity Waiver based on low erosivity potential shall complete the electronic Notice of Intent (NOI) and Sediment Risk form through the State Water Board's SMARTS system, certifying that the construction activity will take place during a period when the value of the rainfall erosivity factor is less than five. Where the LRP changes or another LRP is added during construction, the new LRP must also submit a waiver certification through the SMARTS system.

   If a small construction site continues beyond the projected completion date given on the waiver certification, the LRP shall recalculate the rainfall erosivity factor for the new project duration and submit this information through the SMARTS system. If the new R factor is below five (5), the discharger shall update through SMARTS all applicable information on the waiver certification and retain a copy of the revised waiver onsite. The LRP shall submit the new waiver certification 30 days prior to the projected completion date listed on the original waiver form to assure exemption from permitting requirements is uninterrupted. If the new R factor is five (5) or above, the LRP shall be required to apply for coverage under this Order.

8. In the case of a public emergency that requires immediate construction activities, a discharger shall submit a brief description of the emergency construction activity within five days of the onset of construction, and then shall submit all PRDs within thirty days.

C. Revising Permit Coverage for Change of Acreage or New Ownership

1. The discharger may reduce or increase the total acreage covered under this General Permit when a portion of the site is complete and/or conditions for termination of coverage have been met (See Section II.D Conditions for Termination of Coverage); when ownership of a portion of the site is sold to a different entity; or when new acreage, subject to this General Permit, is added to the site.

2. Within 30 days of a reduction or increase in total disturbed acreage, the discharger shall electronically file revisions to the PRDs that include:

    a. A revised NOI indicating the new project size;

    b. A revised site map showing the acreage of the site completed, acreage currently under construction, acreage sold/transferred or added, and acreage currently stabilized in accordance with the Conditions for Termination of Coverage in Section II.D below.

    c. SWPPP revisions, as appropriate; and

    d. Certification that any new landowners have been notified of applicable requirements to obtain General Permit coverage. The certification shall include the name, address, telephone number, and e-mail address of the new landowner.

    e. If the project acreage has increased, dischargers shall mail payment of revised annual fees within 14 days of receiving the revised annual fee notification.

3. The discharger shall continue coverage under the General Permit for any parcel that has not achieved "Final Stabilization" as defined in Section II.D.

4. When an LRP with active General Permit coverage transfers its LRP status to another person or entity that qualifies as an LRP, the existing LRP shall inform the new LRP of the General Permit's requirements. In order for the new LRP to continue the construction activity on its parcel of property, the new LRP, or the new LRP's approved signatory, must submit PRDs in accordance with this General Permit's requirements.

D. Conditions for Termination of Coverage

1. Within 90 days of when construction is complete or ownership has been transferred, the discharger shall electronically file a Notice of Termination (NOT), a final site map, and photos through the State Water Boards SMARTS system. Filing a NOT certifies that all General Permit requirements have been met. The Regional Water Board will consider a construction site complete only when all portions of the site have been transferred to a new owner, or all of the following conditions have been met:

    a. For purposes of "final stabilization," the site will not pose any additional sediment discharge risk than it did prior to the commencement of construction activity;

    b. There is no potential for construction-related storm water pollutants to be discharged into site runoff;

    c. Final stabilization has been reached;

    d. Construction materials and wastes have been disposed of properly;

    e. Compliance with the Post-Construction Standards in Section XIII of this General Permit has been demonstrated;

    f. Post-construction storm water management measures have been installed and a long-term maintenance plan[7] has been established; and

    g. All construction-related equipment, materials and any temporary BMPs no longer needed are removed from the site.

[7] For the purposes of this requirement a long-term maintenance plan will be designed for a minimum of five years, and will describe the procedures to ensure that the post-construction storm water management measures are adequately maintained.

2. The discharger shall certify that final stabilization conditions are satisfied in their NOT. Failure to certify shall result in continuation of permit coverage and annual billing.

3. The NOT must demonstrate through photos, RUSLE or RUSLE2, or results of testing and analysis that the site meets all of the conditions above (Section II.D.1) and the final stabilization condition (Section II.D.1.a) is attained by one of the following methods:

   a. “70% final cover method,” no computational proof required

      OR:

   b. “RUSLE or RUSLE2 method,” computational proof required

      OR:

   c. “Custom method”, the discharger shall demonstrate in some other manner than a or b, above, that the site complies with the “final stabilization” requirement in Section II.D.1.a.

III. DISCHARGE PROHIBITIONS

A. Dischargers shall not violate any discharge prohibitions contained in applicable Basin Plans or statewide water quality control plans. Waste discharges to Areas of Special Biological Significance (ASBS) are prohibited by the California Ocean Plan, unless granted an exception issued by the State Water Board.

B. All discharges are prohibited except for the storm water and non-storm water discharges specifically authorized by this General Permit or another NPDES permit.

C. Authorized non-storm water discharges may include those from de-chlorinated potable water sources such as: fire hydrant flushing, irrigation of vegetative erosion control measures, pipe flushing and testing, water to control dust, uncontaminated ground water from dewatering, and other discharges not subject to a separate general NPDES permit adopted by a Regional Water Board. The discharge of non-storm water is authorized under the following conditions:

1. The discharge does not cause or contribute to a violation of any water quality standard;

2. The discharge does not violate any other provision of this General Permit;

3. The discharge is not prohibited by the applicable Basin Plan;

4. The discharger has included and implemented specific BMPs required by this General Permit to prevent or reduce the contact of the non-storm water discharge with construction materials or equipment.

5. The discharge does not contain toxic constituents in toxic amounts or (other) significant quantities of pollutants;

6. The discharge is monitored and meets the applicable NALs and NELs; and

7. The discharger reports the sampling information in the Annual Report.

If any of the above conditions are not satisfied, the discharge is not authorized by this General Permit. The discharger shall notify the Regional Water Board of any anticipated non-storm water discharges not already authorized by this General Permit or another NPDES permit, to determine whether a separate NPDES permit is necessary.

D. Debris resulting from construction activities are prohibited from being discharged from construction sites.

E. When soil contamination is found or suspected and a responsible party is not identified, or the responsible party fails to promptly take the appropriate action, the discharger shall have those soils sampled and tested to ensure proper handling and public safety measures are implemented. The discharger shall notify the appropriate local, State, and federal agency(ies) when contaminated soil is found at a construction site, and will notify the appropriate Regional Water Board.

IV. SPECIAL PROVISIONS

A. Duty to Comply

1. The discharger shall comply with all of the conditions of this General Permit. Any permit noncompliance constitutes a violation of the Clean Water Act (CWA) and the Porter-Cologne Water Quality Control Act and is grounds for enforcement action and/or removal from General Permit coverage.

2. The discharger shall comply with effluent standards or prohibitions established under Section 307(a) of the CWA for toxic pollutants within the time provided in the regulations that establish these standards or prohibitions, even if this General Permit has not yet been modified to incorporate the requirement.

B. General Permit Actions

1. This General Permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the discharger for a General Permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance does not annul any General Permit condition.

2. If any toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is promulgated under Section 307(a) of the CWA for a toxic pollutant which is present in the discharge and that standard or prohibition is more stringent than any limitation on the pollutant in this General Permit, this General Permit shall be modified or revoked and reissued to conform to the toxic effluent standard or prohibition and the dischargers so notified.

C. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for a discharger in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this General Permit.

D. Duty to Mitigate

The discharger shall take all responsible steps to minimize or prevent any discharge in violation of this General Permit, which has a reasonable likelihood of adversely affecting human health or the environment.

E. Proper Operation and Maintenance

The discharger shall at all times properly operate and maintain any facilities and systems of treatment and control (and related appurtenances) which are installed or used by the discharger to achieve compliance with the conditions of this General Permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. Proper operation and maintenance may require the operation of backup or auxiliary facilities or similar systems installed by a discharger when necessary to achieve compliance with the conditions of this General Permit.

F. Property Rights

This General Permit does not convey any property rights of any sort or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor does it authorize any infringement of Federal, State, or local laws or regulations.

G. Duty to Maintain Records and Provide Information

1. The discharger shall maintain a paper or electronic copy of all required records, including a copy of this General Permit, for three years from the date generated or date submitted, whichever is last. These records shall be available at the construction site until construction is completed.

2. The discharger shall furnish the Regional Water Board, State Water Board, or U.S. EPA, within a reasonable time, any requested information to determine compliance with this General Permit. The discharger shall also furnish, upon request, copies of records that are required to be kept by this General Permit.

H. Inspection and Entry

The discharger shall allow the Regional Water Board, State Water Board, U.S. EPA, and/or, in the case of construction sites which discharge through a municipal separate storm sewer, an authorized representative of the municipal operator of the separate storm sewer system receiving the discharge, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the discharger's premises at reasonable times where a regulated construction activity is being conducted or where records must be kept under the conditions of this General Permit;

2. Access and copy at reasonable times any records that must be kept under the conditions of this General Permit;

3. Inspect at reasonable times the complete construction site, including any off-site staging areas or material storage areas, and the erosion/sediment controls; and

4. Sample or monitor at reasonable times for the purpose of ensuring General Permit compliance.

I. Electronic Signature and Certification Requirements

1. All Permit Registration Documents (PRDs) and Notices of Termination (NOTs) shall be electronically signed, certified, and submitted via SMARTS to the State Water Board. Either the Legally Responsible Person (LRP), as defined in Appendix 5 – Glossary, or a person legally authorized to sign and certify PRDs and NOTs on behalf of the LRP (the LRP's Approved Signatory, as defined in Appendix 5 - Glossary) must submit all information electronically via SMARTS.

2. Changes to Authorization. If an Approved Signatory's authorization is no longer accurate, a new authorization satisfying the requirements of paragraph (a) of this section must be submitted via SMARTS prior to or together with any reports, information or applications to be signed by an Approved Signatory.

3. All Annual Reports, or other information required by the General Permit (other than PRDs and NOTs) or requested by the Regional Water Board, State Water Board, U.S. EPA, or local storm water management agency shall be certified and submitted by the LRP or the LRP's Approved Signatory.

J. Certification

Any person signing documents under Section IV.I above, shall make the following certification:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system or those persons directly responsible for gathering the information, to the best of my knowledge and belief, the information submitted is, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

K. Anticipated Noncompliance

The discharger shall give advance notice to the Regional Water Board and local storm water management agency of any planned changes in the construction activity, which may result in noncompliance with General Permit requirements.

L. Bypass

Bypass[8] is prohibited. The Regional Water Board may take enforcement action against the discharger for bypass unless:

1. Bypass was unavoidable to prevent loss of life, personal injury or severe property damage;[9]

2. There were no feasible alternatives to bypass, such as the use of auxiliary treatment facilities, retention of untreated waste, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass that could occur during normal periods of equipment downtime or preventative maintenance;

3. The discharger submitted a notice at least ten days in advance of the need for a bypass to the Regional Water Board; or

4. The discharger may allow a bypass to occur that does not cause effluent limitations to be exceeded, but only if it is for essential maintenance to assure efficient operation. In such a case, the above bypass conditions are not applicable. The discharger shall submit notice of an unanticipated bypass as required.

M. Upset

1. A discharger that wishes to establish the affirmative defense of an upset[10] in an action brought for noncompliance shall demonstrate,

[8] The intentional diversion of waste streams from any portion of a treatment facility
[9] Severe property damage means substantial physical damage to property, damage to the treatment facilities that causes them to become inoperable, or substantial and permanent loss of natural resources that can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

[10] An exceptional incident in which there is unintentional and temporary noncompliance the technology based numeric effluent limitations because of factors beyond the reasonable control of the discharger. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

through properly signed, contemporaneous operating logs, or other relevant evidence that:

a. An upset occurred and that the discharger can identify the cause(s) of the upset

b. The treatment facility was being properly operated by the time of the upset

c. The discharger submitted notice of the upset as required; and

d. The discharger complied with any remedial measures required

2. No determination made before an action of noncompliance occurs, such as during administrative review of claims that noncompliance was caused by an upset, is final administrative action subject to judicial review.

3. In any enforcement proceeding, the discharger seeking to establish the occurrence of an upset has the burden of proof

N. Penalties for Falsification of Reports

Section 309(c)(4) of the CWA provides that any person who knowingly makes any false material statement, representation, or certification in any record or other document submitted or required to be maintained under this General Permit, including reports of compliance or noncompliance shall upon conviction, be punished by a fine of not more than $10,000 or by imprisonment for not more than two years or by both.

O. Oil and Hazardous Substance Liability

Nothing in this General Permit shall be construed to preclude the institution of any legal action or relieve the discharger from any responsibilities, liabilities, or penalties to which the discharger is or may be subject to under Section 311 of the CWA.

P. Severability

The provisions of this General Permit are severable; and, if any provision of this General Permit or the application of any provision of this General Permit to any circumstance is held invalid, the application of such provision to other circumstances and the remainder of this General Permit shall not be affected thereby.

Q. Reopener Clause

This General Permit may be modified, revoked and reissued, or terminated for cause due to promulgation of amended regulations, receipt of U.S. EPA guidance concerning regulated activities, judicial decision, or in accordance with 40 Code of Federal Regulations (CFR) 122.62, 122.63, 122.64, and 124.5.

R. Penalties for Violations of Permit Conditions

1. Section 309 of the CWA provides significant penalties for any person who violates a permit condition implementing Sections 301, 302, 306, 307, 308, 318, or 405 of the CWA or any permit condition or limitation implementing any such section in a permit issued under Section 402. Any person who violates any permit condition of this General Permit is subject to a civil penalty not to exceed $37,500[11] per calendar day of such violation, as well as any other appropriate sanction provided by Section 309 of the CWA.

2. The Porter-Cologne Water Quality Control Act also provides for civil and criminal penalties, which in some cases are greater than those under the CWA.

S. Transfers

This General Permit is not transferable.

T. Continuation of Expired Permit

This General Permit continues in force and effect until a new General Permit is issued or the SWRCB rescinds this General Permit. Only those dischargers authorized to discharge under the expiring General Permit are covered by the continued General Permit.

[11] May be further adjusted in accordance with the Federal Civil Penalties Inflation Adjustment Act.

V. EFFLUENT STANDARDS

A. Narrative Effluent Limitations

1. Storm water discharges and authorized non-storm water discharges regulated by this General Permit shall not contain a hazardous substance equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4, unless a separate NPDES Permit has been issued to regulate those discharges.

2. Dischargers shall minimize or prevent pollutants in storm water discharges and authorized non-storm water discharges through the use of controls, structures, and management practices that achieve BAT for toxic and non-conventional pollutants and BCT for conventional pollutants.

B. Numeric Effluent Limitations (NELs)

Table 1- Numeric Effluent Limitations, Numeric Action Levels, Test Methods, Detection Limits, and Reporting Units

Parameter	Test Method	Discharge Type	Min. Detection Limit	Units	Numeric Action Level	Numeric Effluent Limitation
pH	Field test with calibrated portable instrument	Risk Level 2	0.2	pH units	lower NAL = 6.5 upper NAL = 8.5	N/A
		Risk Level 3			lower NAL = 6.5 upper NAL = 8.5	lower NEL = 6.0 upper NEL = 9.0
Turbidity	EPA 0180.1 and/or field test with calibrated portable instrument	Risk Level 2	1	NTU	250 NTU	N/A
		Risk Level 3			250 NTU	500 NTU

1. Numeric Effluent Limitations (NELs):

   a. **Storm Event, Daily Average pH Limits –** For Risk Level 3 dischargers, the pH of storm water and non-storm water discharges shall be within the ranges specified in Table 1 during any site phase where there is a "high risk of pH discharge."[12]

b. **Storm Event Daily Average Turbidity Limit –** For Risk Level 3 dischargers, the turbidity of storm water and non-storm water discharges shall not exceed 500 NTU.

2. If daily average sampling results are outside the range of pH NELs (i.e., is below the lower NEL for pH or exceeds the upper NEL for pH) or exceeds the turbidity NEL (as listed in Table 1), the discharger is in violation of this General Permit and shall electronically file monitoring results in violation within 5 business days of obtaining the results.

3. **Compliance Storm Event**:

   Discharges of storm water from Risk Level 3 sites shall comply with applicable NELs (above) unless the storm event causing the discharges is determined after the fact to be equal to or larger than the Compliance Storm Event (expressed in inches of rainfall). The Compliance Storm Event for Risk Level 3 discharges is the 5 year, 24 hour storm (expressed in tenths of an inch of rainfall), as determined by using these maps:

   http://www.wrcc.dri.edu/pcpnfreq/nca5y24.gif
   http://www.wrcc.dri.edu/pcpnfreq/sca5y24.gif

   Compliance storm event verification shall be done by reporting on-site rain gauge readings as well as nearby governmental rain gauge readings.

4. Dischargers shall not be required to comply with NELs if the site receives run-on from a forest fire or any other natural disaster.

C. Numeric Action Levels (NALs)

1. For Risk Level 2 and 3 dischargers, the lower storm event average NAL for pH is 6.5 pH units and the upper storm event average NAL for pH is 8.5 pH units. The discharger shall take actions as described below if the discharge is outside of this range of pH values.

[12] A period of high risk of pH discharge is defined as a project's complete utilities phase, complete vertical build phase, and any portion of any phase where significant amounts of materials are placed directly on the land at the site in a manner that could result in significant alterations of the background pH of the discharges.

2. For Risk Level 2 and 3 dischargers, the NAL storm event daily average for turbidity is 250 NTU. The discharger shall take actions as described below if the discharge is outside of this range of turbidity values.

3. Whenever the results from a storm event daily average indicate that the discharge is below the lower NAL for pH, exceeds the upper NAL for pH, or exceeds the turbidity NAL (as listed in Table 1), the discharger shall conduct a construction site and run-on evaluation to determine whether pollutant source(s) associated with the site's construction activity may have caused or contributed to the NAL exceedance and shall immediately implement corrective actions if they are needed.

4. The site evaluation shall be documented in the SWPPP and specifically address whether the source(s) of the pollutants causing the exceedance of the NAL:

    a. Are related to the construction activities and whether additional BMPs are required to (1) meet BAT/BCT requirements; (2) reduce or prevent pollutants in storm water discharges from causing exceedances of receiving water objectives; and (3) determine what corrective action(s) were taken or will be taken and with a description of the schedule for completion.

    AND/OR:

    b. Are related to the run-on associated with the construction site location and whether additional BMPs measures are required to (1) meet BAT/BCT requirements; (2) reduce or prevent pollutants in storm water discharges from causing exceedances of receiving water objectives; and (3) what corrective action(s) were taken or will be taken with a description of the schedule for completion.

VI. RECEIVING WATER LIMITATIONS

A. The discharger shall ensure that storm water discharges and authorized non-storm water discharges to any surface or ground water will not adversely affect human health or the environment.

B. The discharger shall ensure that storm water discharges and authorized non-storm water discharges will not contain pollutants in quantities that threaten to cause pollution or a public nuisance.

C. The discharger shall ensure that storm water discharges and authorized non-storm water discharges will not contain pollutants that cause or contribute to an exceedance of any applicable water quality objectives or water quality standards (collectively, WQS) contained in a Statewide Water Quality Control Plan, the California Toxics Rule, the National Toxics Rule, or the applicable Regional Water Board's Water Quality Control Plan (Basin Plan).

D. Dischargers located within the watershed of a CWA § 303(d) impaired water body, for which a TMDL has been approved by the U.S. EPA, shall comply with the approved TMDL if it identifies "construction activity" or land disturbance as a source of the pollution.

VII. TRAINING QUALIFICATIONS AND CERTIFICATION REQUIREMENTS

A. General

The discharger shall ensure that all persons responsible for implementing requirements of this General Permit shall be appropriately trained in accordance with this Section. Training should be both formal and informal, occur on an ongoing basis, and should include training offered by recognized governmental agencies or professional organizations. Those responsible for preparing and amending SWPPPs shall comply with the requirements in this Section VII.

The discharger shall provide documentation of all training for persons responsible for implementing the requirements of this General Permit in the Annual Reports.

B. SWPPP Certification Requirements

1. **Qualified SWPPP Developer:** The discharger shall ensure that SWPPPs are written, amended and certified by a Qualified SWPPP Developer (QSD). A QSD shall have one of the following registrations or certifications, and appropriate experience, as required for:

   a. A California registered professional civil engineer;

   b. A California registered professional geologist or engineering geologist;

   c. A California registered landscape architect;

   d. A professional hydrologist registered through the American Institute of Hydrology;

   e. A Certified Professional in Erosion and Sediment Control (CPESC) ™ registered through Enviro Cert International, Inc.;

   f. A Certified Professional in Storm Water Quality (CPSWQ) ™ registered through Enviro Cert International, Inc.;

   g. A professional in erosion and sediment control registered through the National Institute for Certification in Engineering Technologies (NICET); or

Effective two years after the adoption date of this General Permit, a QSD shall have attended a State Water Board-sponsored or approved QSD training course.

2. The discharger shall list the name and telephone number of the currently designated Qualified SWPPP Developer(s) in the SWPPP.

3. **Qualified SWPPP Practitioner:** The discharger shall ensure that all BMPs required by this General Permit are implemented by a Qualified SWPPP Practitioner (QSP). A QSP is a person responsible for non-storm water and storm water visual observations, sampling and analysis. Effective two years from the date of adoption of this General Permit, a QSP shall be either a QSD or have one of the following certifications:

    a. A certified erosion, sediment and storm water inspector registered through Enviro Cert International, Inc.; or

    b. A certified inspector of sediment and erosion control registered through Certified Inspector of Sediment and Erosion Control, Inc.

    Effective two years after the adoption date of this General Permit, a QSP shall have attended a State Water Board-sponsored or approved QSP training course.

4. The LRP shall list in the SWPPP, the name of any Approved Signatory, and provide a copy of the written agreement or other mechanism that provides this authority from the LRP in the SWPPP.

5. The discharger shall include, in the SWPPP, a list of names of all contractors, subcontractors, and individuals who will be directed by the Qualified SWPPP Practitioner. This list shall include telephone numbers and work addresses. Specific areas of responsibility of each subcontractor and emergency contact numbers shall also be included.

6. The discharger shall ensure that the SWPPP and each amendment will be signed by the Qualified SWPPP Developer. The discharger shall include a listing of the date of initial preparation and the date of each amendment in the SWPPP.

VIII. RISK DETERMINATION

The discharger shall calculate the site's sediment risk and receiving water risk during periods of soil exposure (i.e. grading and site stabilization) and use the calculated risks to determine a Risk Level(s) using the methodology in

Appendix 1. For any site that spans two or more planning watersheds,[13] the discharger shall calculate a separate Risk Level for each planning watershed. The discharger shall notify the State Water Board of the site's Risk Level determination(s) and shall include this determination as a part of submitting the PRDs. If a discharger ends up with more than one Risk Level determination, the Regional Water Board may choose to break the project into separate levels of implementation.

IX. RISK LEVEL 1 REQUIREMENTS

Risk Level 1 Dischargers shall comply with the requirements included in Attachment C of this General Permit.

X. RISK LEVEL 2 REQUIREMENTS

Risk Level 2 Dischargers shall comply with the requirements included in Attachment D of this General Permit.

XI. RISK LEVEL 3 REQUIREMENTS

Risk Level 3 Dischargers shall comply with the requirements included in Attachment E of this General Permit.

XII. ACTIVE TREATMENT SYSTEMS (ATS)

Dischargers choosing to implement an ATS on their site shall comply with all of the requirements in Attachment F of this General Permit.

[13] Planning watershed: defined by the Calwater Watershed documents as a watershed that ranges in size from approximately 3,000 to 10,000 acres http://cain.ice.ucdavis.edu/calwater/calwfaq.html, http://gis.ca.gov/catalog/BrowseRecord.epl?id=22175 .

XIII. POST-CONSTRUCTION STANDARDS

A. All dischargers shall comply with the following runoff reduction requirements unless they are located within an area subject to post-construction standards of an active Phase I or II municipal separate storm sewer system (MS4) permit that has an approved Storm Water Management Plan.

1. This provision shall take effect three years from the adoption date of this permit, or later at the discretion of the Executive Officer of the Regional Board.

2. The discharger shall demonstrate compliance with the requirements of this section by submitting with their NOI a map and worksheets in accordance with the instructions in Appendix 2. The discharger shall use non-structural controls unless the discharger demonstrates that non-structural controls are infeasible or that structural controls will produce greater reduction in water quality impacts.

3. The discharger shall, through the use of non-structural and structural measures as described in Appendix 2, replicate the pre-project water balance (for this permit, defined as the volume of rainfall that ends up as runoff) for the smallest storms up to the 85^{th} percentile storm event (or the smallest storm event that generates runoff, whichever is larger). Dischargers shall inform Regional Water Board staff at least 30 days prior to the use of any structural control measure used to comply with this requirement. Volume that cannot be addressed using non-structural practices shall be captured in structural practices and approved by the Regional Water Board. When seeking Regional Board approval for the use of structural practices, dischargers shall document the infeasibility of using non-structural practices on the project site, or document that there will be fewer water quality impacts through the use of structural practices.

4. For sites whose disturbed area exceeds two acres, the discharger shall preserve the pre-construction drainage density (miles of stream length per square mile of drainage area) for all drainage areas within the area serving a first order stream[14] or larger stream and ensure that post-project time of runoff concentration is equal or greater than pre-project time of concentration.

[14] A first order stream is defined as a stream with no tributaries.

B. All dischargers shall implement BMPs to reduce pollutants in storm water discharges that are reasonably foreseeable after all construction phases have been completed at the site (Post-construction BMPs).

XIV. SWPPP REQUIREMENTS

A. The discharger shall ensure that the Storm Water Pollution Prevention Plans (SWPPPs) for all traditional project sites are developed and amended or revised by a QSD. The SWPPP shall be designed to address the following objectives:

1. All pollutants and their sources, including sources of sediment associated with construction, construction site erosion and all other activities associated with construction activity are controlled;

2. Where not otherwise required to be under a Regional Water Board permit, all non-storm water discharges are identified and either eliminated, controlled, or treated;

3. Site BMPs are effective and result in the reduction or elimination of pollutants in storm water discharges and authorized non-storm water discharges from construction activity to the BAT/BCT standard;

4. Calculations and design details as well as BMP controls for site run-on are complete and correct, and

5. Stabilization BMPs installed to reduce or eliminate pollutants after construction are completed.

B. To demonstrate compliance with requirements of this General Permit, the QSD shall include information in the SWPPP that supports the conclusions, selections, use, and maintenance of BMPs.

C. The discharger shall make the SWPPP available at the construction site during working hours while construction is occurring and shall be made available upon request by a State or Municipal inspector. When the original SWPPP is retained by a crewmember in a construction vehicle and is not currently at the construction site, current copies of the BMPs and map/drawing will be left with the field crew and the original SWPPP shall be made available via a request by radio/telephone.

XV. REGIONAL WATER BOARD AUTHORITIES

A. In the case where the Regional Water Board does not agree with the discharger's self-reported risk level (e.g., they determine themselves to be a Level 1 Risk when they are actually a Level 2 Risk site), Regional Water Boards may either direct the discharger to reevaluate the Risk Level(s) for their site or terminate coverage under this General Permit.

B. Regional Water Boards may terminate coverage under this General Permit for dischargers who fail to comply with its requirements or where they determine that an individual NPDES permit is appropriate.

C. Regional Water Boards may require dischargers to submit a Report of Waste Discharge / NPDES permit application for Regional Water Board consideration of individual requirements.

D. Regional Water Boards may require additional Monitoring and Reporting Program Requirements, including sampling and analysis of discharges to sediment-impaired water bodies.

E. Regional Water Boards may require dischargers to retain records for more than the three years required by this General Permit.

XVI. ANNUAL REPORTING REQUIREMENTS

A. All dischargers shall prepare and electronically submit an Annual Report no later than September 1 of each year.

B. The discharger shall certify each Annual Report in accordance with the Special Provisions.

C. The discharger shall retain an electronic or paper copy of each Annual Report for a minimum of three years after the date the annual report is filed.

D. The discharger shall include storm water monitoring information in the Annual Report consisting of:

1. a summary and evaluation of all sampling and analysis results, including copies of laboratory reports;

2. the analytical method(s), method reporting unit(s), and method detection limit(s) of each analytical parameter (analytical results that are less than the method detection limit shall be reported as "less than the method detection limit");

3. a summary of all corrective actions taken during the compliance year;

4. identification of any compliance activities or corrective actions that were not implemented;

5. a summary of all violations of the General Permit;

6. the names of individual(s) who performed the facility inspections, sampling, visual observation (inspections), and/or measurements;

7. the date, place, time of facility inspections, sampling, visual observation (inspections), and/or measurements, including precipitation (rain gauge); and

8. the visual observation and sample collection exception records and reports specified in Attachments C, D, and E.

E. The discharger shall provide training information in the Annual Report consisting of:

1. documentation of all training for individuals responsible for all activities associated with compliance with this General Permit;

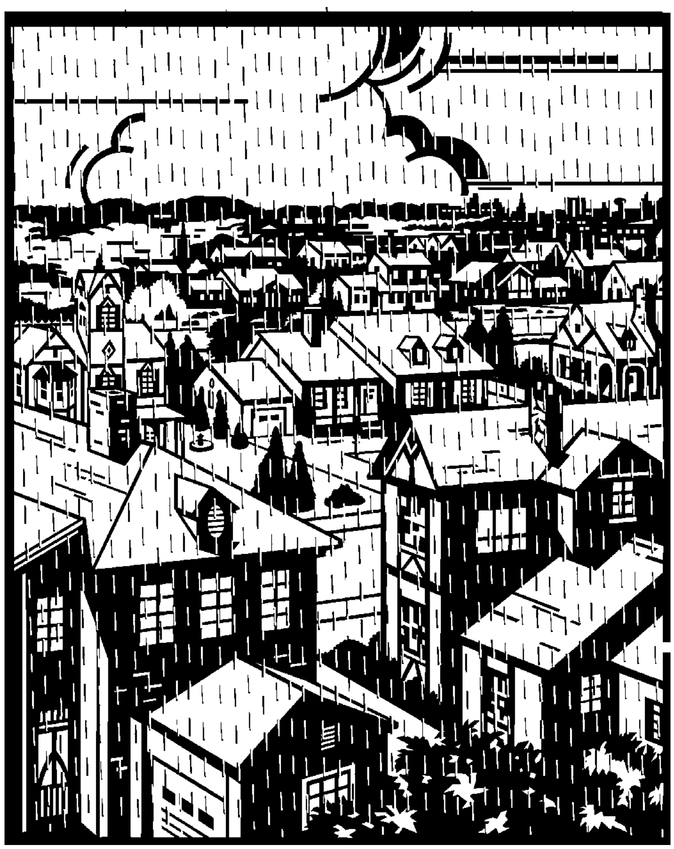
2. documentation of all training for individuals responsible for BMP installation, inspection, maintenance, and repair; and

3. documentation of all training for individuals responsible for overseeing, revising, and amending the SWPPP.

Exhibit 3

Development Planning for Storm Water Management
"SUSMP Manual"

Development Planning for Storm Water Management



September 2002

A Manual for the Standard Urban Storm Water Mitigation Plan (SUSMP)

Los Angeles County Department of Public Works

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SECTION 1 INTRODUCTION

1.1 BACKGROUND

Urban and stormwater runoff is a serious concern, in both the dry and rainy season. Studies have shown that stormwater runoff from urban and industrial areas typically contain the same general types of pollutants that are often found in wastewater from industrial discharges. Pollutants commonly found in stormwater runoff include heavy metals, pesticides, herbicides, fertilizer, animal droppings, trash, food wastes, and synthetic organic compounds such as fuels, waste oils, solvents, lubricants, and grease[1]. Waters that flow over streets, parking lots, construction sites and industrial facilities carry these pollutants through the storm drain network directly to the lakes, streams and beaches of southern California.

These compounds can have damaging effects on both human health and aquatic ecosystems. In addition to pollutants, the high volumes of stormwater discharged from the storm drain system in areas of rapid urbanization have had significant impacts on aquatic ecosystems due to physical modifications such as bank erosion and widening of channels[2].

Water Quality Assessments conducted by the Regional Water Quality Control Board (Regional Board) identified impairment of a number of water bodies in Los Angeles County[3]. The beneficial uses of certain water bodies specifically identified in these assessments are either impaired or threaten to be impaired. Pollutants found causing impairment include: heavy metals, coliform, enteric viruses, pesticides, nutrients, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, organic solvents, sediments, trash, debris, algae, scum, and odor. An epidemiological study conducted during the summer of 1995 for the Santa Monica Bay Restoration Project (SMBRP) demonstrated that there is an increased risk of acute illnesses caused by swimming near flowing storm drain outlets in Santa Monica Bay[4].

The Regional Board therefore considers stormwater and urban runoff discharges to be significant sources of pollutants that may be causing, threatening to cause, or contributing

[1] *Surface Runoff to the Southern California Bight* and, *Characteristics of Effluents from Large Municipal Wastewater Treatment Facilities in 1990 and 1991*, SCCWRP Annual Report 1990-1991 and 1991-1992 (1993); Pitt and Field, *Hazardous and Toxic Wastes Associated with Urban Storm Water Runoff*, In Proceedings of the Sixteenth Annual RREL Hazardous Waste Reduction Symposium, Document No. EPA 600-9-90-037 (1990); *Storm Runoff in Los Angeles and Ventura Counties, Final Report*, California Regional Water Quality Control Board, Los Angeles Region (1988).

[2] *Fundamentals of Urban Storm Water Management*, Terrene Institute and USEPA, (1994); *Guidance Manual for the Preparation of Part 2 of the NPDES Permit Applications for Discharges from Municipal Separate Storm Sewer Systems*, USEPA, Document No. EPA 833-B-92-002 (1992).

[3] *Proposed 1998 List of Impaired Surface Waters*, Regional Water Quality Control Board, Los Angeles Region (1998).

[4] *An Epidemiological Study of Possible Adverse Health Effects of Swimming in Santa Monica Bay*, SMBRP (1996).

to the impairment of the water quality and beneficial uses of the receiving water bodies in Los Angeles County.

Urban runoff is considered to be one of the largest sources of pollution to the waterway and coastal areas of the United States. Locally, we see the impacts in increased health risks to swimmers near storm drains, high concentrations of toxic metals in harbor and ocean sediments, and toxicity to aquatic life. These impacts translate into losses to the County's annual tourism economy, loss of recreational resources, dramatic cost increases for cleaning up contaminated sediments and impaired function and vitality of our natural resources.

In the ongoing effort to improve the quality of stormwater runoff and groundwater within Los Angeles County, the Department of Public Works, in conjunction with other involved stakeholders, has organized a BMP Task Force for the purpose of providing and discussing Best Management Practices (BMP) related matters. The BMP Task Force has developed the website www.BMPLA.org in order to share information about the selection and implementation of effective BMPs.

1.2 LEGAL FRAMEWORK

In 1987, the Federal Water Pollution Control Act (also referred to as the Clean Water Act [CWA]) was amended to provide that the discharge of pollutants to waters of the United States from stormwater is effectively prohibited, unless the discharge is in compliance with a National Pollutant Discharge Elimination System (NPDES) Permit. The 1987 amendments to the CWA added Section 402(p) which established a framework for regulating municipal, industrial and construction stormwater discharges under the NPDES program. In California, these permits are issued through the State Water Resources Control Board (SWRCB) and the nine Regional Water Quality Control Boards.

On December 13, 2001, the Regional Water Quality Control Board, Los Angeles Region (RWQCB), adopted Order No. 01-182. This Order is the NPDES Permit (NPDES No. CAS004001) for municipal stormwater and urban runoff discharges within the County of Los Angeles.

As adopted in December 2001, the requirements of Order No. 01-182 (the “Permit”) covers 84 cities and the unincorporated areas of Los Angeles County, with the exception of the portion of Los Angeles County in the Antelope Valley including the cities of Lancaster and Palmdale, the City of Long Beach, and the City of Avalon. Under the Permit, the Los Angeles County Flood Control District is designated as the Principal Permittee; the County of Los Angeles along with the 84 incorporated cities are designated as Permittees. The

Principal Permittee coordinates and facilitates activities necessary to comply with the requirements of the Permit, but is not responsible for ensuring compliance of any of the Permittees.

In compliance with the Permit, the Permittees have implemented a stormwater quality management program (SQMP) with the ultimate goal of accomplishing the requirements of the Permit and reducing the amount of pollutants in stormwater and urban runoff. The SQMP is broken up into six separate programs as outlined in the Permit. These programs are Public Information and Participation, Industrial/Commercial Facilities, Development Planning, Development Construction, Public Agency Activities, and Illicit Connection/Illicit Discharge. Each Permittee is required by the Permit to have implemented these programs by February 1, 2002.

1.3 STANDARD URBAN STORMWATER MITIGATION PLAN

One specific requirement of the Development Planning Program is the Standard Urban Stormwater Mitigation Plan (SUSMP). This manual serves as a guideline for compliance with this SUSMP. The SUSMP outlines the necessary Best Management Practices (BMPs) which must be incorporated into design plans for the following categories of development and/or redevelopment[5]:

1. Single-family hillside[6] homes (only development of one acre or more of surface area is subject to the SUSMP numerical design criteria requirement);
2. Ten or more unit homes (includes single family homes, multifamily homes, condominiums, and apartments);
3. Automotive service facilities (SIC codes 5013, 5014, 5541, 7532-7534, and 7536-7539);
4. Restaurants (SIC code 5812);
5. 100,000 or more square-feet of impervious surface in industrial/commercial

[5] "Redevelopment" means land-disturbing activity that results in the creation, addition, or replacement of 5,000 square feet or more of impervious surface area on an already developed site. Redevelopment includes, but is not limited to: the expansion of a building footprint; addition or replacement of a structure; replacement of impervious surface area that is not part of a routine maintenance activity; and land disturbing activities related to structural or impervious surfaces. It does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety. Where redevelopment results in an increase of less than fifty percent of the impervious surfaces of a previously existing development, and the existing development was not subject to these SUSMPs, the Design Standards apply only to the addition, and not to the entire development.

[6] "Hillside" means property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is 25% or greater and where grading contemplates cut or fill slopes.

development; [7,8]

6. Retail gasoline outlet;
7. Parking lot 5,000 square feet or more of surface area or with 25 or more parking spaces;
8. Redevelopment projects in subject categories that meet redevelopment thresholds; and
9. Location within or directly adjacent to or discharging directly to an environmentally sensitive area if the discharge is likely to impact a sensitive biological species or habitat and the development creates 2500 square feet or more of impervious surface.

Development and/or redevelopment projects having the following characteristics or activities will be required to address the applicable sections of the above-mentioned SUSMP when completing the project design:

1. vehicle or equipment fueling areas;
2. vehicle or equipment maintenance areas, including washing and repair;
3. commercial or industrial waste handling or storage;
4. outdoor handling or storage of hazardous materials;
5. outdoor manufacturing areas;
6. outdoor food handling or processing;
7. outdoor animal care, confinement, or slaughter; or
8. outdoor horticulture activities.

The following are specific requirements for single-family hillside homes given by the Permit in order to reduce the impact of the development on the natural areas:

1. conserve natural areas;
2. protect slopes and channels;
3. provide storm drain system stenciling and signage;
4. divert roof runoff to vegetated areas before discharging unless the diversion would result in slope instability; and
5. direct surface flow to vegetated areas before discharge unless the diversion would result in slope instability.

[7] 100,000 Square Foot Industrial/Commercial Development means any commercial development that creates at least 100,000 square feet of impermeable area, including parking area. SUSMP and post-construction control requirements shall be implemented for Industrial Commercial Development of one acre (43,560 square feet) no later than March 3, 2003.

[8] Commercial Development means any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, plant nurseries, multi-apartment buildings, car wash facilities, mini-malls, and other business complexes, shopping malls, hotels, office buildings, public warehouses and other light industrial complexes.

Section 2

PERMITTING AND INSPECTION OF SUSMP

SECTION 2 PERMITTING & INSPECTION OF SUSMP

2.1 GENERAL DESCRIPTION OF PERMITTING & INSPECTION OF SUSMP

Any project submitted to the County for review and approval may be subject to the requirements of the NPDES Permit. Development and redevelopment projects submitted for review and approval will be screened to determine if a SUSMP is required.

All development and redevelopment projects falling into either Part A or Part B of the following table, will be required to submit a drainage concept and stormwater quality plan. Details of facilities and measures which mitigate impacts to water quality would then be shown on improvement plans and reviewed as part of those plans.

To assist in the preparation of this plan, a SUSMP has been developed for the eight project types listed in Part A of the following table. This SUSMP outlines the BMPs to be incorporated into the project design. Development and redevelopment projects having characteristics or activities listed in Part B of the table will be required to address the applicable sections of the above-mentioned SUSMP when completing the project design.

Table 2-1
SUSMP Project Types, Characteristics, & Activities

Part A. Type of Proposed Project:
10+ home subdivision
100,000+ square-foot commercial development [1, 2]
Automotive repair shop (SIC codes 5013, 5014, 5541, 7532-7534, and 7536-7539) [3]
Retail gasoline outlet
Restaurant (SIC code 5812) [4]
Hillside-located single-family dwelling [5]
Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces
Redevelopment projects in subject categories that meet redevelopment thresholds [6]
Projects located within or directly adjacent to or discharging directly to an environmentally sensitive area if the discharge is likely to impact a sensitive biological species or habitat and the development creates 2500 square feet or more of impervious surface area.

Table 2-1 (continued) SUSMP Project Types, Characteristics, & Activities
Part B. Project Characteristics or Activities:
Vehicle or equipment fueling areas;
Vehicle or equipment maintenance areas, including washing and repair;
Commercial or industrial waste handling or storage;
Outdoor handling or storage of hazardous materials;
Outdoor manufacturing areas;
Outdoor food handling or processing;
Outdoor animal care, confinement, or slaughter; or
Outdoor horticulture activities.

[1] "100,000 Square Foot Commercial Development" means any commercial development that creates at least 100,000 square feet of impermeable area, including parking areas. SUSMP and post-construction control requirements shall be implemented for Industrial Commercial Development of one acre (43,560 square feet) no later than March 3, 2003.

[2] "Commercial Development" means any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, plant nurseries, multi-apartment buildings, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses and other light industrial complexes.

[3] "Automotive Repair Shop" means a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539.

[4] "Restaurant" means a stand-alone facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption, (SIC code 5812).

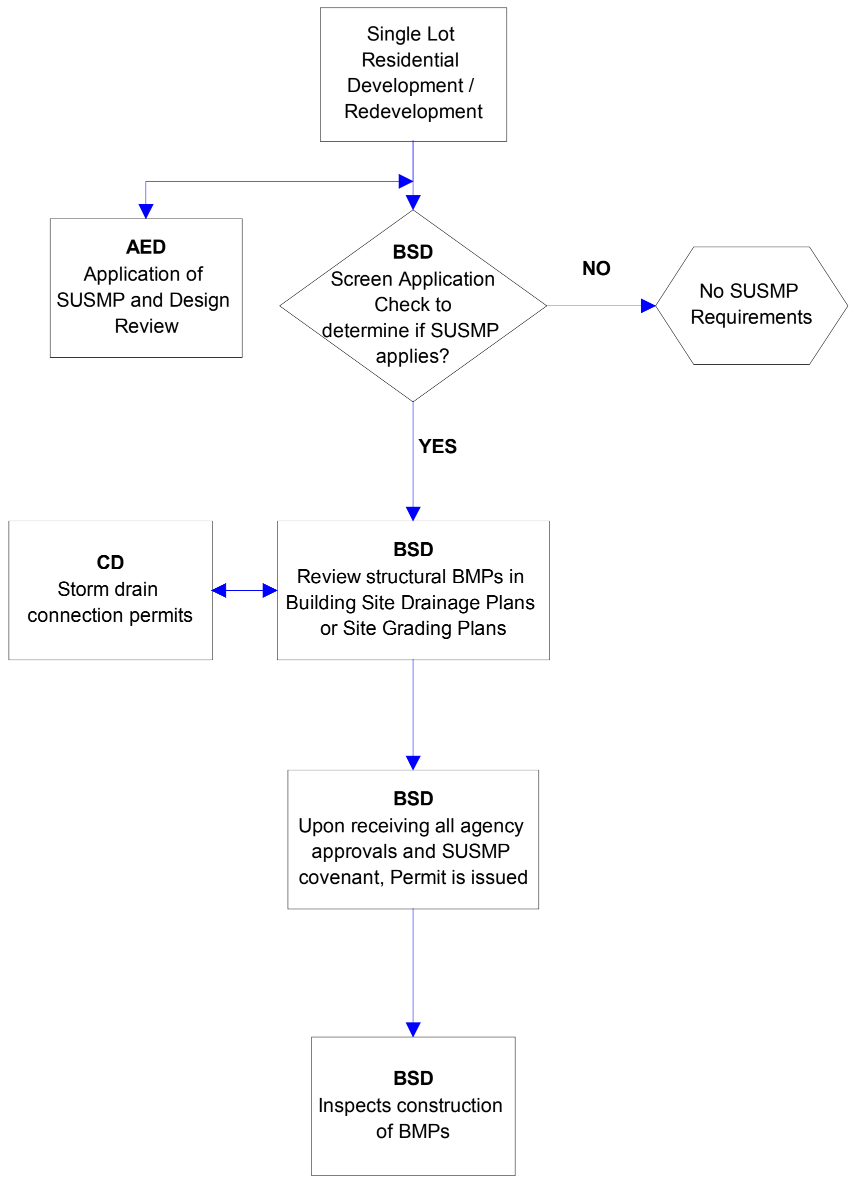
[5] "Hillside" means property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is 25% or greater and where grading contemplates cut or fill slopes. Single-family hillside homes are required to conserve natural areas, protect slopes and channels, provide storm drain system stenciling and signage, divert roof and surface flow runoff to vegetated areas before discharge unless the diversion would result in slope instability.

[6] "Redevelopment" means land-disturbing activity that results in the creation, addition, or replacement of 5,000 square feet or more of impervious surface area on an already developed site. Redevelopment includes, but is not limited to: the expansion of a building footprint; addition or replacement of a structure; replacement of impervious surface area that is not part of a routine maintenance activity; and land disturbing activities related to structural or impervious surfaces. It does not include routine maintenance to maintain

original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety. Where redevelopment results in an increase of less than fifty percent of the impervious surfaces of a previously existing development, and the existing development was not subject to these SUSMPs, the Design Standards apply only to the addition, and not to the entire development.

Please refer to the following flow charts for your specific project permitting and inspection process.

FIGURE 2-1 PERMITTING AND INSPECTION OF SUSMP SINGLE LOT NON-SUBDIVISION RESIDENTIAL DEVELOPMENT / REDEVELOPMENT FLOWCHART



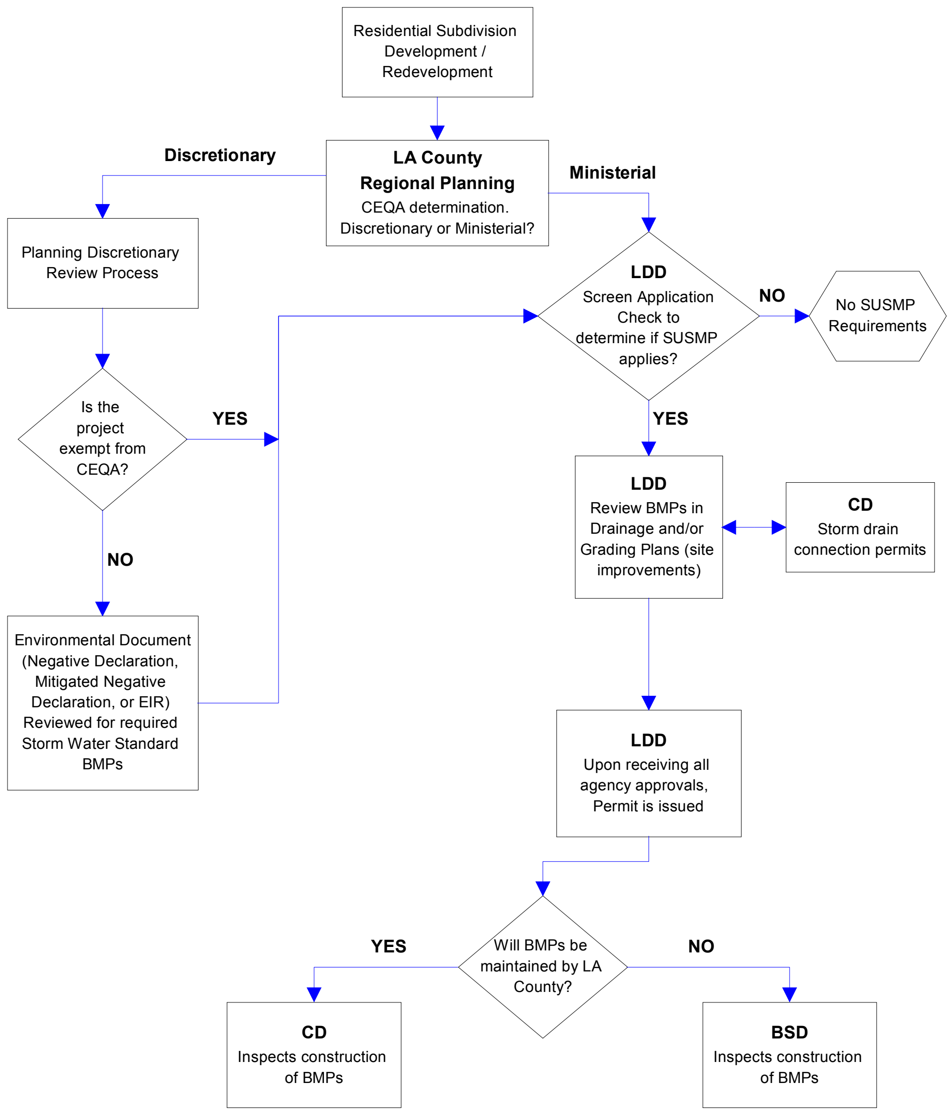
DEFINITIONS

AED- LACDPW Architectural Eng. Division

BSD- LACDPW Building & Safety Division

CD- LACDPW Construction Division

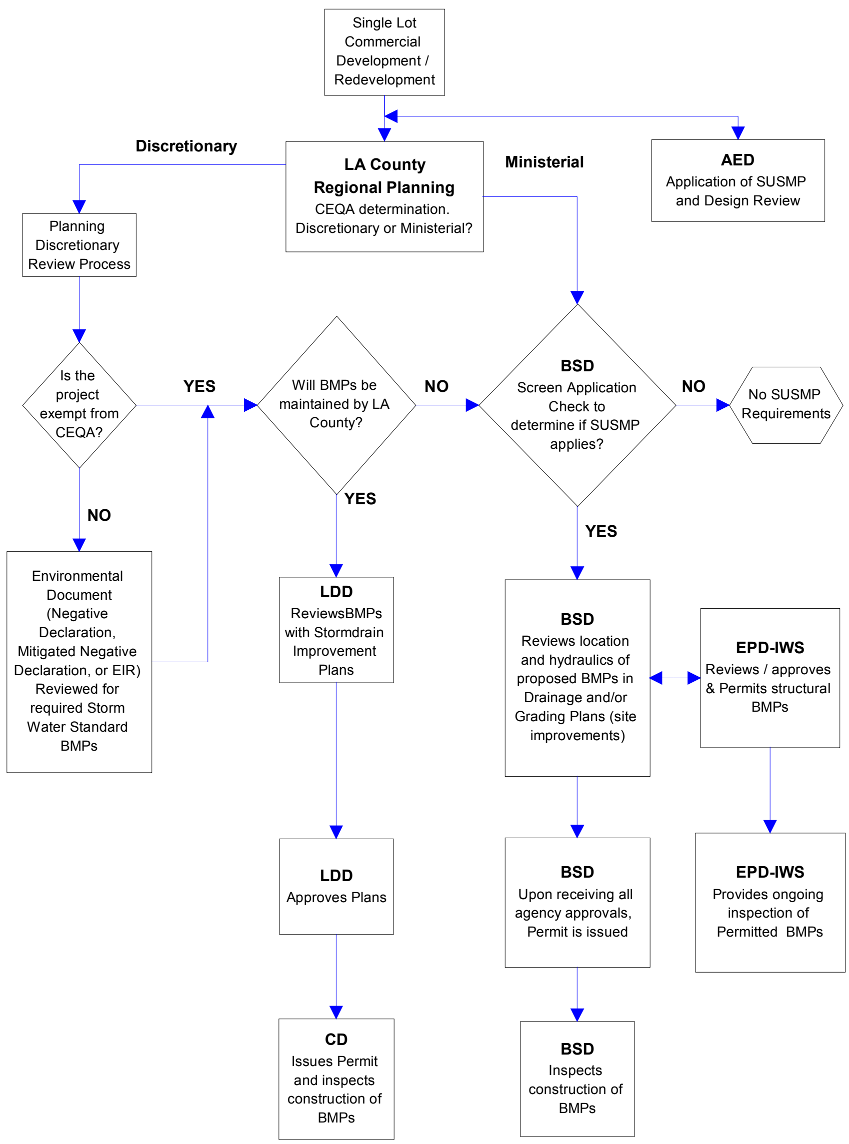
FIGURE 2-2 PERMITTING AND INSPECTION OF SUSMP RESIDENTIAL SUBDIVISION DEVELOPMENT / REDEVELOPMENT FLOWCHART



DEFINITIONS

BSD- LACDPW Building & Safety Division
CD- LACDPW Construction Division
LDD- LACDPW Land Development Division

FIGURE 2-3 PERMITTING AND INSPECTION OF SUSMP NON-SUBDIVISION RELATED COMMERCIAL DEVELOPMENT / REDEVELOPMENT FLOWCHART



DEFINITIONS

AED- LACDPW Architectural Eng. Division
BSD- LACDPW Building & Safety Division
CD- LACDPW Construction Division
LDD- LACDPW Land Development Division
EPD-IWS - LACDPW Environmental Programs Division, Industrial Waste Section

Section 3

STANDARD URBAN STORMWATER MITIGATION PLAN

STANDARD URBAN STORM WATER MITIGATION PLAN

FOR LOS ANGELES COUNTY AND CITIES IN LOS ANGELES COUNTY

LOS ANGELES COUNTY URBAN RUNOFF AND STORM WATER NPDES PERMIT

STANDARD URBAN STORM WATER MITIGATION PLAN

BACKGROUND

The municipal storm water National Pollutant Discharge Elimination System (NPDES) permit (Los Angeles County Permit) issued to Los Angeles County and 85 cities (Permittees) by the Los Angeles Regional Water Quality Control Board (Regional Board) on July 15, 1996, required the development and implementation of a program addressing storm water pollution issues in development planning for private projects. The same requirements are applicable to the City of Long Beach under its separate municipal storm water permit (City of Long Beach MS4 Permit), which was issued on June 30, 1999.

On December 13, 2001, the Regional Board issued a new NPDES Permit to the County of Los Angeles and 84 Permittees. The Program is being updated based on the 2001 Permit.

The requirement to implement a program for development planning is based on, federal and state statutes including: Section 402 (p) of the Clean Water Act, Section 6217 of the Coastal Zone Act Reauthorization Amendments (CZARA) of 1990, and the California Water Code. The Clean Water Act amendments of 1987 established a framework for regulating storm water discharges from municipal, industrial, and construction activities under the NPDES program. The primary objectives of the municipal storm water program requirements are to:

1. Effectively prohibit non-storm water discharges, and
2. Reduce the discharge of pollutants from storm water conveyance systems to the Maximum Extent Practicable (MEP) statutory standard.

The Standard Urban Storm Water Mitigation Plan (SUSMP) was developed as part of the municipal storm water program to address storm water pollution from new Development and Redevelopment by the private sector. This SUSMP contains a list of the minimum required Best Management Practices (BMPs) that must be used for a designated project. Additional BMPs may be required by ordinance or code adopted by the Permittee and applied generally or on a case by case basis. The Permittees are required to adopt the requirements set herein in their own SUSMP. Developers must incorporate appropriate SUSMP requirements into their project plans. Each Permittee will approve the project plan as part of the development plan approval process and prior to issuing building and grading permits for the projects covered by the SUSMP requirements.

All projects that fall into one of nine categories are identified in the 2001 Los Angeles County MS4 Permit as requiring SUSMPs. These categories are:

- Single-family hillside home (only development of one acre or more of surface area is subject to the SUSMP numerical design criteria requirement);
- Ten or more unit homes (including single family homes, multifamily homes, condominiums, and apartments);
- A 100,000 or more square feet of impervious surface area industrial/commercial developments;
- Automotive service facilities (SIC 5013, 5014, 5541, 7532-7534, and 7536-7539);
- Retail gasoline outlets;
- Restaurants (SIC 5812);
- Parking lots 5,000 square feet or more of surface area or with 25 or more parking spaces;
- Redevelopment projects in subject categories that meet Redevelopment thresholds; and
- Location within or directly adjacent to or discharging directly to an environmentally sensitive area.

The City of Long Beach permit requires SUSMP for the following categories only: (i) 10-99 home subdivisions; (ii) 100 or more subdivisions; (iii) 100,000 or more square foot commercial developments; and (iv) Projects located adjacent to or discharging to environmentally sensitive areas. For the remaining five categories, equivalent requirements have been included directly in the City of Long Beach Storm Water Management Plan.

Permittees shall have amended codes and ordinances, if necessary, not later than August 1, 2002, to give legal effect to the SUSMP requirements. The SUSMP requirements for projects identified herein took effect on September 2, 2002.

DEFINITIONS

"100,000 Square Foot Commercial Development" means any commercial development that creates at least 100,000 square feet of impermeable area, including parking areas."Automotive Repair Shop" means a facility that is categorized in any one of the following Standard Industrial Classification (SIC) codes: 5013, 5014, 5541, 7532-7534, or 7536-7539.

"Best Management Practice (BMP)" means methods, measures, or practices designed and selected to reduce or eliminate the discharge of pollutants to surface waters from point and nonpoint source discharge including storm water. BMPs include structural and nonstructural controls, and operation and maintenance procedures, which can be applied before, during, and/or after pollution producing activities.

"Commercial Development" means any development on private land that is not heavy industrial or residential. The category includes, but is not limited to: hospitals, laboratories and other medical facilities, educational institutions, recreational facilities, plant nurseries, multi-apartment buildings, car wash facilities, mini-malls and other business complexes, shopping malls, hotels, office buildings, public warehouses and other light industrial complexes.

“Directly Connected Impervious Area (DCIA)” means the area covered by a building, impermeable pavement, and/ or other impervious surfaces, which drains directly into the storm drain without first flowing across permeable land area (e.g. lawns).

“Environmentally Sensitive Area” means an area “in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which would be easily disturbed or degraded by human activities and developments” (California Public Resources Code § 30107.5). Areas subject to storm water mitigation requirements are: areas designated as Significant Ecological by the County of Los Angeles (Los Angeles County Significant Areas Study, Los Angeles County Department of Regional Planning (1976) and amendments); an area designated as a Significant Natural Area by the California Department of Fish and Game’s Significant Natural Areas Program, provided that area has been field verified by the Department of Fish and Game; an area listed in the Basin Plan as supporting the "Rare, Threatened, or Endangered Species (RARE)" beneficial use; and an area identified by a Permittee as environmentally sensitive.

“Greater than (>) 9 unit home subdivision” means any subdivision being developed for 10 or more 10 single-family or multi-family dwelling units.

“Hillside” means property located in an area with known erosive soil conditions, where the development contemplates grading on any natural slope that is twenty-five percent or greater.

“Infiltration” means the downward entry of water into the surface of the soil.

“New Development” means land disturbing activities; structural development, including construction or installation of a building or structure, creation of impervious surfaces; and land subdivision.

“Parking Lot” means land area or facility for the parking or storage of motor vehicles used for business, commerce, industry, or personal use, with a lot size of 5,000 square feet or more of surface area, or with 25 or more parking spaces.

“Redevelopment” means a) land-disturbing activity that results in the creation, addition, or replacement of 5,000 square feet or more of impervious surface area on an already developed site. Where Redevelopment results in an alteration to more than fifty percent of impervious surfaces of a previously existing development, and the existing development was not subject to post development storm water quality control requirements, the entire project must be mitigated. Where Redevelopmet results in an alteration to less than fifty percent of impervious surfaces of a previously existing development, and the existing development was not subject to post development storm water quality control requirements, only the alteration must be mitigated, and not the entire development. b) Redevelopment does not include routine maintenance to maintain original line and grade, hydraulic capacity, or original purpose of facility, nor does it include emergency construction activities required to immediately protect public health and safety. c) Existing single-family structures are exempt from the Redevelopment requirements.

"Restaurant" means a facility that sells prepared foods and drinks for consumption, including stationary lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption. (SIC code 5812).

"Retail Gasoline Outlet" means any facility engaged in selling gasoline and lubricating oils.

"Source Control BMP" means any schedules of activities, prohibitions of practices, maintenance procedures, managerial practices or operational practices that aim to prevent storm water pollution by reducing the potential for contamination at the source of pollution.

"Storm Event" means a rainfall event that produces more than 0.1 inch of precipitation and that, which is separated from the previous storm event by at least 72 hours of dry weather.

"Structural BMP" means any structural facility designed and constructed to mitigate the adverse impacts of storm water and urban runoff pollution (e.g. canopy, structural enclosure). The category may include both Treatment Control BMPs and Source Control BMPs.

"Treatment" means the application of engineered systems that use physical, chemical, or biological processes to remove pollutants. Such processes include, but are not limited to, filtration, gravity settling, media adsorption, biodegradation, biological uptake, chemical oxidation and UV radiation.

"Treatment Control BMP" means any engineered system designed to remove pollutants by simple gravity settling of particulate pollutants, filtration, biological uptake, media adsorption or any other physical, biological, or chemical process.

CONFLICTS WITH LOCAL PRACTICES

Where provisions of the SUSMP requirements conflict with established local codes, (e.g., specific language of signage used on storm drain stenciling), the Permittee may continue the local practice and modify the SUSMP to be consistent with the code, except that to the extent that the standards in the SUSMP are more stringent than those under local codes, such more stringent standards shall apply.

SUSMP PROVISIONS APPLICABLE TO ALL CATEGORIES

<u>REQUIREMENTS</u>

1. PEAK STORM WATER RUNOFF DISCHARGE RATES

Post-development peak storm water runoff discharge rates shall not exceed the estimated pre-development rate for developments where the increased peak storm water discharge rate will result in increased potential for downstream erosion.

2. CONSERVE NATURAL AREAS

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Concentrate or cluster Development on portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

3. MINIMIZE STORM WATER POLLUTANTS OF CONCERN

Storm water runoff from a site has the potential to contribute oil and grease, suspended solids, metals, gasoline, pesticides, and pathogens to the storm water conveyance system. The development must be designed so as to minimize, to the maximum extent practicable, the introduction of pollutants of concern that may result in significant impacts, generated from site runoff of directly connected impervious areas (DCIA), to the storm water conveyance system as approved by the building official. Pollutants of concern, consist of any pollutants that exhibit one or more of the following characteristics: current loadings or historic deposits of the pollutant are impacting the beneficial uses of a receiving water, elevated levels of the pollutant are found in sediments of a receiving water and/or have the potential to bioaccumulate in organisms therein, or the detectable inputs of the pollutant are at a concentrations or loads considered potentially toxic to humans and/or flora and fauna.

In meeting this specific requirement, “minimization of the pollutants of concern” will require the incorporation of a BMP or combination of BMPs best suited to maximize the reduction of pollutant loadings in that runoff to the Maximum Extent Practicable. Those BMPs best suited for that purpose are those listed in the *California Storm Water Best Management Practices Handbooks*; *Caltrans Storm Water Quality Handbook: Planning and Design Staff Guide*; *Manual for Storm Water Management in Washington State*; *The Maryland Stormwater Design Manual*; *Florida Development Manual: A Guide to Sound Land and Water Management*; Denver *Urban Storm Drainage Criteria Manual,* *Volume 3 – Best Management Practices* and *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* , USEPA Report No. EPA-840-B-92-002, as "likely to have significant impact" beneficial to water quality for targeted pollutants that are of concern at the site in question. However, it is possible that a combination of BMPs not so designated, may in a particular circumstance, be better suited to maximize the reduction of the pollutants.

Examples of BMPs that can be used for minimizing the introduction of pollutants of concern generated from site runoff are identified in Table 2. Any BMP not specifically approved by the Regional Board in Resolution No. 99-03, "Approving Best Management Practices for Municipal Storm Water and Urban Runoff Programs in Los Angeles County", for development planning may be used if they have been recommended in one of the above references.

4. PROTECT SLOPES AND CHANNELS

Project plans must include BMPs consistent with local codes and ordinances and the SUSMP to decrease the potential of slopes and/or channels from eroding and impacting storm water runoff:

- Convey runoff safely from the tops of slopes and stabilize disturbed slopes.
- Utilize natural drainage systems to the maximum extent practicable
- Control or reduce or eliminate flow to natural drainage systems to the maximum extent practicable
- Stabilize permanent channel crossings.
- Vegetate slopes with native or drought tolerant vegetation.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion, with the approval of all agencies with jurisdiction, e.g., the U.S. Army Corps of Engineers and the California Department of Fish and Game

5. PROVIDE STORM DRAIN SYSTEM STENCILING AND SIGNAGE

Storm drain stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets. The stencil contains a brief statement that prohibits the dumping of improper materials into the storm water conveyance system. Graphical icons, either illustrating anti-dumping symbols or images of receiving water fauna, are effective supplements to the anti-dumping message.

- All storm drain inlets and catch basins within the project area must be stenciled with prohibitive language (such as: "NO DUMPING – DRAINS TO OCEAN") and/or graphical icons to discourage illegal dumping.
- Signs and prohibitive language and/or graphical icons, which prohibit illegal

dumping, must be posted at public access points along channels and creeks within the project area.
- Legibility of stencils and signs must be maintained.

6. PROPERLY DESIGN OUTDOOR MATERIAL STORAGE AREAS

Outdoor material storage areas refer to storage areas or storage facilities solely for the storage of materials. Improper storage of materials outdoors may provide an opportunity for toxic compounds, oil and grease, heavy metals, nutrients, suspended solids, and other pollutants to enter the storm water conveyance system. Where proposed project plans include outdoor areas for storage of materials that may contribute pollutants to the storm water conveyance system, the following Structural or Treatment BMPs are required:

- Materials with the potential to contaminate storm water must be: (1) placed in an enclosure such as, but not limited to, a cabinet, shed, or similar structure that prevents contact with runoff or spillage to the storm water conveyance system; or (2) protected by secondary containment structures such as berms, dikes, or curbs.
- The storage area must be paved and sufficiently impervious to contain leaks and spills.
- The storage area must have a roof or awning to minimize collection of storm water within the secondary containment area.

7. PROPERLY DESIGN TRASH STORAGE AREAS

A trash storage area refers to an area where a trash receptacle or receptacles are located for use as a repository for solid wastes.

Loose trash and debris can be easily transported by the forces of water or wind into nearby storm drain inlets, channels, and/or creeks. All trash container areas must meet the following Structural or Treatment Control BMP requirements (individual single family residences are exempt from these requirements):

- Trash container areas must have drainage from adjoining roofs and pavement diverted around the area(s).

- Trash container areas must be screened or walled to prevent off-site transport of trash.

8. PROVIDE PROOF OF ONGOING BMP MAINTENANCE

Improper maintenance is one of the most common reasons why water quality controls will not function as designed or which may cause the system to fail entirely. It is important to consider who will be responsible for maintenance of a permanent BMP, and what equipment is required to perform the maintenance properly. As part of project review, if a project applicant has included or is required to include, Structural or Treatment Control BMPs in project plans, the Permittee shall require that the applicant provide verification of maintenance provisions through such means as may be appropriate, including, but not limited to legal agreements, covenants, CEQA mitigation requirements and/or Conditional Use Permits.

For all properties, the verification will include the developer's signed statement, as part of the project application, accepting responsibility for all structural and treatment control BMP maintenance until the time the property is transferred and, where applicable, a signed agreement from the public entity assuming responsibility for Structural or Treatment Control BMP maintenance. The transfer of property to a private or public owner must have conditions requiring the recipient to assume responsibility for maintenance of any Structural or Treatment Control BMP to be included in the sales or lease agreement for that property, and will be the owner's responsibility. The condition of transfer shall include a provision that the property owners conduct maintenance inspection of all Structural or Treatment Control BMPs at least once a year and retain proof of inspection. For residential properties where the Structural or Treatment Control BMPs are located within a common area which will be maintained by a homeowner's association, language regarding the responsibility for maintenance must be included in the projects conditions, covenants and restrictions (CC&Rs). Printed educational materials will be required to accompany the first deed transfer to highlight the existence of the requirement and to provide information on what storm water management facilities are present, signs that maintenance is needed, how the necessary maintenance can be performed, and assistance that the Permittee can provide. The transfer of this information shall also be required with any subsequent sale of the property.

If Structural or Treatment Control BMPs are located within a public area proposed for transfer, they will be the responsibility of the developer until they are accepted for transfer by the County or other appropriate public agency. Structural or Treatment Control BMPs proposed for transfer must meet design standards adopted by the public entity for the BMP installed and should be approved by the County or other appropriate public agency prior to its installation.

9. DESIGN STANDARDS FOR STRUCTURAL OR TREATMENT CONTROL BMPs

Structural or Treatment control BMPs selected for use at any of the following categories of planning development project shall meet the design standards of this Section unless specifically exempted:

a) Single-family hillside residential developments of one acre or more of surface area;

b) Housing developments (includes single family homes, multifamily homes, condominium, and apartments) of ten units or more;
c) A 100,000 square feet or more impervious surface area industrial/commercial development;
d) Automotive service facilities (SIC 5013, 5014, 5541, 7532-7534 and 7536-7538) [5,000 square feet or more of surface area];
e) Retail gasoline outlets [5,000 square feet or more impervious surface area and with projected Average Daily Traffic (ADT) of 100 or more vehicles]. Subsurface Treatment Control BMPs which may endanger public safety (i.e., create an explosive environment) are considered not appropriate;
f) Restaurants (SIC 5812) [5,000 square feet or more of surface area];
g) Parking lot 5,000 square feet or more of surface area or with 25 or more parking spaces;
h) Projects located in, adjacent to or discharging directly to an ESA that meet the following threshold conditions:
    (1) Discharge storm water and urban runoff that is likely to impact a sensitive biological species or habitat; and
    (2) Create 2,500 square feet or more of impervious surface area.
i) Redevelopment projects in subject categories that meet Redevelopment thresholds.

Post-construction Structural or Treatment Control BMPs shall be designed to:

A. Mitigate (infiltrate or treat) storm water runoff from either:

a) Volumetric Treatment Control BMP

(1) The 85th percentile 24-hour runoff event determined as the maximized capture storm water volume for the area, from the formula recommended in Urban Runoff Quality Management, WEF Manual of Practice No. 23/ ASCE Manual of Practice No. 87, (1998), or

(2) The volume of annual runoff based on unit basin storage water quality volume, to achieve 80 percent or more volume treatment by the method recommended in California Stormwater Best Management Practices Handbook – Industrial/ Commercial, (1993), or

(3) The volume of runoff produced from a 0.75 inch storm event, prior to its discharge to a storm water conveyance system, or

(4) The volume of runoff produced from a historical-record based reference 24-hour rainfall criterion for “treatment” (0.75 inch average for the Los Angeles County area) that achieves approximately the same reduction in pollutant loads achieved by the 85th percentile 24-hour runoff event.

Or

b) Flow Based Treatment Control BMP

(1) The flow of runoff produced from a rain event equal to at least 0.2 inches per hour intensity, or

(2) The flow of runoff produced from a rain event equal to at least two times the 85th percentile hourly rainfall intensity for Los Angeles County, or

(3) The flow of runoff produced from a rain event that will result in treatment of the same portion of runoff as treated using volumetric standards above.

AND

B. Control peak flow discharge to provide stream channel and over bank flood protection, based on flow design criteria selected by the local agency.

Limited Exclusion

Restaurants, where the land area for development or redevelopment is less than 5,000 square feet, are excluded from the numerical Structural or Treatment Control BMP design standard requirement only.

10. PROVISIONS APPLICABLE TO INDIVIDUAL PRIORITY PROJECT CATEGORIES

REQUIREMENTS

A. SINGLE-FAMILY HILLSIDE HOME

(1) Conserve natural areas;
(2) Protect slopes and channels;
(3) Provide storm drain system stenciling and signage;
(4) Divert roof runoff to vegetated areas before discharge unless the diversion would result in slope instability; and
(5) Direct surface flow to vegetated areas before discharge unless the diversion would result in slope instability

B. 100,000 SQUARE FEET INDUSTRIAL/COMMERCIAL DEVELOPMENTS

1. PROPERLY DESIGN LOADING/UNLOADING DOCK AREAS

Loading/unloading dock areas have the potential for material spills to be quickly transported to the storm water conveyance system. To minimize this potential, the following design criteria are required:

- Cover loading dock areas or design drainage to minimize run-on and runoff of storm water.
- Direct connections to storm drains from depressed loading docks (truck wells) are prohibited.

2. PROPERLY DESIGN REPAIR/MAINTENANCE BAYS

Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can negatively impact storm water if allowed to come into contact with storm water runoff. Therefore, design plans for repair bays must include the following:

- Repair/maintenance bays must be indoors or designed in such a way that do not allow storm water runon or contact with storm water runoff.
- Design a repair/maintenance bay drainage system to capture all washwater, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.

3. PROPERLY DESIGN VEHICLE/EQUIPMENT WASH AREAS

The activity of vehicle/equipment washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates, and suspended solids to the storm water conveyance system. Include in the project plans an area for washing/steam cleaning of vehicles and equipment. The area in the site design must be:

- Self-contained and/ or covered, equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer.

C. RESTAURANTS

1. PROPERLY DESIGN EQUIPMENT/ACCESSORY WASH AREAS

The activity of outdoor equipment/accessory washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates, and suspended solids to the storm water conveyance system. Include in the project plans an area for the washing/steam cleaning of equipment and accessories. This area must be:

- Self-contained, equipped with a grease trap, and properly connected to a sanitary sewer.
- If the wash area is to be located outdoors, it must be covered, paved, have secondary containment, and be connected to the sanitary sewer.

D. RETAIL GASOLINE OUTLETS

1. PROPERLY DESIGN FUELING AREA

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the storm water conveyance system. The project plans must include the following BMPs:

- The fuel dispensing area must be covered with an overhanging roof structure or canopy. The canopy's minimum dimensions must be equal to or greater than the area within the grade break. The canopy must not drain onto the fuel dispensing area, and the canopy downspouts must be routed to prevent drainage across the fueling area.
- The fuel dispensing area must be paved with Portland cement concrete (or equivalent smooth impervious surface), and the use of asphalt concrete shall be prohibited.
- The fuel dispensing area must have a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of storm water to the extent practicable.
- At a minimum, the concrete fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.

E. AUTOMOTIVE REPAIR SHOPS

1. PROPERLY DESIGN FUELING AREA

Fueling areas have the potential to contribute oil and grease, solvents, car battery acid, coolant and gasoline to the storm water conveyance system. Therefore, design plans, which include fueling areas, must contain the following:

- The fuel dispensing area should be covered with an overhanging roof structure or canopy. The cover's minimum dimensions must be equal to or greater than the area within the grade break. The cover must not drain onto the fuel dispensing area and the downspouts must be routed to prevent drainage across the fueling area.
- The fuel dispensing areas must be paved with Portland cement concrete (or equivalent smooth impervious surface), and the use of asphalt concrete shall be prohibited.
- The fuel dispensing area must have a 2% to 4% slope to prevent ponding, and must be separated from the rest of the site by a grade break that prevents run-on of storm water.
- At a minimum, the concrete fuel dispensing area must extend 6.5 feet (2.0 meters) from the corner of each fuel dispenser, or the length at which the hose and nozzle assembly may be operated plus 1 foot (0.3 meter), whichever is less.

2. PROPERLY DESIGN REPAIR/MAINTENANCE BAYS

Oil and grease, solvents, car battery acid, coolant and gasoline from the repair/maintenance bays can negatively impact storm water if allowed to come into contact with storm water runoff. Therefore, design plans for repair bays must include the following:

- Repair/maintenance bays must be indoors or designed in such a way that doesn't allow storm water run-on or contact with storm water runoff.
- Design a repair/maintenance bay drainage system to capture all wash-water, leaks and spills. Connect drains to a sump for collection and disposal. Direct connection of the repair/maintenance bays to the storm drain system is prohibited. If required by local jurisdiction, obtain an Industrial Waste Discharge Permit.

3. PROPERLY DESIGN VEHICLE/EQUIPMENT WASH AREAS

The activity of vehicle/equipment washing/steam cleaning has the potential to contribute metals, oil and grease, solvents, phosphates, and suspended solids to the storm water conveyance system. Include in the project plans an area for washing/steam cleaning of vehicles and equipment. This area must be:

- Self-contained and/or covered, equipped with a clarifier, or other pretreatment facility, and properly connected to a sanitary sewer or to a permitted disposal facility.

4. PROPERLY DESIGN LOADING/UNLOADING DOCK AREAS

Loading/unloading dock areas have the potential for material spills to be quickly transported to the storm water conveyance system. To minimize this potential, the following design criteria are required:

- Cover loading dock areas or design drainage to minimize run-on and runoff of storm water.
- Direct connections to storm drains from depressed loading docks (truck wells) are prohibited.

F. PARKING LOTS

1. PROPERLY DESIGN PARKING AREA

Parking lots contain pollutants such as heavy metals, oil and grease, and polycyclic aromatic hydrocarbons that are deposited on parking lot surfaces by motor-vehicles. These pollutants are directly transported to surface waters. To minimize the offsite transport of pollutants, the following design criteria are required:

- Reduce impervious land coverage of parking areas
- Infiltrate runoff before it reaches storm drain system.
- Treat runoff before it reaches storm drain system

2. PROPERLY DESIGN TO LIMIT OIL CONTAMINATION AND PERFORM MAINTENANCE

Parking lots may accumulate oil, grease, and water insoluble hydrocarbons from vehicle drippings and engine system leaks.

- Treat to remove oil and petroleum hydrocarbons at parking lots that are heavily used (e.g. fast food outlets, lots with 25 or more parking spaces , sports event parking lots, shopping malls, grocery stores, discount warehouse stores)
- Ensure adequate operation and maintenance of treatment systems particularly sludge and oil removal, and system fouling and plugging prevention control

11. WAIVER

A Permittee may, through adoption of an ordinance or code incorporating the treatment requirements of the SUSMP, provide for a waiver from the requirement if impracticability for a specific property can be established. A waiver of impracticability shall be granted only when all other Structural or Treatment Control BMPs have been considered and rejected as infeasible. Recognized situations of impracticability include, (i) extreme limitations of space for treatment on a redevelopment project, (ii) unfavorable or unstable soil conditions at a site to attempt infiltration, and (iii) risk of ground water contamination because a known unconfined aquifer lies beneath the land surface or an existing or potential underground source of drinking water is less than 10 feet from the soil surface. Any other justification for impracticability must be separately petitioned by the Permittee and submitted to the Regional Board for consideration. The Regional Board may consider approval of the waiver justification or may delegate the authority to approve a class of waiver justifications to the Regional Board Executive Officer. The supplementary waiver justification becomes recognized and effective only after approval by the Regional Board or the Regional Board Executive Officer. A waiver granted by a Permittee to any development or redevelopment project may be revoked by the Regional Board Executive Officer for cause and with proper notice upon petition.

12. MITIGATION FUNDING

The Permittees may propose a management framework, for endorsement by the Regional Board Executive Officer, to support regional or sub-regional solutions to storm water pollution, where any of the following situations occur:

a) A waiver for impracticability is granted
b) Legislative funds become available;
c) Off-site mitigation is required because of loss of environmental habitat; or
d) An approved watershed management plan or a regional storm water mitigation plan exists that incorporates an equivalent or improved strategy for storm water mitigation.

13. LIMITATION ON USE OF INFILTRATION BMPs

Three factors significantly influence the potential for storm water to contaminate ground water. They are (i) pollutant mobility, (ii) pollutant abundance in storm water, (iii) and soluble fraction of pollutant. The risk of contamination of groundwater may be reduced by pretreatment of storm water. A discussion of limitations and guidance for infiltration practices is contained in, *Potential Groundwater Contamination from Intentional and Non-Intentional Stormwater Infiltration, Report No. EPA/600/R-94/051, USEPA (1994).*

In addition, the distance of the groundwater table from the infiltration BMP may also be a factor determining the risk of contamination. A water table distance separation of ten feet depth in California presumptively poses negligible risk for storm water not associated with industrial activity or high vehicular traffic.

Infiltration BMPs are not recommended for areas of industrial activity or areas subject to high vehicular traffic (25,000 or greater average daily traffic (ADT) on main roadway or 15,000 or more ADT on any intersecting roadway) unless appropriate pretreatment is provided to ensure groundwater is protected and the infiltration BMP is not rendered ineffective by overload.

14. ALTERNATIVE CERTIFICATION FOR STORM WATER TREATMENT MITIGATION

In lieu of conducting detailed BMP review to verify Structural or Treatment Control BMPs adequacy, a Permittee may elect to accept a signed certification from a Civil Engineer or a Licensed Architect registered in the State of California, that the plan meets the criteria established herein. The Permittee is encouraged to verify that certifying person(s) have been trained on BMP design for water quality, not more than two years prior to the signature date. Training conducted by an organization with storm water BMP design expertise (e.g., a University, American Society of Civil Engineers, American Society of Landscape Architects, American Public Works Association, or the California Water Environment Association) may be considered qualifying.

15. RESOURCES AND REFERENCE

TABLE 3-1

SUGGESTED RESOURCES	HOW TO GET A COPY
Start at the Source (1999) by Bay Area Stormwater Management Agencies Association Detailed discussion of permeable pavements and alternative driveway designs presented.	Bay Area Stormwater Management Agencies Association 2101 Webster Street Suite 500 Oakland, CA 510-286-1255
Design of Stormwater Filtering Systems (1996) by Richard A. Claytor and Thomas R. Schuler Presents detailed engineering guidance on ten different storm water-filtering systems.	Center for Watershed Protection 8391 Main Street Ellicott City, MD 21043 410-461-8323

Better Site Design: A Handbook for Changing Development Rules in Your Community (1998) Presents guidance for different model development alternatives.	Center for Watershed Protection 8391 Main Street Ellicott City, MD 21043 410-461-8323
Design Manual for Use of Bioretention in Stormwater Management (1993) Presents guidance for designing bioretention facilities.	Prince George's County Watershed Protection Branch 9400 Peppercorn Place, Suite 600 Landover, MD 20785
Operation, Maintenance and Management of Stormwater Management (1997) Provides a thorough look at stormwater practices including, planning and design considerations, programmatic and regulatory aspects, maintenance considerations, and costs.	Watershed Management Institute, Inc. 410 White Oak Drive Crawfordville, FL 32327 850-926-5310
California Storm Water Best Management Practices Handbooks (1993) for Construction Activity, Municipal, and Industrial/Commercial Presents a description of a large variety of Structural BMPs, Treatment Control, BMPs and Source Control BMPs	Los Angeles County Department of Public Works Cashiers Office 900 S. Fremont Avenue Alhambra, CA 91803 626-458-6959
Second Nature: Adapting LA's Landscape for Sustainable Living (1999) by Tree People Detailed discussion of BMP designs presented to conserve water, improve water quality, and achieve flood protection.	Tree People 12601 Mullholland Drive Beverly Hills, CA 90210 818-753-4600 (?)
Florida Development Manual: A Guide to Sound Land and Water Management (1988) Presents detailed guidance for designing BMPs	Florida Department of the Environment 2600 Blairstone Road, Mail Station 3570 Tallahassee, FL 32399 850-921-9472
Stormwater Management in Washington State (1999) Vols. 1-5 Presents detailed guidance on BMP design for new development and construction.	Department of Printing State of Washington Department of Ecology P.O. Box 798 Olympia, WA 98507-0798 360-407-7529
Maryland Stormwater Design Manual (1999) Presents guidance for designing storm water BMPs	Maryland Department of the Environment 2500 Broening Highway Baltimore, MD 21224 410-631-3000

Texas Nonpoint Source Book – Online Module (1998)www.txnpsbook.org Presents BMP design and guidance information on-line	Texas Statewide Storm Water Quality Task Force North Central Texas Council of Governments 616 Six Flags Drive Arlington, TX 76005 817-695-9150
Urban Storm Drainage, Criteria Manual – Volume 3, Best Management Practices (1999) Presents guidance for designing BMPs	Urban Drainage and Flood Control District 2480 West 26th Avenue, Suite 156-B Denver, CO 80211 303-455-6277
Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters (1993) Report No. EPA–840-B-92-002. Provides an overview of, planning and design considerations, programmatic and regulatory aspects, maintenance considerations, and costs.	National Technical Information Service U.S. Department of Commerce Springfield, VA 22161 800-553-6847
National Stormwater Best Management Practices (BMP) Database, Version 1.0 Provides data on performance and evaluation of storm water BMPs	American Society of Civil Engineers 1801 Alexander Bell Drive Reston, VA 20191 703-296-6000
Caltrans Storm Water Quality Handbook: Planning and Design Staff Guide (Best Management Practices Handbooks (1998) Presents guidance for design of storm water BMPs	California Department of Transportation P.O. Box 942874 Sacramento, CA 94274-0001 916-653-2975

TABLE 3-2

EXAMPLE BEST MANAGEMENT PRACTICES (BMPs)

The following are examples of BMPs that can be used for minimizing the introduction of pollutants of concern that may result in significant impacts, generated from site runoff to the storm water conveyance system. (See Table 1: Suggested Resources for additional sources of information):

- Provide reduced width sidewalks and incorporate landscaped buffer areas between sidewalks and streets. However, sidewalk widths must still comply with regulations for the Americans with Disabilities Act and other life safety requirements.
- Design residential streets for the minimum required pavement widths needed to comply with all zoning and applicable ordinances to support travel lanes; on-street parking; emergency, maintenance, and service vehicle access; sidewalks; and vegetated open channels.
- Comply with all zoning and applicable ordinances to minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.
- Use permeable materials for private sidewalks, driveways, parking lots, or interior roadway surfaces (examples: hybrid lots, parking groves, permeable overflow parking, etc.).
- Use open space development that incorporates smaller lot sizes.
- Reduce building density.
- Comply with all zoning and applicable ordinances to reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.
- Comply with all zoning and applicable ordinances to reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials in spillover parking areas.
- Direct rooftop runoff to pervious areas such as yards, open channels, or vegetated areas, and avoid routing rooftop runoff to the roadway or the storm water conveyance system.
- Vegetated swales and strips
- Extended/dry detention basins
- Infiltration basin
- Infiltration trenches
- Wet ponds
- Constructed wetlands
- Oil/Water separators
- Catch basin inserts
- Continuous flow deflection/ separation systems
- Storm drain inserts
- Media filtration
- Bioretention facility
- Dry-wells
- Cisterns
- Foundation planting
- Catch basin screens
- Normal flow storage/ separation systems
- Clarifiers
- Filtration systems
- Primary waste water treatment systems

TABLE 3-3

HABITAT PROTECTION IN THE LOS ANGELES COUNTY AREA

Agency:
Los Angeles County Department of Regional Planning

Designation:
Significant Ecological Areas (SEA)

Definitions:
Significant Ecological Areas (SEAs) are areas that have been identified by the Los Angeles County General Plan as containing unique or unusual species assemblages, or areas of habitat that are rapidly declining in the Los Angeles County. The SEAs were established to protect a special or sometimes unique collection of habitats and species from loss due to encroachment and human disturbances. However, SEAs are not intended to function as isolated preservation areas.

Affected Areas:
(See Figure 1)

Agency:
Los Angeles Regional Water Quality Control Board

Designation:
Rare, Threatened, or Endangered Species (RARE)

Definitions:
An area listed in the Los Angeles Basin Plan as supporting the "RARE, Threatened, or Endangered Species (RARE)" beneficial use.

Affected Areas:
(See Table 3A)

Agency:
California Department of Fish & Game

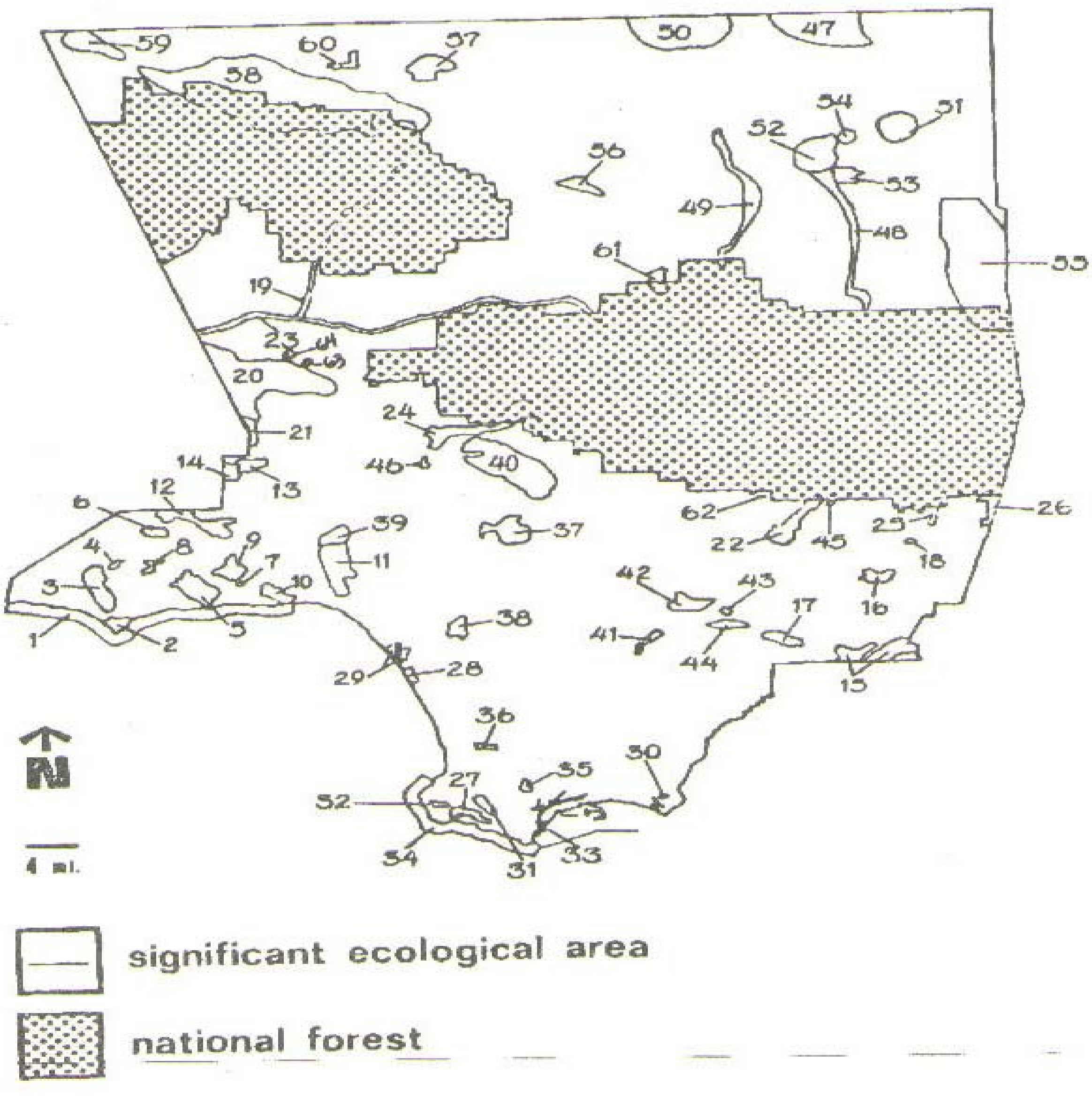
Designation:
Significant Natural Area

<u>Definition:</u>
An area designated by the California Department of Fish and Game's Significant Natural Areas Progra.

Affected Area:
N/A

FIGURE 1

SIGNIFICANT ECOLOGICAL AREAS
IN LOS ANGELES COUNTY



APPENDIX A

VOLUME AND FLOW RATE CALCULATIONS

APPENDIX A VOLUME & FLOW RATE CALCULATIONS

A.1 METHOD FOR CALCULATING STANDARD URBAN STORMWATER MITIGATION PLAN FLOW RATES AND VOLUMES BASED ON 0.75-INCHES OF RAINFALL: WORKSHEET

PROJECT NAME

____

NOMENCLATURE

A_I = Impervious Area (acres)
A_P = Pervious Area (acres)
A_U = Contributing Undeveloped Upstream Area (acres)
A_{Total} = Total Area of Development and Contributing Undeveloped Upstream Area (acres)
C_D = Developed Runoff Coefficient
C_U = Undeveloped Runoff Coefficient
I_X = Rainfall Intensity (inches / hour)
Q_{PM} = Peak Mitigation Flow Rate (cfs)
T_C = Time of Concentration (minutes, must be between 5-30 min.)
V_M = Mitigation Volume (ft^3)

EQUATIONS

$A_{Total} = A_I + A_P + A_U$
$A_I = (A_{Total} * \text{ \% of Development which is Impervious})$
$A_P = (A_{Total} * \text{ \% of Development which is Pervious})$
$A_U = (A_{Total} * \text{ \% of Contributing Undeveloped Upstream Area***})$

$C_D = (0.9 * \text{Imp.}) + [(1.0 - \text{Imp.}) * C_U]$ If $C_D < C_U$, use $C_D = C_U$

$Q_{PM} = C_D * I_X * A_{Total} * (1 \text{ hour} / 3{,}600 \text{ seconds}) * (1 \text{ ft} / 12 \text{ inches}) * (43{,}560 \text{ ft}^2 / 1 \text{ acre})$
$= C_D * I_X * A_{Total} * (1.008333 \text{ ft}^3\text{-hour} / \text{acre-inches-seconds})$

$T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * \text{Length}^{0.483} * \text{Slope}^{-0.135}$

$V_M = (0.75 \text{ inches}) * [(A_I)(0.9) + (A_P + A_U)(C_U)] * (1 \text{ ft} / 12 \text{ inches}) * (43{,}560 \text{ ft}^2 / 1 \text{ acre})$
$= (2{,}722.5 \text{ ft}^3 / \text{acre}) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$

***** Contributing Undeveloped Upstream Area is an area where stormwater runoff from an undeveloped upstream area will flow directly or indirectly to the Post-Construction Best Management Practices (BMPs) proposed for the development. This additional flow must be included in the flow rate and volume calculations to appropriately size the BMPs.**

PROVIDE PROPOSED PROJECT CHARACTERISTICS

A_{Total}	________________	Acres
Type of Development	________________	
Predominate Soil Type #	________________	
% of Project Impervious	________________	
% of Project Pervious	________________	
% of Project Contributing Undeveloped Area	________________	
A_I	________________	Acres
A_P	________________	Acres
A_U	________________	Acres

DETERMINING THE PEAK MITIGATED FLOW RATE (Q_{PM}):

In order to determine the peak mitigated flow rate (Q_{PM}) from the new development, use the Los Angeles County Department of Public Works *Hydrology Manual*. Use the Modified Rational Method for calculating the peak mitigation Q_{PM} for compliance with the Standard Urban Stormwater Mitigation Plan (SUSMP). Use attached **Table 1** for all maximum intensity (I_X) values used.

By trial and error, determine the time of concentration (T_C), as shown below:

<u>CALCULATION STEPS</u>:

1. Assume an initial T_C value between 5 and 30 minutes.

T_C __________ minutes

2. Using Table 1, look up the assumed T_C value and select the corresponding I_X intensity in inches/hour.

I_X __________ inches/hour

3. Determine the value for the Undeveloped Runoff Coefficient, C_U, using the runoff coefficient curve corresponding to the predominant soil type.

C_U __________

4. Calculate the Developed Runoff Coefficient, $C_D = (0.9 * Imp.) + [(1.0 - Imp.) * C_U]$

C_D __________

5. Calculate the value for $C_D * I_X$

$C_D * I_X$ __________

6. Calculate the time of concentration, $T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * Length^{0.483} * Slope^{-0.135}$

Calculated T_C __________ minutes

7. Calculate the difference between the initially assumed T_C and the calculated T_C, if the difference is greater than 0.5 minutes. Use the calculated T_C as the assumed initial T_C in the second iteration. If the T_C value is within 0.5 minutes, round the acceptable T_C value to the nearest minute.

TABLE FOR ITERATIONS:

Iteration No.	Initial T_C (min)	I_X (in/hr)	C_U	C_D	C_D*I_X (in/hr)	Calculated T_C (min)	Difference (min)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							

Acceptable T_C value _____________ minutes

8. Calculate the Peak Mitigation Flow Rate,
   $Q_{PM} = C_D * I_X * A_{Total} * (1.008333\ ft^3\text{-hour / acre-inches-seconds})$

Q_{PM} __________ cfs

TABLE 1

INTENSITY - DURATION DATA FOR 0.75-INCHES OF RAINFALL
FOR ALL RAINFALL ZONES

Duration, T_C (min)	Rainfall Intensity, I_X (in/hr)
5	0.447
6	0.411
7	0.382
8	0.359
9	0.339
10	0.323
11	0.309
12	0.297
13	0.286
14	0.276
15	0.267
16	0.259
17	0.252
18	0.245
19	0.239
20	0.233
21	0.228
22	0.223
23	0.218
24	0.214
25	0.210
26	0.206
27	0.203
28	0.199
29	0.196
30	0.193

DETERMINING THE VOLUME (V_M)

In order to determine the volume (V_M) of stormwater runoff to be mitigated from the new development, use the following equation:

$$V_M = (2{,}722.5 \text{ ft}^3 / \text{acre}) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$$

A.2 FLOW RATE AND VOLUME CALCULATION EXAMPLE

PROJECT NAME

Industrial Site Example

NOMENCLATURE

A_I = Impervious Area (acres)
A_P = Pervious Area (acres)
A_U = Contributing Undeveloped Upstream Area (acres)
A_{Total} = Total Area of Development and Contributing Undeveloped Upstream Area (acres)
C_D = Developed Runoff Coefficient
C_U = Undeveloped Runoff Coefficient
I_X = Rainfall Intensity (inches / hour)
Q_{PM} = Peak Mitigation Flow Rate (cfs)
T_C = Time of Concentration (minutes, must be between 5-30 min.)
V_M = Mitigation Volume (ft^3)

EQUATIONS

$A_{Total} = A_I + A_P + A_U$
$A_I = (A_{Total}$ * % of Development which is Impervious)
$A_P = (A_{Total}$ * % of Development which is Pervious)
$A_U = (A_{Total}$ * % of Contributing Undeveloped Upstream Area***)

$C_D = (0.9 * \text{Imp.}) + [(1.0 - \text{Imp.}) * C_U]$ If $C_D < C_U$, use $C_D = C_U$

$Q_{PM} = C_D * I_X * A_{Total} * (1 \text{ hour} / 3{,}600 \text{ seconds}) * (1 \text{ ft} / 12 \text{ inches}) * (43{,}560 \text{ ft}^2 / 1 \text{ acre})$
$= C_D * I_X * A_{Total} * (1.008333 \text{ ft}^3\text{-hour} / \text{acre-inches-seconds})$

$T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * \text{Length}^{0.483} * \text{Slope}^{-0.135}$

$V_M = (0.75 \text{ inches}) * [(A_I)(0.9) + (A_P + A_U)(C_U)] * (1 \text{ ft} / 12 \text{ inches}) * (43{,}560 \text{ ft}^2 / 1 \text{ acre})$
$= (2{,}722.5 \text{ ft}^3 / \text{acre}) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$

***** Contributing Undeveloped Upstream Area is an area where stormwater runoff from an undeveloped upstream area will flow directly or indirectly to the Post-Construction Best Management Practices (BMPs) proposed for the development. This additional flow must be included in the flow rate and volume calculations to appropriately size the BMPs.**

PROVIDE PROPOSED PROJECT CHARACTERISTICS

A_{Total}	**5.51**	Acres
Type of Development	**Industrial**	
Predominate Soil Type #	**6**	
% of Project Impervious	**91%**	
% of Project Pervious	**9%**	
% of Project Contributing Undeveloped Area	**0%**	
A_I	**5.0141**	Acres
A_P	**0.4959**	Acres
A_U	**0**	Acres

DETERMINING THE PEAK MITIGATED FLOW RATE (Q_{PM}):

In order to determine the peak mitigated flow rate (Q_{PM}) from the new development, use the Los Angeles County Department of Public Works *Hydrology Manual*. Use the Modified Rational Method for calculating the peak mitigation Q_{PM} for compliance with the Standard Urban Stormwater Mitigation Plan (SUSMP). Use attached **Table 1** for all maximum intensity (I_X) values used.

By trial and error, determine the time of concentration (T_C), as shown below:

<u>CALCULATION STEPS</u>:

1. Assume an initial T_C value between 5 and 30 minutes.

T_C **15** minutes

2. Using Table 1, look up the assumed T_C value and select the corresponding I_X intensity in inches/hour.

I_X **0.267** inches/hour

3. Determine the value for the Undeveloped Runoff Coefficient, C_U, using the runoff coefficient curve corresponding to the predominant soil type.

C_U **0.1**

4. Calculate the Developed Runoff Coefficient, $C_D = (0.9 * \text{Imp.}) + [(1.0 - \text{Imp.}) * C_U]$

C_D **0.828**

5. Calculate the value for $C_D * I_X$

$C_D * I_X$ **0.221076**

6. Calculate the time of concentration, $T_C = 10^{-0.507} * (C_D * I_X)^{-0.519} * \text{Length}^{0.483} * \text{Slope}^{-0.135}$

Calculated T_C **28.26** minutes

7. Calculate the difference between the initially assumed T_C and the calculated T_C, if the difference is greater than 0.5 minutes. Use the calculated T_C as the assumed initial T_C in the second iteration. If the T_C value is within 0.5 minutes, round the acceptable T_C value to the nearest minute.

TABLE FOR ITERATIONS:

Iteration No.	Initial T_C (min)	I_X (in/hr)	C_U	C_D	C_D*I_X (in/hr)	Calculated T_C (min)	Difference (min)
1	**15**	**0.267**	**0.1**	**0.828**	**0.221076**	**28.26**	**13.26**
2	**28.26**	**0.198**	**0.1**	**0.828**	**0.163944**	**33.01**	**4.75**
3	**33.01**	**n/a**					
4							
5							
6							
7							
8							
9							
10							

Acceptable T_C value ______**30**_____ minutes

8. Calculate the Peak Mitigation Flow Rate,
   $Q_{PM} = C_D * I_X * A_{Total} * (1.008333\ ft^3\text{-hour / acre-inches-seconds})$

Q_{PM} ____**0.89**___ cfs

Q_{PM} = 0.89 cfs

C_D = 0.828
I_{30} = 0.193
A_{Total} = 5.51 acres

Use I_{30} since T_c is greater than 30 minutes.

TABLE 1

INTENSITY - DURATION DATA FOR 0.75-INCHES OF RAINFALL
FOR ALL RAINFALL ZONES

Duration, T_C (min)	Rainfall Intensity, I_X (in/hr)
5	0.447
6	0.411
7	0.382
8	0.359
9	0.339
10	0.323
11	0.309
12	0.297
13	0.286
14	0.276
Iteration #1 ➔ 15	0.267
16	0.259
17	0.252
18	0.245
19	0.239
20	0.233
21	0.228
22	0.223
23	0.218
24	0.214
25	0.210
26	0.206
27	0.203
Iteration #2 ➔ 28	0.199 Approx. ~0.198
29	0.196
30	0.193

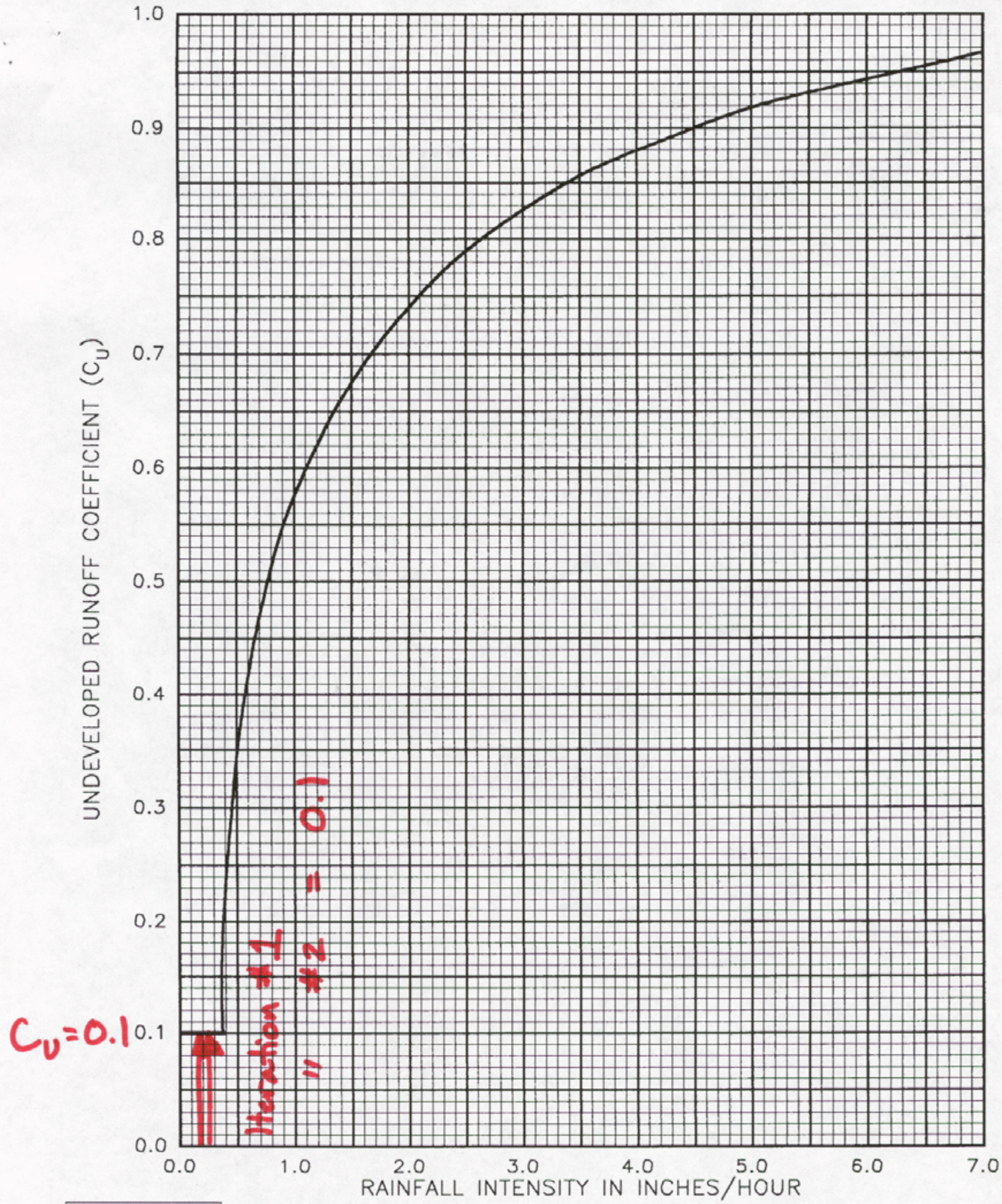
DETERMINING THE VOLUME (V_M)

In order to determine the volume (V_M) of stormwater runoff to be mitigated from the new development, use the following equation:

$$V_M = (2{,}722.5 \text{ ft}^3 / \text{acre}) * [(A_I)(0.9) + (A_P + A_U)(C_U)]$$

A_I = 5.0141 acres
A_P = 0.4959 acres
C_U = 0.1

$$\boxed{V_M = 12{,}420 \text{ ft}^3}$$



Equation:

$C_D = (0.9 * IMP) + (1.0 - IMP)\ C_U$

Where:
C_D = Developed runoff coefficient.
IMP = Proportion impervious.
C_U = Undeveloped runoff coefficient.

Los Angeles County
Department of Public Works

RUNOFF COEFFICIENT CURVE

SOIL TYPE NO. 006

NS006.SPG

Hydrology/Sedimentation Appendix D-25 December 1990

APPENDIX B

BMP DESIGN CRITERIA

APPENDIX B BMP DESIGN CRITERIA

B.1 BIORETENTION FACILITY

DESCRIPTION

Bioretention is a best management practice (BMP) developed in the early 1990's by the Prince George's County, MD, Department of Environmental Resources (PGDER). Bioretention utilizes soils and both woody and herbaceous plants to remove pollutants from stormwater runoff. As shown in Figure 1, runoff is conveyed as sheet flow to the treatment area, which consists of a grass buffer strip, sand bed, ponding area, organic layer or mulch layer, planting soil, and plants. Runoff passes first over or through a sand bed, which slows the runoff's velocity, distributes it evenly along the length of the ponding area, which consists of a surface organic layer and/or ground cover and the underlying planting soil. The ponding area is graded; its center depressed. Water is ponded to a depth of 6 inches and gradually infiltrates the bioretention area and/or is evapotranspired. Bioretention areas are applicable as on-lot retention facilities that are designed to mimic forested systems that naturally control hydrology. The bioretention area is graded to drain excess runoff over a weir and into the storm drain system. Stored water in the bioretention area planting soil infiltrates over a period of days into the underlying soils.

The basic bioretention design shown in Figure 1 can be modified to accommodate more specific needs. The bioretention BMP design can be modified to include an underdrain within the sand bed to collect the infiltrated water and discharge it to a downstream storm drain system. This modification may be required when impervious subsoils and marine clays prevent complete infiltration in the soil system. This modified design makes the bioretention area act more as a filter that discharges treated water than as an infiltration device.

There are six basic components of a bioretention facility:

(1) Grass Buffer Strip	-	Designed to filter out particulates and reduce runoff velocity.
(2) Sand Bed	-	Further reduces velocity by capturing a portion of the runoff and distributes it evenly along the length of the ponding area. Also provides aeration to the plant bed and enhances infiltration.
(3) Ponding Area	-	Collects and stores runoff prior to infiltration.
(4) Organic/Mulch Layer	-	Provides some filtering of runoff, encourages development of beneficial microorganisms, and protects the soil surface from erosion.
(5) Planting Soil	-	Provides nourishment for the plant life. Clay particles within the soil also remove certain pollutants through

adsorption.

(6) Plants - Provides uptake of harmful pollutants.

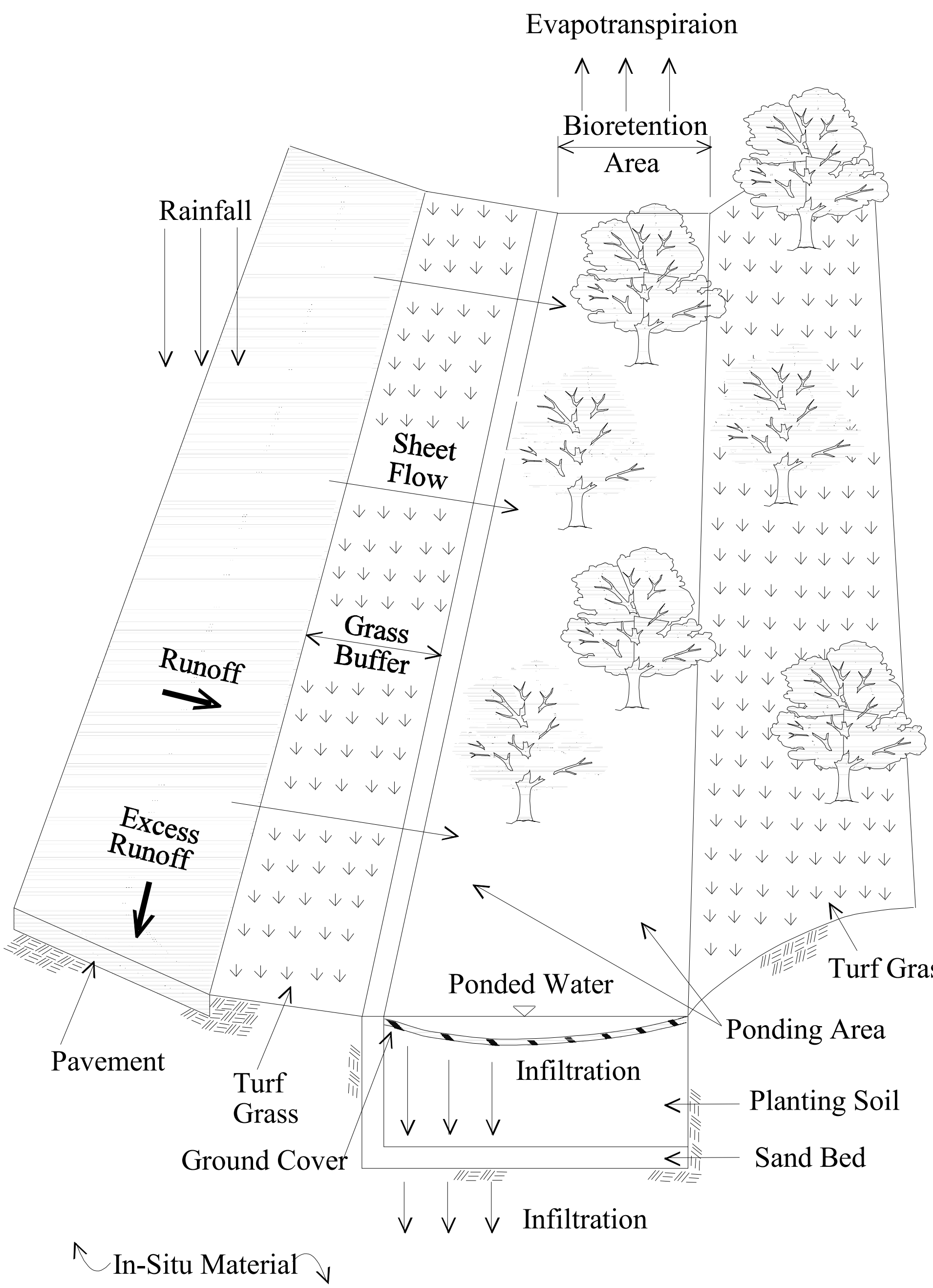


Figure 1. Schematic of a typical bioretention area BMP
(adapted from Prince George's County, 1993)

ADVANTAGES

1. If designed properly, has shown ability to remove significant amounts of dissolved heavy metals, phosphorous, TSS, and fine sediments.
2. Requires relatively little engineering design in comparison to other stormwater management facilities (e.g. sand filters).
3. Provides groundwater recharge when the runoff is allowed to infiltrate into the subsurface.
4. Enhances the appearance of parking lots and provides shade and wind breaks, absorbs noise, and improves an area's landscape.
5. Maintenance on a bioretention facility is limited to the removal of leaves from the bioretention area each fall.
6. The vegetation recommended for use in bioretention facilities is generally hardier than the species typically used in parking lot landscapes. This is a particular advantage in urban areas where plants often fare poorly due to poor soils and air pollution.

LIMITATIONS

1. Low removal of nitrates.
2. Not applicable on steep, unstable slopes or landslide areas (slopes greater than 20 percent).
3. Requires relatively large areas.
4. Not appropriate at locations where the water table is within 6 feet of the ground surface and where the surrounding soil stratum is unstable.
5. Clogging may be a problem, particularly if the BMP receives runoff with high sediment loads.

DESIGN CRITERIA

1. Calculate the volume of stormwater to be mitigated by the bioretention facility using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.
2. The soil should have infiltration rates greater than 0.5 inches per hour, otherwise an underdrain system should be included (see # 11).
3. Drainage to the bioretention facility must be graded to create sheet flow, not a concentrated stream. Level spreaders (i.e. slotted curbs) can be used to facilitate sheet flow. The maximum sheet flow velocity should be 1 ft/s for the planted ground cover and 3 ft/s for mulched cover.
4. Soil shall be a uniform mix, free of stones, stumps, roots or other similar objects

larger than 1-inch in diameter. No other materials or substances shall be mixed or dumped within the bioretention area that may be harmful to plant growth, or prove a hindrance to the planting or maintenance operations. The planting soil shall be free of Bermuda grass, Quackgrass, Johnson grass, Mugwort, Nutsedge, Poison Ivy, Canadian Thistle, Tearthumb, or other noxious weeds.

5. Planting soil shall be tested and meet the following criteria:

pH range	5.2-7.0
Organic matter	1.5-4.0%
Magnesium	35 lbs. per acre, minimum
Phosphorus P_2O_5	75 lbs. per acre, minimum
Potassium K_2O	85 lbs. per acre, minimum
Soluble salts	not to exceed 500 ppm
Clay	0-25% by volume
Silt	30-55% by volume
Sand	35-60% by volume

6. It is very important to minimize compaction of both the base of the bioretention area and the required backfill. When possible, use excavation hoes to remove original soil. If excavated using a loader, the excavator should use a wide track or marsh track equipment, or light equipment with turf type tires. Use of equipment with narrow tracks or narrow tires, rubber tires with large lugs, or high pressure tires will cause excessive compaction resulting in reduced infiltration rates and storage volumes and is not acceptable. Compaction will significantly contribute to design failure.
7. Compaction can be alleviated at the base of the bioretention facility by using a primary tilling operation such as a chisel plow, ripper, or subsoiler. These tilling operations are to refracture the soil profile through the 12 inch compaction zone. Substitute methods must be approved by the engineer. Rototillers typically do not till deep enough to reduce the effects of compaction from heavy equipment. Rototill 2 to 3 inches of sand into the base of the bioretention facility before back filing the required sand layer. Pump any ponded water before preparing (rototilling) base.
8. When back filling topsoil over the sand layer, first place 3 to 4 inches of topsoil over the sand, then rototill the sand/topsoil to create a gradation zone. Backfill the remainder of the topsoil to final grade.
9. Mulch around individual plants only. Shredded hardwood mulch is the only accepted mulch. Shredded hardwood mulch must be well aged (stockpiled or stored for at least 12 months) for acceptance. The mulch should be applied to a maximum depth of 3-inches.
10. The plant root ball should be planted so 1/8th of the ball is above final grade surface.
11. If used, place underdrains on a 3 feet wide section of filter cloth followed by a gravel bedding. Pipe is placed next, followed by the gravel bedding. The ends of underdrain pipes not terminating in an observation well shall be capped.

12. The main collector pipe for underdrain systems shall be constructed at a minimum slope of 0.5%. Observation wells and/or clean-out pipes must be provided (one minimum per every 1,000 square feet of surface area).
13. Size an emergency overflow weir with 6-inches of head, using the Weir equation:

$$Q=CLH^{3/2}$$

Where C= 2.65 (smooth crested grass weir)
Q= flow rate
H = 6-inches of head
L = length of weir

14. Bioretention areas should be at least 15 feet wide with a 25 foot width preferable, and a minimum length of 40 feet long. Generally, the length-to-width ratio should be around 2 to 1 to improve surface flow characteristics.
15. The plant soil depth should be 4 feet or more to provide beneficial root zone, both in terms of space and moisture content.
16. The depth of the ponding area should be limited to no more than 6 inches to limit the duration of standing water to no more than 4 days. If an underdrain system is used, the depth of the ponding area should be limited to no more than 1 foot. Longer ponding times can lead to anaerobic conditions that are not conductive to plant growth. Longer periods of standing water can also lead to the breeding of mosquitoes and other pests.
17. The bioretention area should be vegetated to resemble a terrestrial forest community ecosystem, which is dominated by understory trees, a shrub layer, and herbaceous ground covers. Three species each of both trees and shrubs are recommended to be planted at a rate of 1000 trees and shrubs per acre. The shrub-to-tree ratio should be 2:1 to 3:1. Trees should be spread 12 feet apart and the shrubs should be spaced 8 feet apart.

REFERENCES

1. S. Bitter and J. Keith Bowers, 1994. Bioretention as a Water Quality Best Management Practice. *Watershed Protection Techniques*, Vol. 1, No. 3. Silver Spring, MD.

2. The Center for Watershed Protection, Environmental Quality Resources and Loiederman Associates. 1997. *Maryland Stormwater Design Manual*. Prepared for: Maryland Department of the Environment. Baltimore, MD.

3. A.P. Davis, M. Shokouhian, H. Sharma, C. Minani, 1998. *Optimization of Bioretention Design for Water Quality and Hydrologic Characteristics*.

4. DEQ Storm Water Management Guidelines, Department of Environmental Quality,

State of Oregon. http://waterquality.deq.state.or.us/wq/groundwa/swmgmtguide.htm

5. *Design Manual for Use of Bioretention in Stormwater Management*, 1993. Department of Environmental Resources, Division of Environmental Management, Watershed Protection Branch, Prince George's County, MD.

6. GKY and Associates, Inc. June 1996. *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032. Prepared for: US Department of Transportation, Federal Highway Administration. Washington, DC.

7. G.L. Hightshoe, 1988. *Native Trees, Shrubs, and Vines for Urban and Rural America*. Van Nostrand Reinhold, New York, NY.

8. *Low-Impact Development Design Manual*, November 1997. Department of Environmental Resources, Prince George's County, MD.

9. *Maryland Stormwater Design Manual Volumes I & II*, December 1999 Draft. Maryland Department of the Environment, Baltimore, MD.

10. T.R. Schueler, 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban Best Management Practices*. Metropolitan Washington Council of Governments.

11. T.R. Schueler, 1992. *A Current Assessment of Urban Best Management Practices*. Metropolitan Washington Council of Governments.

B.2 CATCH BASIN INSERTS

DESCRIPTION

A catch basin insert is any device that can be inserted into an existing catch basin design to provide some level of runoff contaminant removal. Currently, there are many different catch basin insert models available, with applications ranging from trash and debris removal to carbon adsorption of aliphatic and aromatic hydrocarbons and heavy metals removal. Costs vary widely, ranging from about $40 for a simple screen bag, to over $3,000 for more complex, custom-engineered units. The most frequent application for catch basin inserts is for reduction of sediment, oil, and grease levels in stormwater runoff. These catch basin inserts should also have an overflow outlet, through which water exceeding the treatment capacity can escape without flooding the adjacent area.

ADVANTAGES

1. Provides moderate removal of larger particles and debris as pretreatment.
2. Low installation costs.
3. Units can be installed in existing traditional stormwater infrastructure.
4. Ease of installation.
5. Requires no additional land area.

LIMITATIONS

1. Vulnerable to accumulated sediments being resuspended at low flow rates.
2. Severe clogging potential if exposed soil surfaces exist upstream.
3. Maintenance and inspection of catch basin inserts may be required before and after each rainfall event, excessive cleaning and maintenance.
4. Available head to meet design criteria.
5. Dissolved pollutants are not captured by filter media.
6. Limited pollutant removal capabilities.

DESIGN CRITERIA

1. Calculate the flow rate of stormwater to be mitigated by the catch basin insert using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.
2. Insert device selected should be Best Available Technology for removing constituents of concern for the particular site.

REFERENCES

1. The Center for Watershed Protection, Environmental Quality Resources and Loiederman Associates. 1997. *Maryland Stormwater Design Manual*. Prepared for: Maryland Department of the Environment. Baltimore, MD.

2. DEQ Storm Water Management Guidelines, Department of Environmental Quality, State of Oregon. http://waterquality.deq.state.or.us/wq/groundwa/swmgmtguide.htm

3. K. H. Lichten, June 1997. *Compilation of New Development Stormwater Treatment Controls in the San Francisco Bay Area*, Bay Area Stormwater Management Agencies Association, San Francisco, CA.

The following is a list of known locations where a Catch Basin Insert device was installed. The design of the installed device in each location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the locations herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	Brand/Manufacturer	Owner/Client
Los Angeles: SE corner of 6th St. & Bixel St.	Ultra-Urban Filter	City of Los Angeles
Los Angeles: NW corner of Union Ave. & 11th St.	Fossil Filter	City of Los Angeles
Beverly Hills: E/S Palm Ave. N/o Gregory Way	Ultra-Urban Filter	City of Beverly Hills
Los Angeles: NE corner of 20th St. & Maple Ave.	Not available	City of Los Angeles
Los Angeles: 1700 Wilshire Blvd. near Little St.	Drainpac	City of Los Angeles
Los Angeles: 2187 Riverside Dr.	Drainpac	Caltrans
Los Angeles: 4173 Engineering 1 Box 95153	Not available	UCLA
Los Angeles: 5360 W. Imperial Hwy	Drainpac	Caltrans
Los Angeles	Drainpac	Private

Carson	Drainpac	Private
Wilmington	Drainpac	Private
Pasadena	Drainpac	Private
San Pedro: 425 S. Palos Verdes St.	Drainpac	Port of Los Angeles
El Monte: Valley Blvd & Johnson Ave.	Ultra-Urban Filter	City of El Monte
City of Industry	Drainpac	Private
Thousand Oaks	Drainpac	Private
Calabasas	Fossil Filter	City of Calabasas
Santa Monica : SE corner of Santa Monica Blvd. & 3rd St.	Ultra-Urban Filter	City of Santa Monica
Los Angeles: 786 Mission Rd (Field Yard)	Not available	City of Los Angeles
Foothill Maintenance Station	Fossil Filter	Caltrans
Foothill Maintenance Station	Stream Guard	Caltrans
Las Flores Maintenance Station	Fossil Filter	Caltrans
Las Flores Maintenance Station	Stream Guard	Caltrans
Rosemead Maintenance Station	Fossil Filter	Caltrans
Rosemead Maintenance Station	Stream Guard	Caltrans

B.3 CISTERN

DESCRIPTION

Cisterns are containers which capture stormwater runoff as it comes down through the roof gutter system. This collected stormwater can later be used to water the garden or lawn. The collection of this stormwater reduces the amount of stormwater runoff and assists in the reduction of potential pollutants entering the stormwater conveyance system.

ADVANTAGES

1. Low installation cost.
2. Requires little space for installation.
3. Reduces amount of stormwater runoff.
4. Conserves water usage.

LIMITATIONS

1. Limited amount of stormwater runoff can be captured.
2. Restricted to structure runoff.
3. Aesthetically unpleasing.

DESIGN CRITERIA

1. Calculate the volume of stormwater to be mitigated by the cistern using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.

REFERENCES

1. *Low-Impact Development Design Manual*, November 1997. Department of Environmental Resources, Prince George's County, MD.

2. Rainwater Collection and Gray Water as alternative Water Supply Sources. http://www.mindspring.com/~roadrunner1/Family_Focus/Rainwater_Collection.html.

3. T. Richman, J. Worth, P. Dawe, J. Aldrich, and B. Ferguson, 1997. *Start at the Source: Residential Site Planning and Design Guidance Manual for Stormwater Quality Protection*, Bay Area Stormwater Management Agencies Association, San Francisco, CA.

B.4 CONSTRUCTED WETLANDS

DESCRIPTION

Wetlands provide physical, chemical, and biological water quality treatment of stormwater runoff. Physical treatment occurs as a result of decreasing flow velocities in the wetland, and is present in the form of evaporation, sedimentation, adsorption, and/or filtration. Chemical processes include chelation, precipitation, and chemical adsorption. Biological processes include decomposition, plant uptake and removal of nutrients, plus biological transformation and degradation. Hydrology is one of the most influential factors in pollutant removal due to its effects on sedimentation, aeration, biological transformation, and adsorption onto bottom sediments (Dormann, et al., 1988). The large surface area of the bottom of the wetland encourages higher levels of adsorption, absorption, filtration, microbial transformation, and biological utilization than might normally occur in more channelized water courses.

A natural wetland is defined by examination of the soils, hydrology, and vegetation which are dominant in the area. Wetlands are characterized by the substrate being predominantly undrained hydric soil. A wetland may also be characterized by a substrate which is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year. Wetlands also usually support hydrophytes, or plants which are adapted to aquatic and semiaquatic environments. Natural and artificial wetlands are used to treat stormwater runoff. Figure 1 illustrates an artificial wetland used for treating stormwater runoff.

The success of a wetland will be much more likely if some general guidelines are followed. The wetland should be designed such that a minimum amount of maintenance is required. This will be affected by the plants, animals, microbes, and hydrology. The natural surroundings, including such things as the potential energy of a stream or a flooding river, should be utilized as much as possible. It is necessary to recognize that a fully functional wetland cannot be established spontaneously. Time is required for vegetation to establish and for nutrient retention and wildlife enhancement to function efficiently. Also, the wetland should approximate a natural situation as much as possible, and unnatural attributes, such as a rectangular shape or a rigid channel, should be avoided (Mitsch and Gosselink, 1993).

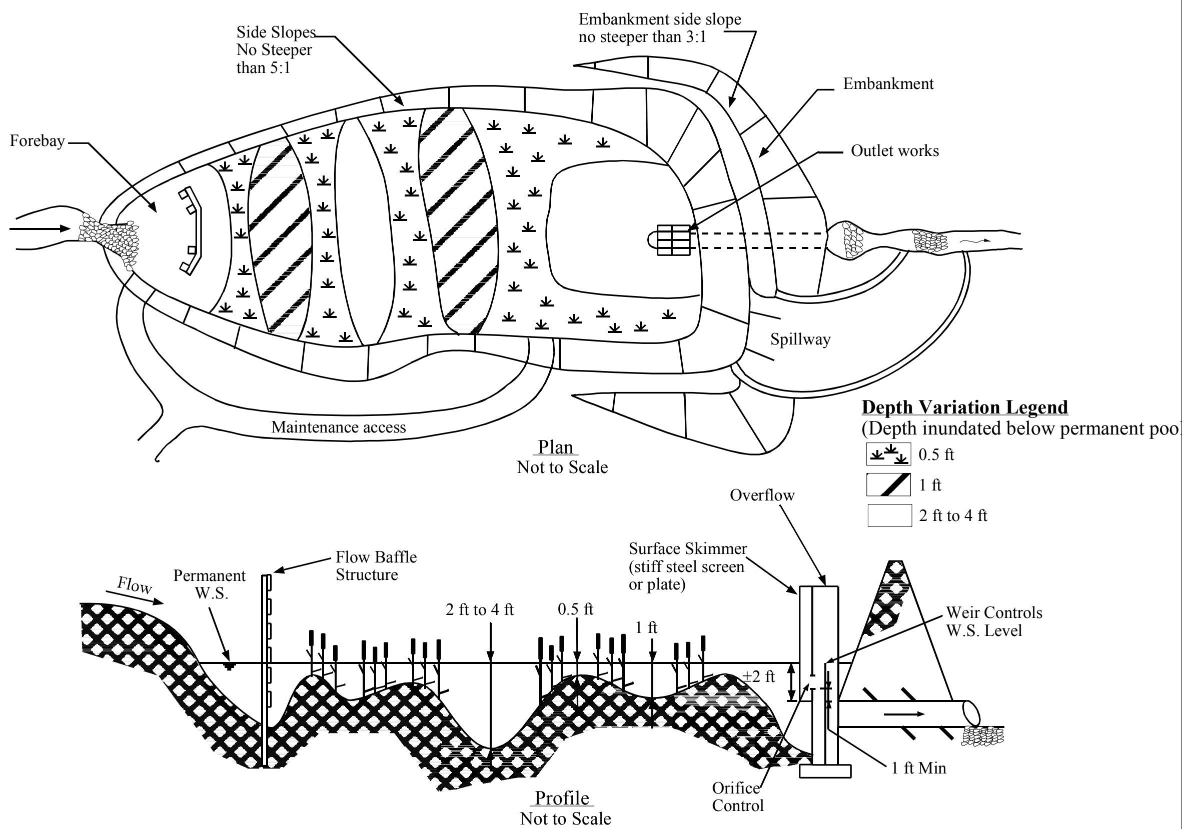


Figure 1. Plan and profile of a wetland pond (adapted from Urbanos, 1992).

1. *Natural Wetland Systems*. If a natural wetland site is potentially available for use to treat stormwater runoff, an assessment should be done to determine whether treatment of stormwater runoff would be appropriate. Important characteristics to look for in a potential natural wetland site include the wetland vegetation, the type of wetland, the existing wetland hydrology, and the geomorphology at the potential site.

   Wetland vegetation can be categorized as either emergent, floating, or submerged. Emergent vegetation is rooted in the sediments, but grows through the water and above the water surface. Floating vegetation is not rooted in the sediments, and has aquatic roots with plant parts partly submerged or fully exposed on the water or surface. Submerged vegetation includes aquatic plants such as algae or plants rooted in the sediments, with all plant parts growing within the water column. Pollutant removal rates generally improve with an increase in the diversity of the vegetation.

The depth of inundation will contribute to the pollutant removal efficiency. Generally, shallow water depths allow for higher pollutant removal efficiencies due to an increased amount of adsorption onto bottom sediments (Dormann, et al.,1988). The water budget of the wetland should be calculated to determine the mean residence time of the wetland, assuming there is no change in storage. Water budget calculations should include precipitation, overland flow from other sources, groundwater, evapotranspiration, and any stormwater runoff into and out of the wetland. Flow patterns in the wetland will affect the removal efficiency also. Meandering channels, slow-moving water and a large surface area will increase pollutant removal through increased sedimentation. Shallow, sheet flow also increases the pollutant removal capabilities, through assimilative processes. A deep pool sometimes improves the denitrification potential. A mixed flow pattern will increase overall pollutant removal efficiency (Dormann, et al., 1988).

2. *Artificial wetlands.* Site considerations should include the water table depth, soil/substrate, and space requirements. Because the wetland must have a source of flow, it is desirable that the water table is at or near the surface. This is not always possible. If runoff is the only source of inflow for the wetland, the water level often fluctuates and establishment of vegetation may be difficult. The soil or substrate of an artificial wetland should be loose loam to clay. A perennial base flow must be present to sustain the artificial wetland. The presence of organic material is often helpful in increasing pollutant removal and retention.

   Using a site where wetlands previously existed or where nearby wetlands still exist is recommended if possible. A hydrologic study should be done to determine if flooding occurs and saturated soils are present. A site where natural inundation is frequent is a good potential site (Mitsch and Gosselink, 1993). Loamy soils are required to permit plants to take root (Urbonas, 1992)

ADVANTAGES

1. Artificial wetlands offer natural aesthetic qualities, wildlife habitat, erosion control, and pollutant removal.
2. Artificial wetlands can offer good treatment following treatment by other BMPs, such as wet ponds, that rely upon settling of larger sediment particles (Urbonas, 1992). They are useful for large basins when used in conjunction with other BMPs.
3. Wetlands which are permanently flooded are less sensitive to polluted water inflows because the ecosystem does not depend upon the polluted water inflow.
4. Can provide uptake of soluble pollutants such as phosphorous, through plant uptake.
5. Can be used as a regional facility.

LIMITATIONS

1. Although the use of natural wetlands may be more cost effective than the use of an artificial wetland; environmental, permitting and legal issues may make it difficult to use natural wetlands for this purpose.
2. Wetlands require a continuous base flow.
3. If not properly maintained, wetlands can accumulate salts and scum which can be flushed out by large storm flows.
4. Regular maintenance, including plant harvesting, is required to provide nutrient removal.
5. Frequent sediment removal is required to maintain the proper functioning of the wetland.
6. A greater amount of space is required for a wetland system than is required for an extended/dry detention basin treating the same amount of area.
7. Although artificial wetlands are designed to act as nutrient sinks, on occasion, the wetland may periodically become a nutrient source.
8. Wetlands which are not permanently flooded are more likely to be affected by drastic changes in inflow of polluted water.
9. Cannot be used on steep unstable slopes or densely populated areas.
10. May be regulated under Chapter 15, Title 23, California Code of Regulations regarding waste disposal to land.
11. Threat of mosquitoes.
12. Hydraulic capacity may be reduced with plant overgrowth.

DESIGN CRITERIA

The wetland may be designed as either a stand-alone BMP, or as part of a larger non-point source treatment facility in conjunction with other devices, such as a wet pond, sediment forebay, or infiltration basin. Basic design elements and considerations are listed below.

1. *Volume.* The wetland pond should provide a minimum permanent storage equal to three-fourths of the water quality control volume. The full water quality capture volume should be provided above the permanent pool. Calculate the water quality volume to be mitigated by the wetland using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.
2. *Depth.* A constant shallow depth should be maintained in the wetland, at approximately 1 ft or less (Schueler, 1987; Boutiette and Duerring, 1994), with 0.5 ft being more desirable (Schueler, 1987). If the wetland is designed as a very shallow detention pond, the pond should provide the full water quality capture volume above the permanent pool level. The permanent wetland depth should be 6 to 12 inches deep. The depth of the water quality capture volume above the permanent pool should not exceed 2 ft (Urbonas, 1992). Regrading may be necessary to allow for this shallow depth over a large area.

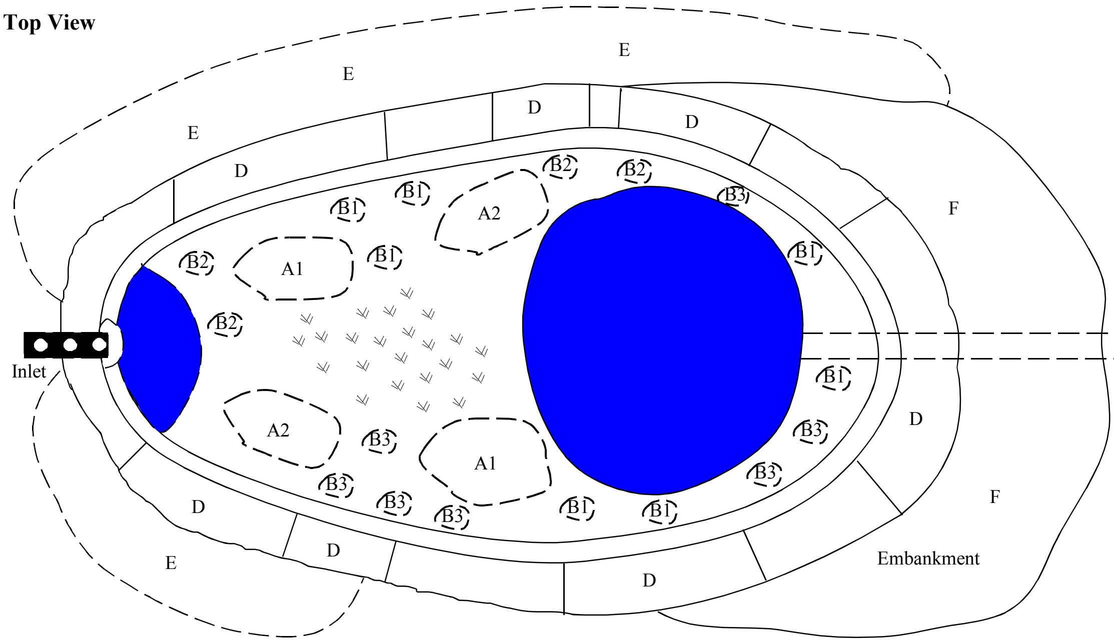
It may also be beneficial to create a wetland with a varying depth. A varying depth within the wetland will enable more diverse vegetation to flourish. Deep water offers a habitat for fish, creates a low velocity area where flow can be redistributed, and can enhance nitrification as a prelude to later denitrification if nitrogen removal is desired. Open-water areas may vary in depth between 2 and 4 ft (Urbonas, 1992).

3. *Surface Area.* Increasing the surface area of the pond increases the nutrient removal capability (Boutiette and Duerring, 1994). A general guideline for surface area is using a marsh area of two to three percent of the contributing drainage area. The minimum surface area of the pond can also be calculated by determining the nutrient loading to the wetland. The nutrient loading to a wetland used for stormwater treatment should not be more than 45 lbs/ac of phosphorus or 225 lbs/ac of nitrogen per year. The pond could be sized to meet this minimum size requirement if the annual nutrient load at the site is known (Schueler, 1987).
4. *Longitudinal Slope.* Both wetland ponds and channels require a near-zero longitudinal slope (Urbonas, 1992).
5. *Base flow.* Enough inflow must be present in the wetland to maintain wetland soil and vegetation conditions. A base flow should be used. Dependence on groundwater for a moisture supply is not recommended.
6. *Seeding.* It is important that any seed which is used to establish vegetation germinate and take root before the site is inundated, or the seeds will be washed away.
7. *Length to Width Ratio.* The pond should gradually expand from the inlet and gradually contract toward the outlet. The length to width ratio of the wetland should be 2:1 to 4:1, with a length to width ratio of 3:1 recommended (Urbonas, 1992)
8. *Emptying Time.* The water quality volume above the permanent pool should empty in 24 hours (Urbonas, 1992). This emptying time is not for the wetland itself, but for the additional storage above the wetland.
9. *Inlet and Outlet Protection.* Inlet and outlet protection should be provided to reduce erosion of the basin. Velocity should be reduced at the entrance to reduce resuspension of sediment by using a forebay. The forebay should be approximately 5 to 10 percent of the water quality capture volume. The outlet should be placed in an offbay at least 3 ft deep. It may be necessary to protect the outlet with a skimmer shield that starts approximately one-half of the depth below the permanent water surface and extends above the maximum capture volume depth. A skimmer can be constructed from a stiff steel screen material that has smaller openings than the outlet orifice or perforations.
10. *Infiltration Avoidance.* Loss of water through infiltration should be avoided. This can be done by compacting the soil, incorporating clay into the soil, or lining the pond with artificial lining.
11. *Side Slopes.* Side slopes should be gradual to reduce erosion and enable easy maintenance. Side slopes should not be steeper than 4:1, and 5:1 is preferable (Urbonas, 1992).
12. *Open Water.* At least 25 percent of the basin should be an open water area at least 2 ft deep if the device is exclusively designed as a shallow marsh. The open water

area will make the marsh area more aesthetically pleasing, and the combined water/wetland area will create a good habitat for waterfowl (Schueler, 1987). The combination of forebay, outlet and free water surface should be 30 to 50 percent, and this area should be between 2 and 4 ft deep. The wetland zone should be 50 to 70 percent of the area, and should be 6 to 12 inches deep (Urbonas, 1992).

13. *Freeboard.* The wetland pond should be designed with at least 1 ft of freeboard (Camp, Dresser and McKee, 1993).
14. *Use with Wet Pond.* Shallow marshes can be established at the perimeter of a wet pond by grading to form a 10 to 20 ft wide shallow bench. Aquatic emergent vegetation can be established in this area. A shallow marsh area can also be used near the inflow channel for sediment deposition (Schueler, 1987).
15. *Shape.* The shape is an important aspect of the wetland. It is recommended that a littoral shelf with gently sloping sides of 6:1 or milder to a point 24 to 28 inches below the water surface (Mitsch and Gosselink, 1993). Bottom slopes of less than one percent slope are also recommended.
16. *Soils*. Clay soils underlying the wetland will help prevent percolation of water to groundwater. However, clay soils will also prevent root penetration, inhibiting growth. Loam and sandy soils may then be preferable. A good design may be use of local soils at the upper layer with clay beneath to prevent infiltration (Mitsch and Gosselink, 1993).
17. *Vegetation.* Vegetation must be established in the wetland to aid in slowing down velocities, and nutrient uptake in the wetland. A dependable way of establishing vegetation in the wetland is to transplant live plants or dormant rhizomes from a nursery. Emergent plants may eventually migrate into the wetland from upstream, but this is not a reliable source of vegetation. Transplanting vegetation from existing wetland areas is not encouraged, as it may damage the existing wetland area. Seeding is more cost effective, but is also not reliable.

    Plants which should be planted on the wetland bottom include cattails, sedges, reeds, and wetland grasses. Berms and side-slopes should be planted with native or irrigated turf-forming grasses. To allow the vegetation to establish, it may be necessary to initially lower the permanent pool, perhaps 3 to 4 inches.



LEGEND
A1: Primary Wetland Species
A2: Primary Wetland Species
B1: Secondary Wetland Species
B2: Secondary Wetland Species
B3: Secondary Wetland Species
C: Deep Open Water Areas (No Vegetation)
D: Shoreline Fringe of Switchgrass, 50% of Safety Bench Perimeter
E: Wildlife Trees and Shrubs in Bugger
F: Maintain Grass Cover on Embankment (No Trees)

Figure 2. Examples of shallow marsh planting strategies (adapted from Schueler, 1987).

Table 1. Wetland plant species (Schueler, 1987).

Plant Name	*Zone*	*Form*	*Tolerance for Periodic Inundation*	*Comments*
Arrow Arum/ Duck Corn (Peltandra virginica)	2	Emergent	to 1 ft depth	Slow colonizer
Arrowhead/ Duck Potato (Saggitaria latifolia	2	Emergent	to 1 ft to 1.5 ft depth	Aggressive colonizer
Buttonbush (Cephalanthus occidentalis)	2, 3	Emergent	to 2 ft depth	Full sun required
Broomsedge (Andropogon virginianus)	2, 3	Perimeter	to 3 in depth	tolerates fluctuating water levels
Cattail (Typha spp.)	2, 3	Emergent	to 1 ft depth	Volunteer, aggressive colonizer

Coontail (Ceratophyllum demersum)	1	Submergent	1 ft to 6 ft deep	
Common Three-Square (Scirpus americanus)	2	Emergent	to 6 in deep	Fast colonizer, tolerates fluctuating water levels
Lizard's Tale (Saururus cernuus)	2	Emergent	to 1 ft	Rapid growing, shade tolerant
Marsh Hibiscus (Hibiscus moscheutos)	2, 3	Emergent	to 3 in	
Pickerelweed (Pontederia cordata)	2, 3	Emergent	to 0.5 ft to 1.0 ft	
Pond Weed (Potamegaton)	2, 3	Submergent	1.5 ft to 3.0 ft deep	
Rice Cutgrass (Leersia oryzoides)	2, 3	Emergent	to 3 in deep	Shade tolerant
Sedges (Cyperus spp.)	2, 3	Emergent	to 3 in deep	
Soft-stem Bulrush (Scirpus validus)	2, 3	Emergent up to 3 m	to 1.0 ft	Aggressive colonizer
Smartweed (Polygonum spp.)	2	Emergent	to 1 ft deep	Fast colonizer
Spatterdock (Nuphar luteum)	2	Emergent	to 1.5 ft	Fast colonizer, deals with fluctuating water levels
Switchgrass (Panicum virgatum)	2, 3, 4, 5, 6	Perimeter emergent	to 3 in deep	Tolerates wet/dry conditions
Sweet Flag (Acorus calamus)	2, 3	Perimeter emergent 2 to 4.5 ft	to 3 in deep	Slow colonizer, tolerates drying
Water Iris (Iris pseudoacorus)	2, 3	Perimeter	to 3 in deep	Attractive, ornamental
Water Cress (Nasturtium officianale)	Flowing water		to 6 in deep	

Zones listed in table:

1. Deep water pool (1 ft to 6 ft deep).
2. Shallow water bench (6 in to 12 in deep).
3. Shoreline fringe (regularly inundated).
4. Riparian fringe (periodically inundated).
5. Floodplain terrace (infrequently inundated).
6. Upland slopes (seldom or never inundated).

The vegetation planted in and around the wetland should correspond to the hydrology of the wetland. This information is unique to specific geographic locations. Topsoiling of the surface prior to planting may not always be necessary. The wetland plants themselves often produce a substantial amount of organic matter below the ground. Topsoiling may be needed if the soils are composed of mainly clay, rock, or pyritic soils. Although KY-31 Tall Fescue has often been used to reduce erosion, it may displace native grass and meadow species, and possibly overtake some of the wetland. Use of this grass type is questionable because of its aggressive nature (The Center for Watershed Protection, 1994).

REFERENCES

1. L. N. Boutiette and C. L. Duerring, 1994. *Massachusetts Nonpoint Source Management Manual, The Megamanual: A Guidance Document for Municipal Officials*, Massachusetts Department of Environmental Protection, Office of Watershed Management, Nonpoint Source Program, Boston, MA.

2. Camp, Dresser and McKee, Inc., Larry Walker Associates, 1993. *California Best Management Practices - Municipal*, California State Water Resources Council Board, Alameda, CA.

3. The Center for Watershed Protection, 1994. *Watershed Protection Techniques*, Vol. 1 No. 2, The Center for Watershed Protection, Silver Spring, MD.

4. M. E. Dormann, J. Hartigan, and B. Maestri, 1988. *Retention, Detention, and Overland Flow for Pollutant Removal from Highway Stormwater Runoff: Interim Guidelines for Management Measures*, FHWA/RD-87/056, Federal Highway Administration, Versar, Inc., Springfield, VA.

5. GKY and Associates, Inc. June 1996. *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032. Prepared for: US Department of Transportation, Federal Highway Administration. Washington, DC.

6. W. J. Mitsch and J. G. Gosselink, 1993. *Wetlands*, Van Nostrand Reinhold, New York, NY.

7. T. R. Schueler, 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*, Department of Environmental Programs, Metropolitan Washington Council of Governments, Washington, DC.

8. B. R. Urbonas, J. T. Doerfer, J. Sorenson, J. T. Wulliman, and T. Fairley, 1992. *Urban Storm Drainage Criteria Manual, Volume 3 - Best Management Practices, Stormwater Quality, Urban Drainage and Flood Control District*, Denver, CO.

9. Ventura Countywide Stormwater Quality Management Program, *Draft BMP CW: Constructed Wetlands*, June 1999. Ventura, CA.

The following is a known location where a Constructed Wetland was installed. The design of the installed wetland in the location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the location herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	Brand/Manufacturer	Owner/Client
Malibu	N/A	Las Virgenes MWD

B.5 DRY WELLS

DESCRIPTION

Commonly known as sumps, french drains, drainfields, and shallow injection wells, dry wells and other such devices simply use gravity to emplace stormwater into the subsurface. A dry well is constructed by digging a hole in the ground and filling it with an open graded aggregate. Stormwater runoff is then diverted to the dry well for infiltration into the ground, allowing it to be stored in the voids. While it may seem harmless and cost-effective at first glance to use these dry wells to infiltrate into the ground, in reality, the impact to groundwater quality from these devices varies and is highly dependent upon many factors.

ADVANTAGES

1. Requires minimal space to install.
2. Low installation costs.
3. Reduces amount of runoff.
4. Provides groundwater recharge.
5. Can serve small impervious areas like rooftops.
6. Helps to disconnect impervious surfaces.

LIMITATIONS

1. Offers little pretreatment which may cause clogging.
2. Dry wells should not be installed where hazardous or toxic materials are used, handled, stored or where a spill of such materials would drain into the dry well.
3. Risk of groundwater contamination in very coarse soils, may require groundwater monitoring.
4. Not suitable on fill sites or steep slopes.
5. Must have a minimum of 3 to 4 feet between the bottom of the dry well and the seasonal high water table.
6. Dry wells service a limited drainage area, typically only rooftop runoff.
7. Dry wells must be located at least 10 feet away, on the down slope side of the structure, from building foundations to prevent seepage.
8. Stormwater runoff carrying bacteria, sediment, fertilizer, pesticides and other chemicals may flow directly into the groundwater.
9. Loss of infiltrative capacity and high maintenance cost in fine soils.
10. Low removal of dissolved pollutants in very coarse soils.
11. Soils must be permeable.
12. Not recommended for use with commercial rooftops unless adequacy of pretreatment is assured.

DESIGN CRITERIA

1. Calculate the volume of stormwater to be mitigated by the dry well using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.
2. For drainage systems draining paved areas, a minimum of one standard dry well shall be installed for each 6,000 cubic feet of drainage volume, 15,000 cubic feet of drainage volume for landscaped areas.
3. A standard dry well system shall have a minimum effective settling capacity of 1,000 gallons per chamber. (Effective settling capacity equals the distance from the bottom of the settling chamber to the height of the overflow outlet.)
4. Systems are to use a shielding device to enhance separation of petrochemicals from water by gravity differentials. Such devices are to be vented to prevent siphoning or skimming of floating petrochemicals.
5. Systems are to use a hydrophobic petrochemical absorbent with a minimum capacity of at least 128 ounces.
6. A device to screen floating debris such as paper, leaves and other trash must be used to retain such material within the settling chamber.
7. The system must be accessible from the surface for maintenance and inspection. Standard minimum opening is a 24 inch diameter nominal size cast iron grating or manhole cover bolted in at least two locations.
8. A minimum penetration of 10 continuous feet into permeable porous soils is recommended for standard installations. In unstable sandy, gravely soils where “belling out” is a problem, an equivalent of 200 square feet of sidewall area is acceptable (bottom area is not to be included). If such penetration is not achieved or if the required design performance rate is greater than 0.25 cubic feet per second, a constant head percolation test on the completed system will be required to determine performance.
9. Multiple dry wells should be spaced a minimum of 100 feet apart center to center.
10. Inlet connecting pipes to dry well systems should be a maximum of 6 inches in diameter.
11. Dry well surface grates should be raised a minimum of 3 inches above bottom of landscaped retention basins.
12. During construction, dry well inlets (including any remote inlets) should be sealed with two layers of UV protected geotextile fabric to prevent sediments from entering the dry wells until paving and landscaping are complete.

REFERENCES

1. Arizona Department of Environmental Quality, 1995. *Guidance for Design,*

Installation, Operation, and Maintenance of Dry Wells, Arizona Department of Environmental Quality, AZ.

2. DEQ Storm Water Management Guidelines, Department of Environmental Quality, State of Oregon. http://waterquality.deq.state.or.us/wq/groundwa/swmgmtguide.htm

3. *Low-Impact Development Design Manual*, November 1997. Department of Environmental Resources, Prince George's County, MD.

4. T. Richman, J. Worth, P. Dawe, J. Aldrich, and B. Ferguson, 1997. *Start at the Source: Residential Site Planning and Design Guidance Manual for Stormwater Quality Protection*, Bay Area Stormwater Management Agencies Association, San Francisco, CA.

The following is a known location where a Drywell was installed. The design of the installed drywell in the location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the location herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	Brand/Manufacturer	Owner/Client
Calabasas	N/A	City of Calabasas

B.6 EXTENDED/DRY DETENTION BASINS OR UNDERGROUND DETENTION TANKS

DESCRIPTION

Extended/dry detention basins are depressed basins that temporarily store a portion of stormwater runoff following a storm event. Underground detention tanks function similar to detention basins. However, since underground detention tanks are located below ground, the surface above these systems can be utilized for other more useful needs (parking lots, sidewalks, landscaping adjacent to buildings, etc). Water is controlled by means of a hydraulic control structure (orifice and/or weirs) to restrict outlet discharge. The extended/dry detention basins and underground detention tanks normally do not have a permanent water pool between storm events. The objectives of both systems are to remove particulate pollutants and to reduce maximum runoff values associated with development to their pre-development levels. Detention basin facilities may be berm-encased areas or excavated basins. Detention tank facilities may be corrugated metal pipe, concrete pipe, or vaults.

ADVANTAGES

1. Modest removal efficiencies for the larger particulate fraction of pollutants.
2. Removal of sediment and buoyant materials. Nutrients, heavy metals, toxic materials, and oxygen-demanding particles are also removed with sediment substances associated with the particles.
3. Can be designed for combined flood control and stormwater quality control.
4. Requires less capital cost and land area when compared to wet pond BMP.
5. Downstream channel protection when properly designed and maintained.

LIMITATIONS

1. Require sufficient area and hydraulic head to function properly.
2. Generally not effective in removing dissolved and finer particulate size pollutants from stormwater.
3. Some constraints other than the existing topography include, but are not limited to, the location of existing and proposed utilities, depth to bedrock, location and number of existing trees, and wetlands.
4. Extended/dry detention basins have moderate to high maintenance requirements.
5. Sediments can be resuspended if allowed to accumulate over time and escape through the hydraulic control to downstream channels and streams.
6. Some environmental concerns with using extended/dry detention basins, include potential impact on wetlands, wildlife habitat, aquatic biota, and downstream water quality.
7. May create mosquito breeding conditions and other nuisances.

DESIGN CRITERIA

EXTENDED/DRY DETENTION BASINS:

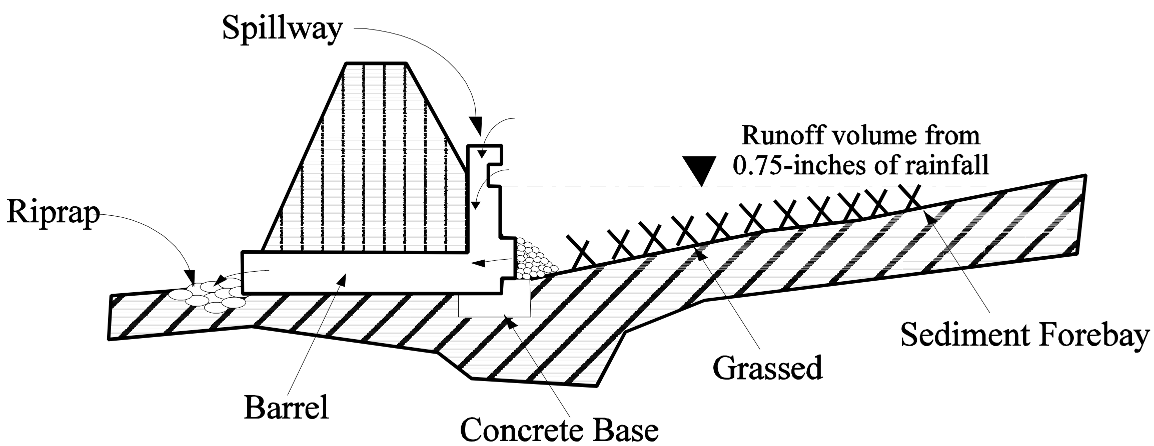


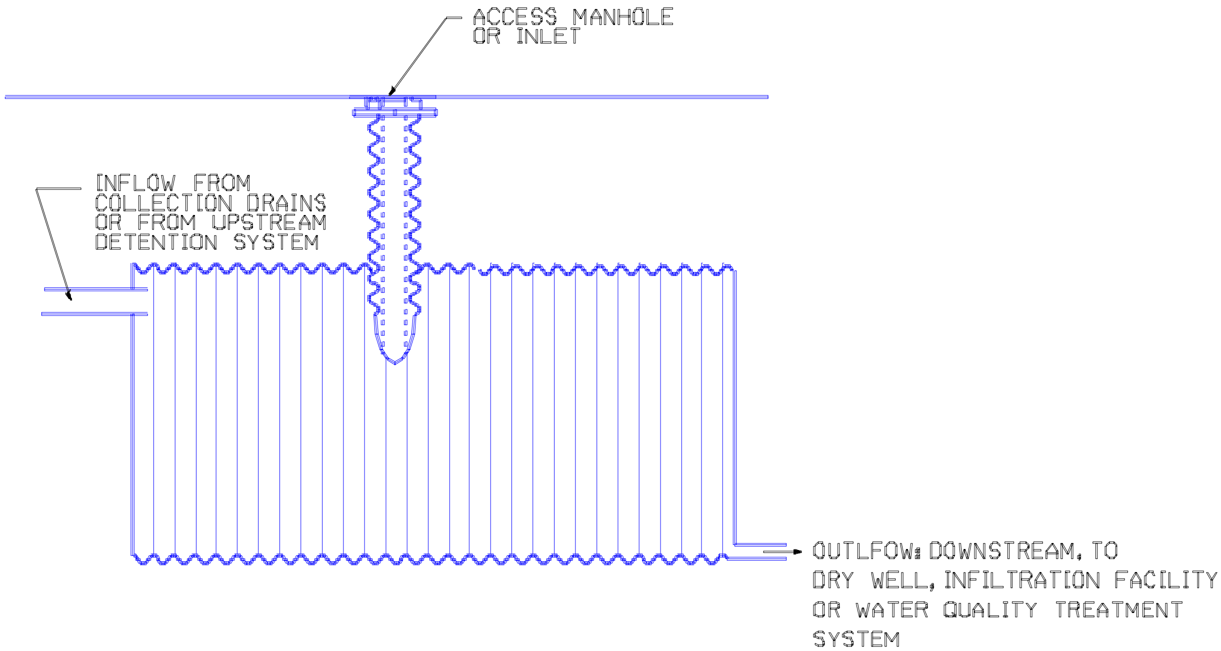
Figure 1. Conceptual elements of typical extended/dry detention structures.

Criteria	***Design Considerations***
Storage volume	Calculate the volume of stormwater to be mitigated by the extended/dry detention basin using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*. Provide a storage volume for 120 percent of the runoff volume generated from 0.75-inches of rainfall above the lowest outlet in the basin. The additional 20 percent of storage volume provides for sediment accumulation and the resultant loss in storage volume.
Emptying time	A 24- to 48-hour emptying time should be used for the runoff volume generated from 0.75-inches of rainfall, with no more than 50 percent of the 0.75-inches of rainfall being released in 12 hours.
Basin geometry	Shape the pond with a gradual expansion from the inlet and a gradual contraction toward the outlet, thereby limiting short circuiting. The basin length to width ratio should be not less than 4.
Two-stage design	A two-stage design with a lower frequency pool that fills often with frequently occurring runoff minimizes standing water and sediment deposition in the remainder of the basin can enhance water quality benefits. The bottom stage should store 10 to 25 percent of the runoff volume generated from 0.75-inches of rainfall.
Low-flow channel	Conveys low base flows from the forebay to the outlet. Erosion protection should be provided for the low-flow channel.

Basin side slopes	Slopes should be stable and gentle enough to limit rill erosion and facilitate maintenance access and needs. Side slopes should be no steeper than 4:1 (H:V), preferably flatter.
Inlet	Dissipate flow energy at basin's inflow point(s) to limit erosion and promote particle sedimentation.
Forebay design	Provide the opportunity for larger particles to settle out in an area that has, as a useful refinement, a solid surface bottom to facilitate mechanical sediment removal. The forebay volume should be 5 to 10 percent of the runoff volume generated from 0.75-inches of rainfall.
Outlet design	Use a water quality outlet that is capable of slowly releasing the runoff volume generated from 0.75-inches of rainfall over a 24- to 48-hour period. A perforated riser can be used in conjunction with orifices and a weir box opening above it to control larger storm outflows. A cutoff collar should be considered for the outlet pipe to control seepage.
Perforation protection	Provide a crushed rock blanket of sufficient size to prevent clogging of the primary water quality outlet while not interfering significantly with its hydraulic capacity.
Dam embankment	The embankment should be designed not to fail during a 100-yr and larger storm. Embankment slopes should be no steeper than 3:1 (H:V), preferably 4:1, and flatter, and planted with turf-forming grasses. Poorly compacted native soils should be excavated and replaced. Embankment soils should be compacted to at least 95 percent of their maximum density. Spillway structures and overflows should be designed in accordance with local drainage criteria.
Vegetation	Bottom vegetation provides erosion control and sediment entrapment. Basin bottom, berms, and side-sloping areas may be planted with native grasses or with irrigated turf, depending on the local setting.
Maintenance access	Access to the forebay and outlet area shall be provided to maintenance vehicles. Maximum grades should be eight percent, and a solid driving surface of gravel, rock, concrete, or gravel-stabilized turf should be provided.

UNDERGROUND DETENTION TANKS:

Figure 2. Conceptual elements of typical underground detention structures.



CRITERIA	*DESIGN CONSIDERATIONS*
Storage volume	Calculate the volume of stormwater to be mitigated by the underground detention tank using the Los Angeles County Department of Public Works Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0. 75-inches of Rainfall Provide a storage volume for 120 percent of the runoff volume generated from 0.75-inches of rainfall above the lowest outlet in the tank. The additional 20 percent of storage volume provides for sediment accumulation and the resultant loss in storage volume.
Emptying time	A 24- to 48-hour emptying time should be used for the runoff volume generated from 0.75-inches of rainfall, with no more than 50 percent of the 0.75-inches of rainfall being released in 12 hours.
Tank geometry	Tank should be constructed to fit within the site layout.
Low-flow outlet	Conveys low base flows from the tank to the outlet.
Outlet design	Use a water quality outlet that is capable of slowly releasing the runoff volume generated from 0.75-inches of rainfall over a 24- to 48-hour period.
Over flow design	Runoff volume generated from a storm greater than a 0.75-inches rainfall event should be diverted via a flow splitter placed at the tank entrance or an overflow weir/orifice system designed in conjunction with the outlet of the tank.
Maintenance access	Access to the tanks shall be provided for maintenance personal.

REFERENCES

1. Camp, Dresser and McKee, Inc., Larry Walker Associates, 1993. *California Best Management Practices - Municipal*, California State Water Resources Council Board, Alameda, CA.

2. GKY and Associates, Inc. June 1996. *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032. Prepared for: US Department of Transportation, Federal Highway Administration. Washington, DC.

3. K. H. Lichten, June 1997. *Compilation of New Development Stormwater Treatment Controls in the San Francisco Bay Area*, Bay Area Stormwater Management Agencies Association, San Francisco, CA.

4. *Low-Impact Development Design Manual*, November 1997. Department of Environmental Resources, Prince George's County, MD.

5. T. R. Schueler, 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*, Department of Environmental Programs, Metropolitan Washington Council of Governments, Washington, DC.

6. Ventura Countywide Stormwater Quality Management Program, *Draft BMP DD: Extended Dry Detention Basins*, June 1999. Ventura, CA.

7. G. K. Young and F. Graziano, 1989. *Outlet Hydraulics of Extended Detention Facilities*, Northern Virginia Planning District Commission, Annandale, VA.

The following is a list of known locations where an Extended Dry Detention Basin was installed. The design of the installed basin in each location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the locations herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	**Brand/Manufacturer**	**Owner/Client**
I-5/I-605 Intersection	N/A	Caltrans
I-605/SR 91 Intersection	N/A	Caltrans

B.6 EXTENDED/DRY DETENTION BASINS

DESCRIPTION

Extended/dry detention basins are depressed basins that temporarily store a portion of stormwater runoff following a storm event. Water is controlled by means of a hydraulic control structure to restrict outlet discharge. The extended/dry detention basins normally do not have a permanent water pool between storm events. The objectives of extended/dry detention basins are to remove particulate pollutants and to reduce maximum runoff values associated with development to their pre-development levels. Detention facilities may be berm-encased areas, excavated basins, or tanks.

ADVANTAGES

1. Modest removal efficiencies for the larger particulate fraction of pollutants.
2. Removal of sediment and buoyant materials. Nutrients, heavy metals, toxic materials, and oxygen-demanding particles are also removed with sediment substances associated with the particles.
3. Can be designed for combined flood control and stormwater quality control.
4. Requires less capital cost and land area when compared to wet pond BMP.
5. Downstream channel protection when properly designed and maintained.

LIMITATIONS

1. Require sufficient area and hydraulic head to function properly.
2. Generally not effective in removing dissolved and finer particulate size pollutants from stormwater.
3. Some constraints other than the existing topography include, but are not limited to, the location of existing and proposed utilities, depth to bedrock, location and number of existing trees, and wetlands.
4. Extended/dry detention basins have moderate to high maintenance requirements.
5. Sediments can be resuspended if allowed to accumulate over time and escape through the hydraulic control to downstream channels and streams.
6. Some environmental concerns with using extended/dry detention basins, include potential impact on wetlands, wildlife habitat, aquatic biota, and downstream water quality.
7. May create mosquito breeding conditions and other nuisances.

DESIGN CRITERIA

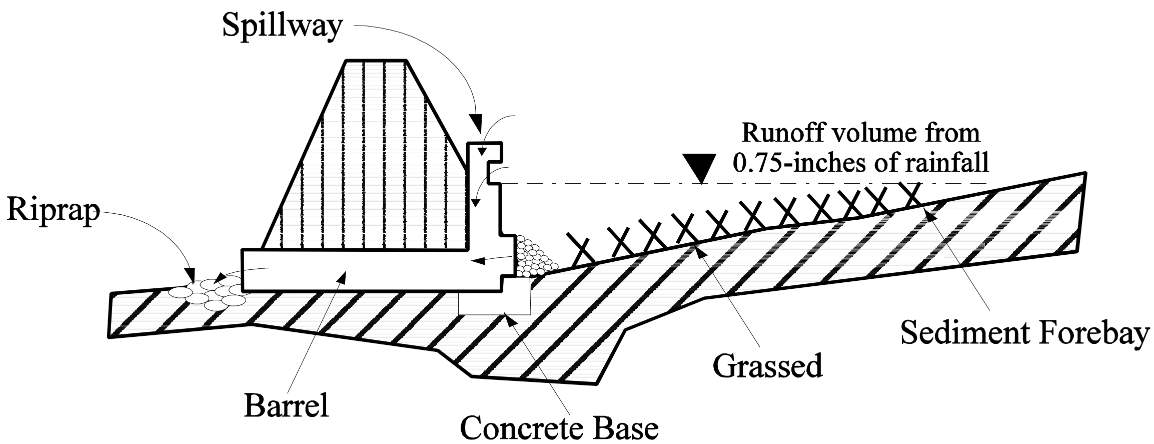


Figure 1. Conceptual elements of typical extended/dry detention structures.

Criteria	*Design Considerations*
Storage volume	Calculate the volume of stormwater to be mitigated by the extended/dry detention basin using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*. Provide a storage volume for 120 percent of the runoff volume generated from 0.75-inches of rainfall above the lowest outlet in the basin. The additional 20 percent of storage volume provides for sediment accumulation and the resultant loss in storage volume.
Emptying time	A 24- to 48-hour emptying time should be used for the runoff volume generated from 0.75-inches of rainfall, with no more than 50 percent of the 0.75-inches of rainfall being released in 12 hours.
Basin geometry	Shape the pond with a gradual expansion from the inlet and a gradual contraction toward the outlet, thereby limiting short circuiting. The basin length to width ratio should be not less than 4.
Two-stage design	A two-stage design with a lower frequency pool that fills often with frequently occurring runoff minimizes standing water and sediment deposition in the remainder of the basin can enhance water quality benefits. The bottom stage should store 10 to 25 percent of the runoff volume generated from 0.75-inches of rainfall.
Low-flow channel	Conveys low base flows from the forebay to the outlet. Erosion protection should be provided for the low-flow channel.
Basin side slopes	Slopes should be stable and gentle enough to limit rill erosion and facilitate maintenance access and needs. Side slopes should be no steeper than 4:1 (H:V), preferably flatter.

Inlet	Dissipate flow energy at basin's inflow point(s) to limit erosion and promote particle sedimentation.
Forebay design	Provide the opportunity for larger particles to settle out in an area that has, as a useful refinement, a solid surface bottom to facilitate mechanical sediment removal. The forebay volume should be 5 to 10 percent of the runoff volume generated from 0.75-inches of rainfall.
Outlet design	Use a water quality outlet that is capable of slowly releasing the runoff volume generated from 0.75-inches of rainfall over a 24- to 48-hour period. A perforated riser can be used in conjunction with orifices and a weir box opening above it to control larger storm outflows. A cutoff collar should be considered for the outlet pipe to control seepage.
Perforation protection	Provide a crushed rock blanket of sufficient size to prevent clogging of the primary water quality outlet while not interfering significantly with its hydraulic capacity.
Dam embankment	The embankment should be designed not to fail during a 100-yr and larger storm. Embankment slopes should be no steeper than 3:1 (H:V), preferably 4:1, and flatter, and planted with turf-forming grasses. Poorly compacted native soils should be excavated and replaced. Embankment soils should be compacted to at least 95 percent of their maximum density. Spillway structures and overflows should be designed in accordance with local drainage criteria.
Vegetation	Bottom vegetation provides erosion control and sediment entrapment. Basin bottom, berms, and side-sloping areas may be planted with native grasses or with irrigated turf, depending on the local setting.
Maintenance access	Access to the forebay and outlet area shall be provided to maintenance vehicles. Maximum grades should be eight percent, and a solid driving surface of gravel, rock, concrete, or gravel-stabilized turf should be provided.

REFERENCES

1. Camp, Dresser and McKee, Inc., Larry Walker Associates, 1993. *California Best Management Practices - Municipal*, California State Water Resources Council Board, Alameda, CA.

2. GKY and Associates, Inc. June 1996. *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032. Prepared for: US Department of Transportation, Federal Highway Administration. Washington, DC.

3. K. H. Lichten, June 1997. *Compilation of New Development Stormwater Treatment Controls in the San Francisco Bay Area*, Bay Area Stormwater Management Agencies Association, San Francisco, CA.

4. *Low-Impact Development Design Manual*, November 1997. Department of Environmental Resources, Prince George's County, MD.

5. T. R. Schueler, 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*, Department of Environmental Programs, Metropolitan Washington Council of Governments, Washington, DC.

6. Ventura Countywide Stormwater Quality Management Program, *Draft BMP DD: Extended Dry Detention Basins*, June 1999. Ventura, CA.

7. G. K. Young and F. Graziano, 1989. *Outlet Hydraulics of Extended Detention Facilities*, Northern Virginia Planning District Commission, Annandale, VA.

The following is a list of known locations where an Extended Dry Detention Basin was installed. The design of the installed basin in each location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the locations herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	**Brand/Manufacturer**	**Owner/Client**
I-5/I-605 Intersection	N/A	Caltrans
I-605/SR 91 Intersection	N/A	Caltrans

B.7 INFILTRATION BASINS

DESCRIPTION

An infiltration basin is a surface pond which captures first-flush stormwater and treats it by allowing it to percolate into the ground and through permeable soils. As the stormwater percolates into the ground, physical, chemical, and biological processes occur which remove both sediments and soluble pollutants. Pollutants are trapped in the upper layers of the soil, and the water is then released to groundwater. Infiltration basins are generally used for drainage areas between 5 and 50 acres (Boutiette and Duerring, 1994). For drainage areas less than 5 acres, an infiltration trench or other BMP may be more appropriate. For drainage areas greater than 50 acres, maintenance of an infiltration basin would be burdensome, and an extended/dry detention basin or wet pond may be more appropriate. Infiltration basins are generally dry except immediately following storms, but a low-flow channel may be necessary if a constant base flow is present.

Infiltration basins create visible surface ponds that dissipate because water is infiltrated through the pond bottom; infiltration trenches hide surface drainage in underground void regions and the water is infiltrated below the rocks. Infiltration basins effectively remove soluble pollutants because processes such as adsorption and biological processes remove these soluble pollutants from stormwater. This kind of treatment is not always available in other kinds of BMPs.

Several types of infiltration basins exist. They can be either in-line or off-line, and may treat different volumes of water, such as the water quality volume or the 2-year or 10-year storm. A full infiltration basin is built to hold the entire water quality volume, and the only outlet from the pond is an emergency spillway. More commonly used is the combined infiltration/detention basin, where the outflow is controlled by a vertical riser. Excess flow volume spills over the drop inlet at the top of the riser, and very large storms will exit through the emergency spillway. Other types of basins include the side-by-side basin, and the off-line infiltration basin. The side by side basin consists of a basin with an elevated channel to carry base flows running along one of its sides. Storm flows also flow through the elevated channel, but overflow the channel and enter the basin when they become deep enough. An off-line infiltration basin is used to treat the first flush runoff, while higher flows remain in the main channel.

ADVANTAGES

1. High removal capability for particulate pollutants and moderate removal for soluble pollutants.
2. Groundwater recharge helps to maintain dry-weather flows in streams.
3. Can minimize increases in runoff volume.

4. When properly designed and maintained, it can replicate pre-development hydrology more closely than other BMP options.
5. Basins provide more habitat value than other infiltration systems.

LIMITATIONS

1. High failure rate due to clogging and high maintenance burden.
2. Low removal of dissolved pollutants in very coarse soils.
3. Not suitable on fill slopes or steep slopes.
4. Risk of groundwater contamination in very coarse soils, may require groundwater monitoring.
5. Should not be used if significant upstream sediment load exists.
6. Slope of contributing watershed needs to be less than 20 percent.
7. Not recommended for discharge to a sole source aquifer.
8. Cannot be located within 100 feet of drinking water wells.
9. Metal and petroleum hydrocarbons could accumulate in soils to potentially toxic levels.
10. Relatively large land requirement.
11. Only feasible where soil is permeable and there is sufficient depth to bedrock and water table.
12. Need to be located a minimum of 10 feet down gradient and 100 feet up gradient from building foundations because of seepage problems.
13. Infiltration facilities could fall under Chapter 15, Title 23, of California Code of Regulations regarding waste disposal to land.

DESIGN CRITERIA

Designing an infiltration basin is a process in which several factors are examined. The soil type and the drainage area are important factors in infiltration basin design. If either one of these two is inappropriate, the infiltration basin will not function properly. The steps in the design of an infiltration basin are listed below.

1. *Drainage Area.* Drainage areas between 5 and 50 acres are good candidates for infiltration basins. Infiltration trenches might be more appropriate for smaller drainage areas, while retention ponds are more appropriate for larger drainage areas (Schueler, 1987).
2. *Soils.* The site must have the appropriate soil, or the basin will not function properly. It is important that the soil be able to accept water at a minimum infiltration rate. Soils with an infiltration rate of less than 0.3 inches per hour, are not suitable sites for infiltration basins. Soils with a high percentage of clay are also undesirable, and should not be used if the percentage of clay is greater than 30. Generally, areas with fine to moderately fine soils are prevalent should not be

considered as sites, because these soils do not have a high infiltration rate. Soils with greater than 40 percent combined silt/clay also should not be used. A series of soil cores should be taken to a depth of at least 5 feet below the proposed basin floor elevation to determine which kinds of soils are prevalent at the potential site.

3. *Volume.* Calculate the volume of stormwater to be mitigated by the infiltration basin using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.
4. *Slope.* The basin floor should be as flat as possible to ensure an even infiltration surface and should not be or greater than 5 percent slope. Also, side slopes should have a maximum slope of 3 horizontal to 1 vertical (Schueler, 1987).
5. *Vegetation.* Vegetation should be established as soon as possible. Water-tolerant reed canary grass or tall fescue should be planted on the floor and side slopes of the basin (Schueler, 1987). Root penetration and thatch formation maintains and sometimes improves infiltration capacity of the basin floor. Also, the vegetation helps to trap the pollutants by growing through the accumulated sediment and preventing resuspension. The vegetation also helps reduce pollution levels by taking up soluble nutrients for growth and converting them into less available pollutant forms.
6. *Inlet.* Sediment forebays or riprap aprons should be installed to reduce flow velocities and trap sediments upon entrance to the basin. Flow should be evenly distributed over the basin floor by a riprap apron. The inlet pile or channel should enter the basin at floor level to prevent erosion (Schueler, 1987).
7. *Drainage Time.* The basin should completely drain within 24 hours to avoid the risk of it not being empty before the next storm. Overestimation of the future infiltration capacity can result in a standing water problem. Ponds with detention times of less than six hours are not effectively removing pollutants from the storm flows (Schueler, 1987). The most common problem is setting the elevation and size of the low-flow orifice. If the orifice is too large, runoff events pass through the basin too quickly. If the low-flow orifice diameter is too narrow, there is a risk of creating an undesirable quasi-permanent pool.
8. *Buffer Zone.* A 25 foot buffer should be placed between the edge of the basin floor, and the nearest adjacent lot (Schueler, 1987). The buffer should consist of water tolerant, native plant species that provide food and cover for wildlife. This buffer zone may also act as a screen if necessary.
9. *Access.* Access to the basin floor should be provided for light equipment (Schueler, 1987).
10. *Water Table.* The basin floor should be a minimum of 10 feet above the water table.
11. *Maximum Depth.* The maximum allowable depth is equal to the infiltration rate multiplied by the maximum allowable dewatering time (24 hours).
12. *Freeboard.* A minimum of 2 feet of freeboard should be available between the

spillway crest and the top of the dam (Dormann, et al., 1988).

13. *Emergency Spillway.* The emergency spillway should be able to safely pass the 100-year flood.
14. *Surface Area of the Basin Floor.* If the surface area of the basin floor is increased, the infiltration rate and quantity of runoff which can be infiltrated will be increased. Larger surface areas can also help compensate for clogging on the surface.

REFERENCES

1. L. N. Boutiette and C. L. Duerring, 1994. *Massachusetts Nonpoint Source Management Manual, The Megamanual: A Guidance Document for Municipal Officials*, Massachusetts Department of Environmental Protection, Office of Watershed Management, Nonpoint Source Program, Boston, MA.

2. Camp, Dresser and McKee, Inc., Larry Walker Associates, 1993. *California Best Management Practices - Municipal*, California State Water Resources Council Board, Alameda, CA.

3. M. E. Dormann, J. Hartigan, and B. Maestri, 1988. *Retention, Detention, and Overland Flow for Pollutant Removal from Highway Stormwater Runoff: Interim Guidelines for Management Measures*, FHWA/RD-87/056, Federal Highway Administration, Versar, Inc., Springfield, VA.

4. GKY and Associates, Inc. June 1996. *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032. Prepared for: US Department of Transportation, Federal Highway Administration. Washington, DC.

5. T. R. Schueler, 1987. *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*, Department of Environmental Programs, Metropolitan Washington Council of Governments, Washington, DC.

6. Ventura Countywide Stormwater Quality Management Program, *Draft BMP IN: Infiltration Facilities*, June 1999. Ventura, CA.

The following is a known location where an Infiltration Basin was installed. The design of the installed basin in the location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the location herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	Brand/Manufacturer	Owner/Client
I 605/SR 91	N/A	Caltrans

B.8 INFILTRATION TRENCHES

DESCRIPTION

An infiltration trench is basically an excavated trench that has been lined with filter fabric and backfilled with stone to form an underground basin. Runoff is diverted into the trench and either infiltrates into the soil, or enters a perforated pipe underdrain and is routed to an outflow facility. The depths of an infiltration trench generally range between 3 and 8 feet (Schueler, 1987) and may change when site-specific factors are considered. Smaller trenches are used for water quality, while larger trenches can be constructed if stormwater quantity control is required (Schueler, 1987). Trenches are not usually feasible in ultra-urban or retrofit situations where the soils have low permeability or low voids (Schueler, 1992). They should be installed only after the contributing area has stabilized to minimize runoff of sediments.

Infiltration trenches and infiltration basins follow similar design logic. The differences are that the former is for small drainage areas and stores runoff out of sight, within a gravel or aggregate matrix, whereas the latter is for larger drainage areas and water is stored in a visible surface pond.

Infiltration trenches effectively remove soluble and particulate pollutants. They can provide groundwater recharge by diverting 60 to 90 percent of annual urban runoff back into the soil (Boutiette and Duerring, 1994). They are generally used for drainage areas less than 10 acres, but some references cite 5 acres as a maximum size drainage area (Schueler, 1987, 1992). Potential locations include residential lots, commercial areas, parking lots, and adjacent to road shoulders. Trenches are only feasible on permeable soils (sand and gravel), and where the water table and bedrock are situated well below the bottom of the trench (Boutiette and Duerring, 1994; Schueler, 1987). Trenches are frequently used in combination with grassed sales. Trenches should not be used to trap course sediments, because the large sediment will clog the trench. Grass buffers can be installed to capture sediment before it enters the trench.

ADVANTAGES

1. Provides groundwater recharge.
2. Trenches fit into small areas.
3. Good pollutant removal capabilities.
4. Can minimize increases in runoff volume.
5. Can fit into medians, perimeters, and other unused areas of a development site.
6. Helps replicate pre-development hydrology and increases dry weather baseflow.

LIMITATIONS

1. Slope of contributing watershed needs to be less than 20 percent.
2. Soil should have infiltration rate greater than 0.3 inches per hour and clay content less than 30 percent.
3. Drainage area should be between 1 to 10 acres.
4. The bottom of infiltration trench should be at least 4 feet above the underlying bedrock and the seasonal high water table.
5. High failure rates of conventional trenches and high maintenance burden.
6. Low removal of dissolved pollutants in very coarse soils.
7. Not suitable on fill slopes or steep slopes.
8. Risk of groundwater contamination in very coarse soils, may require groundwater monitoring.
9. Infiltration facilities could fall under Chapter 15, Title 23, of California Code of Regulations regarding waste disposal to land.
10. Cannot be located within 100 feet of drinking water wells.
11. Need to be located a minimum of 10 feet down gradient and 100 feet up gradient from building foundations because of seepage problems.
12. Should not be used if upstream sediment load cannot be controlled prior to entry into the trench.
13. Metals and petroleum hydrocarbons could accumulate in soils to potentially toxic levels.

DESIGN CRITERIA

Infiltration trenches can be categorized both by trench type, and as surface or below ground. Special inlets are required for underground trenches to prevent sediment and oil or grease from clogging the infiltration trench (Schueler, 1987). Surface trenches are commonly used where land is not limiting and underground trenches are better suited for development with minimal land availabilities.

1. *Volume.* Calculate the volume of stormwater to be mitigated by the infiltration trench using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.
2. *Dimensions.* Generally, soils with low infiltration rates require a higher ratio of bottom surface area to storage volume (Northern Virginia Planning District Commission and Engineers and Surveyors Institute, 1992). The following formulas can be used to determine the dimensions of the infiltration basin:

$$H_{Tmax} = \frac{E \times t_{max}}{P}$$

$$H_{Tmin} = \frac{E \times t_{min}}{P}$$

$$A = \frac{V}{E \times t_{max}}$$

Where:

H_{Tmax}, H_{Tmin}	=	Maximum and minimum trench depths (ft).
E	=	Infiltration rate in length per unit time (ft/hr).
t_{max}, t_{min}	=	Maximum and minimum target drain-time (hr).
P	=	Pore volume ratio of stone aggregate (% porosity/100).
V	=	Fluid storage volume requirement (ft^3).
A	=	Trench bottom surface area (ft^2).

The actual storage volume of the facility is the void ratio multiplied by the total volume of the trench. The available land and other constraints such as depth to bedrock or water table are used to determine the final dimensions of the trench.

3. *Buffer Strip/Special Inlet.* A grass filter strip a minimum of 20 feet should surround the trench on all sides over which surface flow reaches an above-ground trench. A special inlet can be used to prevent floatable material, solids, grease, and oil from entering trenches which are located below ground.
4. *Filter Fabric.* The bottom and sides of the trench should be lined with filter fabric soon after the trench is excavated. The fabric should be flush with the sides, overlap on the order of 2 feet over the seams, and not have trapped air pockets. As an alternative, 6 inches of clean, washed sand may be placed on the bottom of the trench instead of filter fabric.
5. *Grass Cover.* If the trench is grass covered, at least 1 foot of soil should be over the trench for grass substrate.
6. *Surface Area.* The surface area of the trench can be engineered to the site with the understanding that a larger surface area of the bottom of the trench increases infiltration rates and helps to reduce clogging and that depth may be limited by

seasonal groundwater.

7. *Surface Area of the Trench Bottom.* Pollutant removal in a trench can be improved by increasing the surface area of the trench bottom. This is done by adjusting the geometry to make the trench shallow and broad, rather than deep and narrow. Greater bottom surface area increases infiltration rates and provides more area and depth for soil filtering. In addition, broader trench bottoms reduce the risk of clogging at the soil/filter cloth interface by spreading infiltration over a wider area.
8. *Distance from Wells and Foundations.* The trench should be at least 100 feet of any drinking water supply well, and at least 10 feet downgradient and 100 feet upgradient from building foundations (Schueler, 1987).
9. *Drain Time.* The drain time should be between two and three days. The total volume of the trench should drain in 48 hours. The minimum drain time should be 24 hours.
10. *Backfill Material.* The backfill material in the trench should have a D_{50} sized between 1.5 and 3 inches and clay content should be limited to less than 30 percent. The porosity of the material should be between 0.3 and 0.4.
11. *Observation Well.* An observation well of 4 to 6 inches diameter PVC should be located in the center of the trench and the bottom should rest on a plate. The top should be capped. The water level should be measured after a storm event. If it has not completely drained in three days, some remedial work may need to be done.
12. *Overflow Berm.* A 2 to 3 inch emergency overflow berm on the downstream side of the trench serves a twofold purpose. First, it detains surface runoff and allows it to pond and infiltrate to the trench. The berm also promotes uniform sheet flow for runoff overflow.

V. REFERENCES

1. L. N. Boutiette and C. L. Duerring, 1994. *Massachusetts Nonpoint Source Management Manual, The Megamanual: A Guidance Document for Municipal Officials*, Massachusetts Department of Environmental Protection, Office of Watershed Management, Nonpoint Source Program, Boston, MA.

2. Camp, Dresser and McKee, Inc., Larry Walker Associates, 1993. *California Best Management Practices - Municipal*, California State Water Resources Council Board, Alameda, CA.

3. DEQ Storm Water Management Guidelines, Department of Environmental Quality, State of Oregon. http://waterquality.deq.state.or.us/wq/groundwa/swmgmtguide.htm

4. M. E. Dormann, J. Hartigan, and B. Maestri, 1988. *Retention, Detention, and Overland Flow for Pollutant Removal from Highway Stormwater Runoff: Interim Guidelines for Management Measures*, FHWA/RD-87/056, Federal Highway Administration, Versar, Inc., Springfield, VA.

5. GKY and Associates, Inc. June 1996. *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032. Prepared for: US Department of Transportation, Federal Highway Administration. Washington, DC.

6. *Low-Impact Development Design Manual*, November 1997. Department of Environmental Resources, Prince George's County, MD.

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9. T. R. Schueler, P. Kumble, and M. Heraty, 1992. *A Current Assessment of Urban Best Management Practices: Techniques for Reducing Nonpoint Source Pollution in the Coastal Zone*, Anacostia Research Team, Metropolitan Washington Council of Governments, Washington, DC.

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B.9 MEDIA FILTRATION

DESCRIPTION OF SAND FILTERS

Media filters are two-stage constructed treatment systems, including a pretreatment settling basin and a filter bed containing sand or other filter media. Various types of sand filter designs have been developed and implemented successfully in space-limited areas. The filters are not designed to treat the entire storm volume but rather the water quality volume (WQV), that tends to contain higher pollutant levels. The WQV represents the site runoff volume generated from 0.75-inches of rainfall. Sand filters can be designed so that they receive flow directly from the surface (via inlets or even as sheet flow directly onto the filter bed) or via storm drain pipes. They can be exposed to the surface or completely contained in underground pipe systems or vaults.

While there are various designs, most intermittent sand filters contain four basic components, as shown schematically in Figure 1 and discussed below:

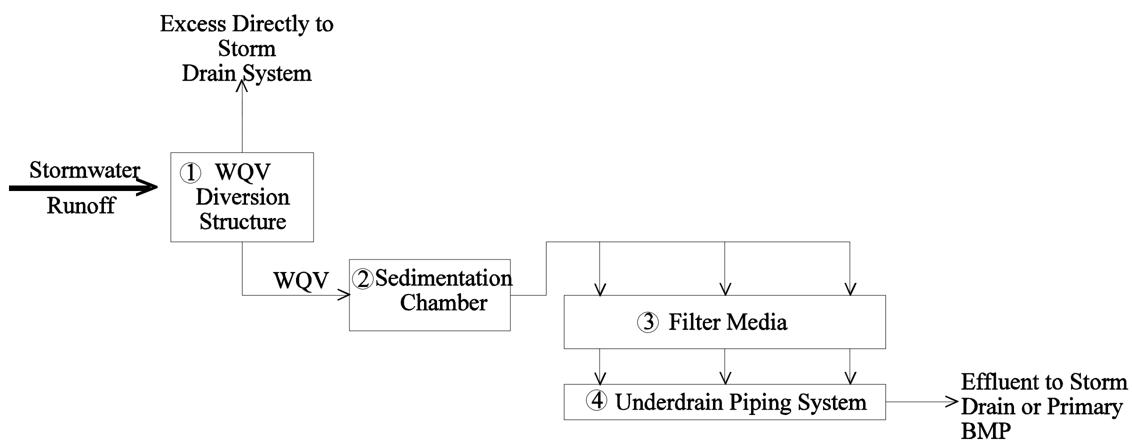

Figure 1. Schematic of a typical sand filter.

1. *Diversion Structure.* Either incorporated into the filter itself or as a stand alone

device, the diversion structure isolates the WQV and routes it to the filter. Larger volumes are bypassed directly to the storm drain system.

2. *Sedimentation Chamber.* Important to the long-term successful operation of any filtration system is the removal of large grained sediments prior to exposure to the filter media. The sedimentation chamber is typically integrated directly into the sand filter BMP but can also be a stand alone unit if space permits.
3. *Filter Media.* Typically consists of a 1-inch gravel layer over an 18 to 24 inch layer of washed sand. A layer of geotextile fabric can be placed between the gravel and sand layers.
4. *Underdrain System.* Below the filter media is a gravel bed, separated from the sand by a layer of geotextile fabric, in which is placed a series of perforated pipes. The treated runoff is routed out of the BMP to the storm sewer system or another BMP.

ADVANTAGES

1. May require less space than other treatment control BMPs and can be located underground.
2. Does not require continuous base flow.
3. Suitable for individual developments and small tributary areas up to 100 acres.
4. Does not require vegetation.
5. Useful in watersheds where concerns over groundwater quality or site conditions prevent use of infiltration.
6. High pollutant removal capability.
7. Can be used in highly urbanized settings.
8. Can be designed for a variety of soils.
9. Ideal for aquifer regions.

LIMITATIONS

1. Given that the amount of available space can be a limitation that warrants the consideration of a sand filter BMP, designing one for a large drainage area where there is room for more conventional structures may not be practical.
2. Available head to meet design criteria.
3. Requires frequent maintenance to prevent clogging.
4. Not effective at removing liquid and dissolved pollutants.
5. Severe clogging potential if exposed soil surfaces exist upstream.
6. Sand filters may need to be placed offline to protect it during extreme storm events.

DESIGN CRITERIA

1. *Volume.* Calculate the flow rate of stormwater to be mitigated by the media filtration

system using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.

2. *Surface area of the filter.* The following equation is for a maximum filtration time of 24 hours:

A. Surface Systems or Vaults

Filter area (ft^2) = $3630 S_u AH/K(D+H)$

Where:
- S_u = unit storage (inches-acre)
- A = area in acres draining to facility
- H = depth (ft) of the sand filter
- D = average water depth (ft) over the filter taken to be one-half the difference between the top of the filter and the maximum water surface elevation
- K = filter coefficient recommended as 3.5

This equation is appropriate for filter media sized at a diameter of 0.02 to 0.04 inches. The filter area must be increased if a smaller media is used.

B. Underground Sandfilter Systems

a. Compute the required size of the sand filter bed surface area, A_F. The following equation is based on Darcy's law and is used to size the sand filter bed area:

A_F (ft^2) = $24(WQV)(d_f)/ [k\ (h_f + d_f)\ t_f]$

Where:
- A_f = sand filter bed surface area (ft^2)
- WQV = Water quality treatment volume (ft^3)
- d_f = sand filter bed depth (ft)
- k = filter coefficient recommended as 3.5 (ft/day)
- h_f = average height of water above the sand bed (ft) = $h_{max}/2$
- h_{max} = elevation difference between the invert of the inlet pipe and the top of the sand filter bed (ft)
- t_f = time required for the runoff to filter through the sand bed (hr). (Typically 24 hr).

Note: 24 in the equation is the 24hr/day constant.

b. Choose a pipe size (diameter). The selection of pipe size should be based on site parameters such as: elevation of the runoff coming into the sand filter system, elevation of downstream connection to which the sand filter system outlet must tie into, and the minimum cover requirements for live loads. A minimum of 5' clearance should be provided between the top of the inner pipe wall and the top of the filter media for maintenance purpose. Use:

$D = d + 5$

Where:	D	=	pipe diameter (ft)
	d	=	depth of sand filter and underdrain pipe media depth (ft)
		=	$d_g + d_f$
	d_g	=	underdrain pipe media depth = 0.67'
	d_f	=	sand filter bed deph (ft): 1.5 to 2.0 feet

c. Compute the sand filter width(based on the pipe geometry):

$W_f = 2\,[R^2 - (R - d)^2\,]^{0.5}$

Where:	W_f	=	filter width (ft)
	R	=	pipe radius (ft)
		=	D/2

d. Compute the filter length:

$L_f = A_f / W_f$

Where:	L_f	=	filter length (ft)

3. *Configuration*

A. Surface sand filter

Criteria for the settling basin.

a. For the outlet use a perforated riser pipe.
b. Size the outlet orifice for a 24 hour drawdown
c. Energy dissipator at the inlet to the settling basin.
d. Trash rack at outlets to the filter.
e. Vegetate slopes to the extent possible.
f. Access ramp (4:1 or less) for maintenance vehicles.
g. One foot of freeboard.
h. Length to width ratio of at least 3:1 and preferably 5:1.

i. Sediment trap at inlet to reduce resuspension.

Criteria for the filter.

a. Use a flow spreader.
b. Use clean sand 0.02 to 0.04 inch diameter.
c. Some have placed geofabric on sand surface to facilitate maintenance.
d. Underdrains with:
   - Schedule 40 PVC.
   - 4 inch diameter.
   - 3/8 inch perforations placed around the pipe, with 6 inch space between each perforation cluster.
   - maximum 10 foot spacing between laterals.
   - minimum grade of 1/8 inch per foot.

B. Underground sand filter

Criteria for the settling tank (if required).

a. Use orifice and/or weir structure for the outlet.
b. Size the outlet orifice or weir for a 24 hour drawdown time
c. Provide access manhole for maintenance.

Criteria for the filter.

a. Use a flow spreader.
b. Use clean sand 0.02 to 0.04 inch diameter.
c. Some have placed geofabric on sand surface to facilitate maintenance.
d. Underdrains with:
   – Schedule 40 PVC.
   – 4 inch diameter
   – 3/8 inch perforations placed around the pipe, with 6 inch space between each perforation cluster.
e. Provide access manhole for maintenance.

REFERENCES

1. Camp, Dresser and McKee, Inc., Larry Walker Associates, 1993. *California Best Management Practices - Municipal*, California State Water Resources Council Board. Alameda, CA.

2. GKY and Associates, Inc. June 1996. *Evaluation and Management of Highway Runoff Water Quality*, Publication No. FHWA-PD-96-032. Prepared for: US Department of Transportation, Federal Highway Administration. Washington, DC.

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5. Northern Virginia BMP Handbook, City of Alexandria Virginia, February 1992. Alexandria, VI.

6. US EPA, Developments in Sand Filter Technology to Improve Runoff Quality, www.epa.gov/owowwtr1/NPS/wpt/wpt02/wpt02fa2.html.

The following is a list of known locations where a Media Filtration was installed. The design of the installed filter in each location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the locations herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	**Brand/Manufacturer**	**Owner/Client**
Eastern Regional Maintenance Station	N/A	Caltrans
Foothill Maintenance Sta.	N/A	Caltrans
Termination Park & Ride	N/A	Caltrans
Paxton Park & Ride	N/A	Caltrans

B.10 POROUS PAVEMENT

DESCRIPTION

Porous pavement is an asphalt based paving material that allows stormwater to quickly infiltrate the surface pavement layer to enter into a high-void aggregate sub-base layer. The captured runoff is stored in this "reservoir" layer until it either infiltrates into the underlying soil strata or is routed through an underdrain system to a conventional stormwater conveyance system. Porous pavements operate in a similar fashion to infiltration trenches and thus provide similar water quality benefits. An example of a typical porous pavement system is shown in Figure 1.

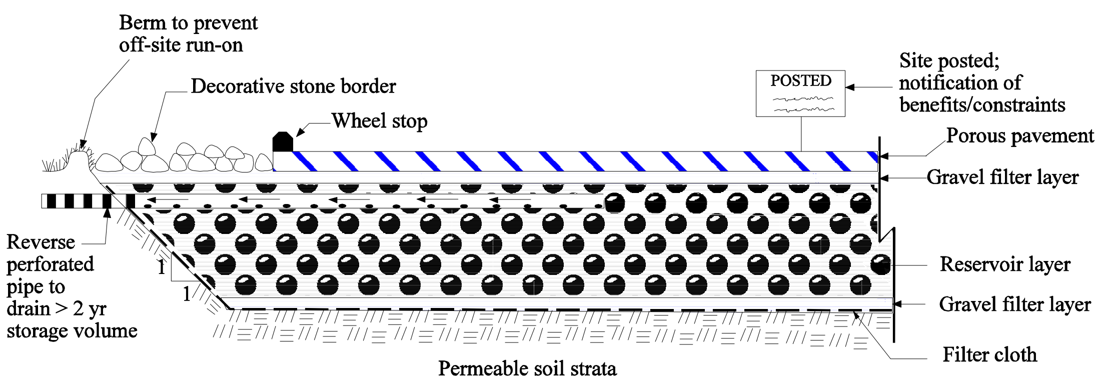

Figure 1. Schematic of porous pavement system.

ADVANTAGES

1, Porous pavements operate in a similar fashion to infiltration trenches and thus provide similar water quality benefits, including reductions in fine grained sediments, nutrients, organic matter, and trace metals.
2. In addition to water quality benefits, porous pavements also provide significant reductions in surface runoff with up to 90 percent of rainfall retained within the BMP (Schueler, 1992).
3. An added benefit provided by the on-site infiltration is the extent to which the stormwater runoff is able to contribute to groundwater recharge.
4. Reduces pavement ponding.

LIMITATIONS

1. Only applicable for low-traffic volume areas.
2. To maintain effectiveness, porous pavements require frequent maintenance.
3. Porous pavements are not intended to remove sediments.
4. Easily clogged by sediments if not situated properly.
5. Porous pavements are limited to treating small areas (0.25 to 10 acres).
6. Contributing drainage area slopes should be 5 percent or less to limit the amount of sediments that could potentially lead to clogging of the porous pavement.
7. On average, porous pavements clog within 5 years.
8. Underlying soil strata must have an adequate infiltration capacity of at least 0.3 inches per hour but preferably 0.50 in/hr or more. Adequate soil permeability should extend for a depth of at least 4 feet.
9. The bottom of the reservoir layer should be at least 4 feet above the seasonally high water table. Porous pavements should be no closer than 100 feet from drinking wells and 100 feet upgradient and 10 feet downgradient from building foundations. Due to the risk of groundwater contamination, porous pavements should not be used for gas stations or other areas with a relatively high potential for chemical spills. Similarly, special consideration should be given to the use of porous pavements in wellhead protection areas serviced by sole source aquifers.
10. The porous pavement should not be located where run-on from adjacent areas can introduce sediments to the pavement surface. Similarly, areas subject to wind-blown sediment loads should be avoided.
11. Extended rain can reduce the pavement's load bearing capacity.
12. More expensive than traditional paving surfaces.

DESIGN CRITERIA

A water quality porous pavement system provides only enough storage volume to capture the "first flush" of the rainfall. The "first flush" is defined as the runoff volume generated from 0.75-inches of rainfall. Calculate the volume of stormwater to be mitigated by the porous pavement using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*. The remaining storm volume bypasses the BMP and is routed to a conventional stormwater conveyance system.

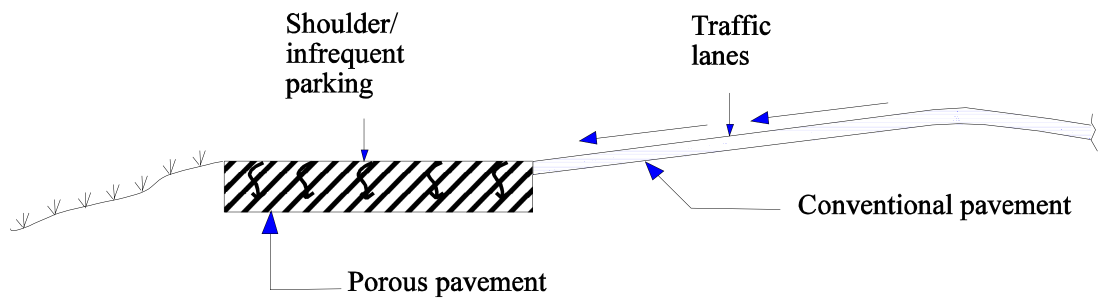

Figure 2. Schematic of a combination conventional/porous pavement system.

1. The prediction of the rate of infiltration of water through natural soils is related to soil type, porosity, degree of compaction, moisture content, and field capacity. This complexity governs soil drain times and has made the development of a single comprehensive model to predict drain times in actual porous pavement applications difficult. However, determining drain time is the key element in designing the size of porous pavement systems. The depth of the sub-base can be determined by:

$$H_d = \frac{E \times t_d}{r}$$

Where:

H_d	=	Depth of reservoir layer (in).
t_d	=	Detention time (hr).
E	=	Soil infiltration rate (in/hr).
r	=	Void ratio.

The required porous pavement surface area can then be computed by:

$$A_s = \frac{V}{r \times H_d}$$

Where:

A_s = Porous pavement surface area (ft^2).
V = Water quality volume (ft^3).

Table 1 provides the required amount of porous pavement surface area per acre and the depth of the reservoir layer with the assumption that the area is completely impervious. Also assumed is that the void ratio is 0.4, typical value, and the detention time is 48 hours.

Table 1. Using a void ratio (r) of 0.4 and a detention time (t_d) of 48 hours the following porous pavement surface area and depth of reservoir layer that is required for the respective infiltration rates.

Soil infiltration rate E (in/hr)	Depth of reservoir layer H_d (feet)	Porous pavement surface area per acre A_s ($feet^2$)
0.27	2.7	2,521
0.30	3.0	2,269
0.35	3.5	1,945
0.40	4.0	1,702
0.45	4.5	1,513
0.50	5.0	1,361
0.55	5.5	1,238
0.60	6.0	1,134
0.65	6.5	1,047
0.70	7.0	972
0.75	7.5	908
0.80	8.0	851
0.85	8.5	801
0.90	9.0	756
0.95	9.5	716
1.00	10.0	681

2. *Specifications.* The cross-section typically consists of four layers, as shown in Figure 3. Descriptions of each of the layers is presented below.
3. *Asphalt Layer* - The surface asphalt layer consists of an open-graded asphalt mixture ranging from depths of 2 to 4 inches depending on required bearing strength and pavement design requirements. Porous pavements contain

approximately 16 percent voids, compared to 3 to 5 percent for conventional pavements, allowing runoff to quickly infiltrate. A recommended gradation specification for an open-graded aggregate mixture is presented in Table 2.

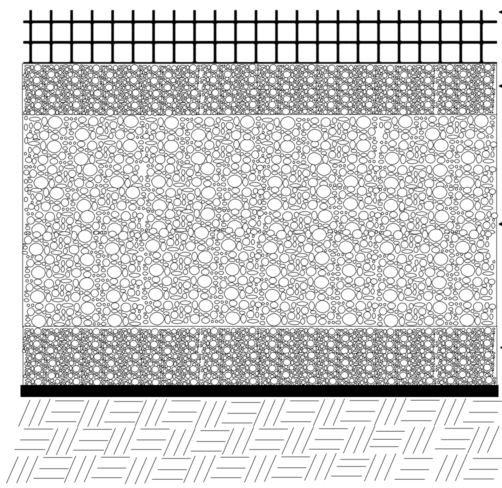

Figure 3. Schematic of typical porous pavement section.

Table 2. Aggregate gradation for porous pavement.

U.S. Sieve Series Size	***Opening (mm)***	***Percent Passing by Weight***
½ in	12.70	100
3/8 in	9.51	95-100
#4	4.76	30-50
#8	2.38	5-15
#200[1]	0.074	2-5

Note : 1. Aggregate should be uniformly graded between #8 and #200 sieve.

4. *Top Filter Layer.* Consists of a 0.5 inch diameter crushed stone to a depth of 1 to 2 inches. This layer serves to stabilize the porous asphalt layer. Table 2

provides typical details on gradation standards and specifications.

5. *Reservoir Layer.* The reservoir sub-base consists of 1.5 to 3 inches crushed stone. The depth of this layer depends on the desired storage volume, which is a function of the soil infiltration rate, void spaces, and, in colder climates, the depth of the frost line, but typically ranges from 2 to 4 feet. The reservoir layer should be designed to drain completely in 48 to 72 hours. Table 3 provides further details on standards and specifications.
6. *Bottom Filter Layer.* This layer serves to stabilize the reservoir layer and is the interface between the reservoir layer and the filter fabric covering the underlying soil. It consists of a 2 inch thick layer of 0.5 inch crushed stone. Table 3 provides further details on standards and specifications.
7. *Filter Fabric.* It is very important to line the entire trench area, including the sides, with filter fabric prior to placement of the aggregate. The filter fabric serves a very important function by inhibiting soil from migrating into the reservoir layer and reducing storage capacity. Table 3 provides further details on standards and specifications.
8. *Underlying Soil.* The underlying soil should have an infiltration capacity of at least 0.3 in/hr, but preferably greater than 0.50 in/hr. Soils at the lower end of this range may not be suited for a full infiltration system. Infiltration rates for several soil types are given in Table 3 (Yu and Kaighn, 1992).
9. *Construction Practices (adapted from Schueler, 1992).*
   (1) All adjacent areas should be stabilized to prevent any sediment from washing onto the pavement surface, leading to premature clogging.
   (2) The subgrade shall be prepared as required while limiting undue compaction; permeability must be maintained. Equipment with tracks or over-sized rubber tires shall be used; DO NOT use vehicles with standard rubber tires.
   (3) The reservoir base course shall be laid in lifts over the base filter course and lightly compacted. The base courses should be kept free of all dirt and debris during construction.
   (4) The asphalt layer shall be laid directly over the top filter course in one lift. The laying temperature should be between 240 and 260 °F. The ambient temperature should be above 50 °F.
   (5) Compaction should take place when the surface is cool enough to resist a 9-Mg roller (class equivalent of a 10-ton roller). One or two passes is all that is required for proper compaction. Any more may reduce porosity.
   (6) Transporting of the mix to the site shall be in clean vehicles with smooth dump beds that have been sprayed with a non-petroleum release agent. The mix should be covered during transport to limit cooling.
   (7) After final rolling, no vehicular traffic of any kind should be permitted on the pavement until cooling and hardening has taken place; no sooner than six hours but preferably a day or two.

Table 3. Standards and specifications for design of porous pavements.

Layer	***Thickness***	***Material***	***Specifications***	***Comments***
Pavement	51-102 mm	Open Graded Aggregate	ASTM D 693-77 *"Crushed Stone, Crushed Slag, and Crushed Gravel for Dry or Water-Bound Macadam Base and Surface Courses of Pavements"*	Two exceptions: 1) open graded. 2) soundness test required per ASTM D 692-79.
		Asphalt	Asphalt Grade: AASHTO M-20.	For 85 to 100 penetration road asphalt as a binder in the northern U. S., 65 to 80 in the middle States, and 50 to 65 in the southern States.
			Viscosity Grade: AC-20 AASHTO M-226-73 I.	Use as a starting point; may be altered as necessary.
			Stripping Resistance: ASTM D1664.	If estimated coating area is not above 95%, add anti-stripping agent to mix.
			Asphalt Content: 5.75-6 % of weight of dry aggregate; test using FHWA Report No. FHWA-RD-74-2.	
Gravel Filters/Reservoir	Top Filter: 25-51 mm	13-mm Dia. Aggregate	Local Highway Dept. Specifications for Crushed Stone.	All aggregates must be washed to remove fines to prevent clogging.
	Reservoir Layer: 0.61-1.21 m	25-76-mm Dia. Aggregate	Local Highway Dept. Specifications for Crushed Stone.	All aggregates must be washed to remove fines to prevent clogging.
	Bottom Filter: 51 mm	13-mm Dia. Aggregate	Local Highway Dept. Specifications for Crushed Stone.	All aggregates must be washed to remove fines to prevent clogging.
Filter Cloth	-	Filter Cloth	MIRIFI # 14 N or equivalent.	

Note: Adapted from Schueler, 1992.

Table 4. Soil types for porous pavement systems.

Soil Type	Minimum Infiltration Rate (mm/hr)	SCS Soil Group	Maximum Depth of Storage (m)[1]	
			48 hr Drain Time	72 hr Drain Time
Sand	210	A	25	15
Loamy Sand	61.2	A	7.4	4.4
Sandy Loam	25.9	B	3.1	4.6
Loam	13.2	B	1.6	2.4
Silt Loam	6.85	C	0.81	1.2

Note : 1. Maximum depth of storage that can be drained within the specified time.

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B.12 STORM DRAIN INSERTS

DESCRIPTION

Storm drain inserts can be a variety of devices that are used in storm drain conveyance systems to reduce pollutant loadings in stormwater runoff. Most storm drain inserts reduce oil and grease, debris, and suspended solids through gravity, centrifugal force, or other methods. BMPs such as these can be particularly useful in areas susceptible to spills of petroleum products, such as gas stations. Figures 1 and 2 illustrate one of many different types of storm drain inserts.

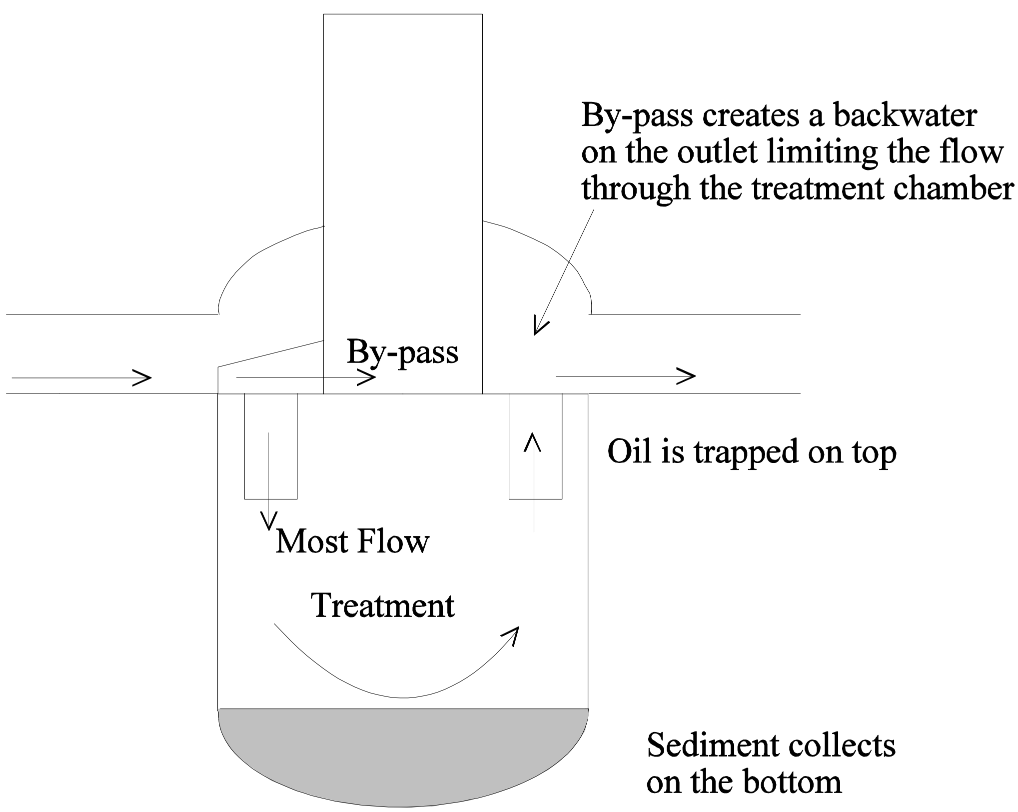

Figure 1. Typical configuration (side view).

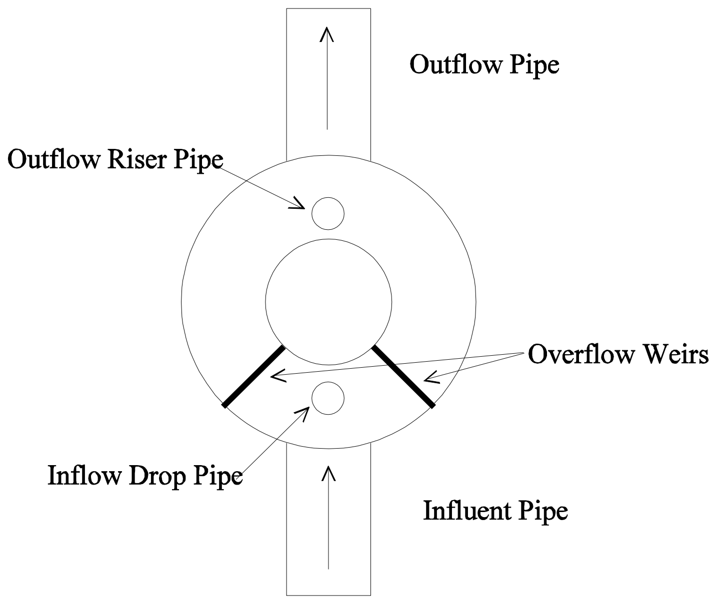

Figure 2. Typical configuration (top view).

Trapped sediments and floatable oils must be pumped out regularly to maintain the effectiveness of the units.

ADVANTAGES

1. Low installation costs.
2. Prefabricated for different standard storm drain designs.
3. Require minimal space to install.

LIMITATIONS

1. Some devices may be vulnerable to accumulated sediments being resuspended during heavy storms.
2. Can only handle limited amounts of sediment and debris.
3. Maintenance and inspection of storm drain inserts are required before and after each rainfall event.
4. High maintenance costs.
5. Hydraulic losses.

DESIGN CRITERIA

1. Calculate the flow rate or volume of stormwater to be mitigated by the storm drain insert using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*.

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The following is a list of known locations where a Storm Drain Insert device was installed. The design of the installed device in each location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the locations herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	Brand/Manufacturer	Owner/Client
I-210/Orcas Ave.	Not available	Caltrans
I-210/Filmore St.	Not available	Caltrans
Marina Del Rey: 13477 Fiji Way, L.A.	CDS (Continuous Deflective Separation Device)	Los Angeles County Beaches & Harbor
Santa Monica [1]	CDS Device	Los Angeles County Dept. of Public Works
Santa Monica	CDS Device	City of Santa Monica
Santa Clarita	CDS Device	City of Santa Clarita
Calabasas	CDS Device	City of Calabasas

[1] Not constructed yet.

B.12 VEGETATED FILTER STRIPS

DESCRIPTION

Vegetated filter strips, also known as vegetated buffer strips, are vegetated sections of land similar to grassed swales, except they are essentially flat with low slopes, and are designed only to accept runoff overland sheet flow (Schueler, 1992). They may appear in any vegetated form from grassland to forest, and are designed to intercept upstream flow, lower flow velocity, and spread water out as sheet flow (Schueler, 1992). The dense vegetative cover facilitates conventional pollutant removal through detention, filtration by vegetation, and infiltration into soil (Yu and Kaighn, 1992). Wooded and grass filter strips have slightly higher removal rates. Dissolved nutrient removal for either type of vegetative cover is usually poor, however wooded strips show slightly higher removal due to increased retention and sequestration by the plant community (Florida Department of

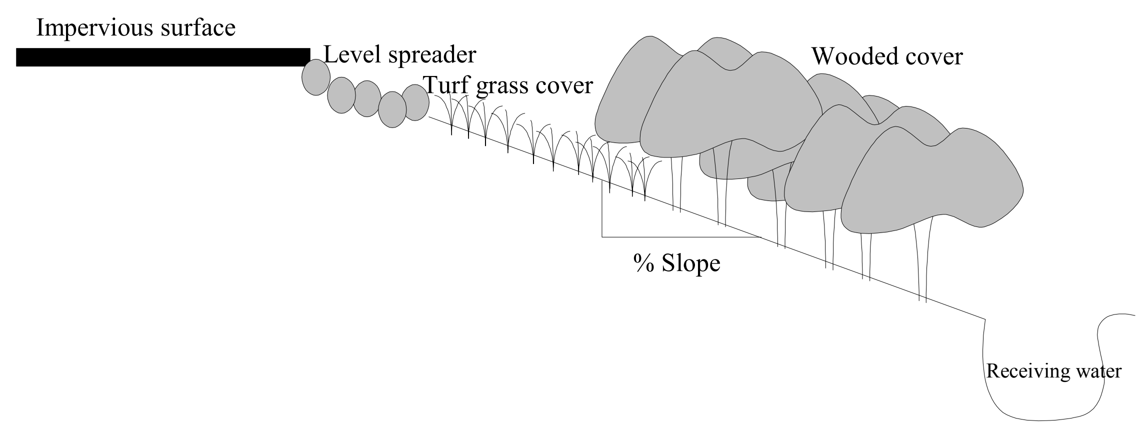

Figure 1. Conceptual design for a vegetated filter strip (Indiana County Conservation District)

Transportation, 1994).

Although an inexpensive control measure, they are most useful in contributing watershed areas where peak runoff velocities are low, as they are unable to treat the high flow velocities typically associated with high impervious cover (Barret, et al., 1993).

Similar to grassed swales, filter strips can last for 10 to 20 years with proper conditions and regular maintenance. Life expectancy is significantly diminished if uniform sheet flow and dense vegetation are not maintained.

ADVANTAGES

1. Lowers runoff velocity (Schueler, 1987).
2. Slightly reduces runoff volume (Schueler, 1987).
3. Slightly reduces watershed imperviousness (Schueler, 1987).
4. Slightly contributes to groundwater recharge (Schueler, 1987).
5. Aesthetic benefit of vegetated “open spaces” (Colorado Department of Transportation, 1992).
6. Preserves the character of riparian zones, prevents erosion along streambanks, and provides excellent urban wildlife habitat (Schueler, 1992).

LIMITATIONS

1. Filter strips cannot treat high velocity flows, and do not provide enough storage or infiltration to effectively reduce peak discharges to predevelopment levels for design storms (Schueler, 1992). This lack of quantity control dictates use in rural or low density development.
2. Requires slope less than 5%.
3. Requires low to fair permeability of natural subsoil.
4. Large land requirement.
5. Often concentrates water, which significantly reduces effectiveness.
6. Pollutant removal is unreliable in urban settings.

DESIGN CRITERIA

1. Successful performance of filter strips relies heavily on maintaining shallow unconcentrated flow (Colorado Department of Transportation, 1992). To avoid flow channelization and maintain performance, a filter strip should:

    (1) Be equipped with a level spreading device for even distribution of runoff,
    (2) Contain dense vegetation with a mix of erosion resistant, soil binding species,
    (3) Be graded to a uniform, even and relatively low slope,
    (4) Laterally traverse the contributing runoff area (Schueler, 1987),
    (5) The area to be used for the strip should be free of gullies or rills that can concentrate overland flow (Schueler, 1987),
    (6) Filters strip should be placed 3 to 4 feet from edge of pavement to accommodate a vegetation free zone (Washington State Department of Transportation, 1995). The top edge of the filter strip along the pavement should be designed to avoid the situation where runoff would travel along the top of the filter strip, rather than through it. Dilhalla, et al., (1986) suggest that berms be placed at 50 to 100 feet intervals perpendicular to the top edge of the strip to prevent runoff from bypassing it (as cited in

Washington State Department of Transportation, 1995),

(7) Top edge of the filter strip should follow the same elevational contour. If a section of the edge of the strip dips below the contour, runoff will tend to form a channel toward the low spot,

(8) Filter strips should be landscaped after other portions of the project are completed (Washington State Department of Transportation, 1995). However, level spreaders and strips used as sediment control measures during the construction phase can be converted to permanent controls if they can be regraded and reseeded to the top edge of the strip.

2. Filter strips can be used on an upgradient from watercourses, wetlands, or other water bodies, along toes and tops of slopes, and at outlets of other stormwater management structures (Boutiette and Duerring, 1994). They should be incorporated into street drainage and master drainage planning (Urbonas, 1992). The most important criteria for selection and use of this BMP are soils, space, and slope, where:

(1) *Soils and moisture are adequate to grow relatively dense vegetative stands.* Underlying soils should be of low permeability so that the majority of the applied water discharges as surface runoff. The range of desirable permeability is between 0.06 to 0.6 inches/hour (Horner, 1985). Common soil textural classes are clay, clay loam, and silty clay. The presence of clay and organic matter in soils improves the ability of filter strips to remove pollutants from the surface runoff (Schueler, 1992). Greater removal of soluble pollutants can be achieved where the water table is within 3 feet of the surface (i.e., within the root zone) (Schueler, 1992). Filter strips function most effectively where the climate permits year-round dense vegetation. They are not recommended in arid regions where vegetation in upland areas is sparse.

(2) *Sufficient space is available.* Because filter strip effectiveness depends on having an evenly distributed sheet flow, the size of the contributing area and the associated volume runoff have to be limited (Urbonas, 1992). To prevent concentrated flows from forming, it is advisable to have each filter strip serve a contributing area of five acres or less (Schueler, 1987). When used alone, filter strip application is in areas where impervious cover is low to moderate and where there are small fluctuations in peak flow.

(3) *Longitudinal slope is five percent or less.* When filter strips are used on steep or unstable slopes, the formation of rills and gullies can disrupt sheet flow (Urbonas, 1992). As a result filter strips will not function at all on slopes greater than 15 percent and may have reduced effectiveness on slopes between 6 to 15 percent.

3. The design should be based on the same methods detailed for swales. The preferred geometry of a filter strip is rectangular, and this should be used when

applying the design procedures of vegetated swales.

When using this procedure, the following provisions apply specifically to filter strips (Horner, 1993):

(1) Slopes should be no greater than 15 percent and should preferably be lower than 5 percent, and be uniform throughout the strip after final grading.
(2) Hydraulic residence time normally no less than 9 minutes, and in no case less than 5 minutes.
(3) Average velocity no greater than 0.9 feet/second.
(4) Manning's friction factor (*n*) of 0.02 should be used for grassed strips, *n* of 0.024 if strip is infrequently mowed, or a selected higher value if the strip is wooded.
(5) The width should be no greater than that where a uniform flow distribution can be assured.
(6) Average depth of flow (design depth) should be no more than 0.5 inches.
(7) Hydraulic radius is taken to be equal to the design flow depth.

5. Filter strips function best with longitudinal slopes less than 10 percent, and ideally less than 5 percent. As filter strip length becomes shorter, slope becomes more influential. Therefore, when a minimum strip length of 20 feet is utilized, slopes should be graded as close to zero as drainage permits (Schueler, 1987). With steeper slopes, terracing through using landscape timber, concrete weirs, or other means may be required to maintain sheet flow.
6. Calculate the flow rate of stormwater to be mitigated by the vegetated filter strip using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*. A minimum of 8 feet is recommended for filter strip width.
7. Another design issue is runoff collection and distribution to the strip, and release to a transport system or receiving water (Horner, 1985). Flow spreader devices should be used to introduce the flow evenly to the filter strip (Urbonas, 1992). Concentrated flow needs to use a level spreader to evenly distribute flow onto a strip. There are many alternative spreader devices, with the main consideration being that the overland flow spreader be distributed equally across the strip. Level spreader options include porous pavement strips, stabilized turf strips, slotted curbing, rock-filled trench, concrete sills, or plastic-lined trench that acts as a small detention pond (Yu and Kaighn, 1992). The outflow and filter side lip of the spreader should have a zero slope to ensure even runoff distribution (Yu and Kaighn, 1992). Once in the filter strip, most runoff from significant events will not be infiltrated and will require a collection and conveyance system. Grass-lined swales are often used for this purpose and can provide another BMP level. A filter strip can also drain to a storm sewer or street gutter (Urbonas, 1992).

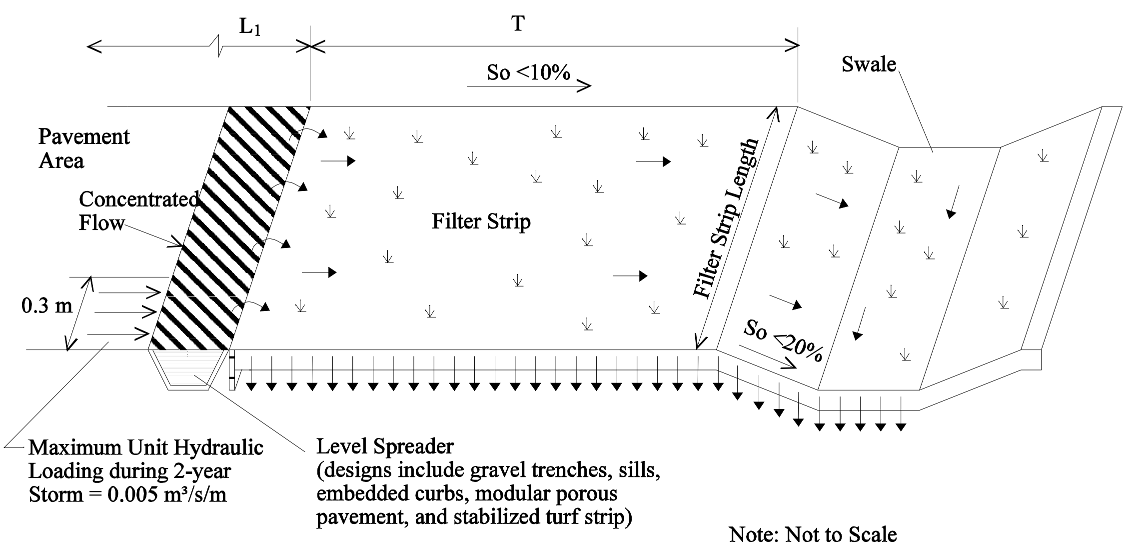

Figure 2. Sample filter strip design (Urbonas, 1992).

8. Filter strips should be constructed of dense, soil-binding deep-rooted water-resistant plants. For grassed filter strips, dense turf is needed to promote sedimentation and entrapment, and to protect against erosion (Yu and Kaighn, 1992). Turf grass should be maintained to a blade height of 2 to 4 inches. Most engineered, sheet-flow systems are seeded with specific grasses. Common grasses established for filter strip systems are rye, fescue, reed canary, and Bermuda (Horner, 1985). Tall fescue and orchard grasses grow well on slopes and under low nutrient conditions (Horner, 1985). The grass species chosen should be appropriate for the climatic conditions and maintenance criteria for each project.
9. Trees and woody vegetation have been shown to increase infiltration and improve performance of filter strips. Trees and shrubs provide many stormwater management benefits by intercepting some rainfall before it reaches the ground, and improving infiltration and retention through the presence of a spongy, organic layer of materials that accumulates underneath the plants (Schueler, 1987). As discussed previously in this section, wooded strips have shown significant increases in pollutant removal over grass strips. Maintenance for wooded strips is virtually non-existent, another argument for using trees and shrubs. However, there are drawbacks to using woody plants. Since the density of the vegetation is not as great as a turf grass cover, wooded filter strips need additional length to

accommodate more vegetation. In addition, shrub and tree trunks can cause uneven distribution of sheet flow, and increase the possibility for development of gullies and channels. Consequently, wooded strips require flatter slopes than a typical grass cover strip to ensure that the presence of heavier plant stems will not facilitate channelization.

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The following is a known location where a Vegetated Filter Strip was installed. The design of the installed strip in the location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the location herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	**Brand/Manufacturer**	**Owner/Client**

I-605/SR91	N/A	Caltrans

B.13 VEGETATIVE SWALE

DESCRIPTION

Vegetated swales are shallow vegetated channels to convey stormwater where pollutants are removed by filtration through grass and infiltration through soil. They look similar to, but are wider than, a ditch that is sized only to transport flow. They require shallow slopes and soils that drain well. Grassed swale designs have achieved mixed performance in pollutant removal efficiency. Moderate removal rates have been reported for suspended solids and metals associated with particulates such as lead and zinc. Runoff waters are typically not detained long enough to effectively remove very fine suspended solids, and swales are generally unable to remove significant amounts of dissolved nutrients. Pollutant removal capability is related to channel dimensions, longitudinal slope, and type of vegetation. Optimum design of these components will increase contact time of runoff through the swale and improve pollutant removal rates.

Vegetated swales are primarily stormwater conveyance systems. They can provide sufficient control under light to moderate runoff conditions, but their ability to control large storms is limited. Therefore, they are most applicable in low to moderate sloped areas as an alternative to ditches and curb and gutter drainage. Their performance diminishes sharply in highly urbanized settings. Vegetated swales are often used as a pretreatment measure for other downstream BMPs, particularly infiltration devices. Enhanced vegetative swales utilize check dams and wide depressions to increase runoff storage and promote greater settling of pollutants.

ADVANTAGES

1. Relatively easy to design, install and maintain.
2. Vegetated areas that would normally be included in the site layout, if designed for appropriate flow patterns, may be used as a vegetated swale.
3. Relatively inexpensive.
4. Vegetation is usually pleasing to residents.

LIMITATIONS

1. Irrigation may be necessary to maintain vegetative cover.
2. Potential for mosquito breeding areas.
3. Possibility of erosion and channelization over time.
4. Requires dry soils with good drainage and high infiltration rates for better pollutant removal.

5. Not appropriate for pollutants toxic to vegetation.
6. Large area requirements may make this BMP infeasible for some sites.
7. Used to serve sites less than 10 acres in size, with slopes no greater than 5 percent.
8. The seasonal high water table should be at least 2 feet below the surface.
9. Buildings should be at least 10 feet from the site.

DESIGN CRITERIA

Several criteria should be kept in mind when beginning swale design. These provisions, presented in Table 1, have been developed through a series of evaluative research conducted on swale performance.

Table 1. Criteria for optimum swale performance (Horner, 1993).

Parameter	***Optimal Criteria***	***Minimum Criteria****
Hydraulic Residence Time	9 min	$\geq$ 5 min
Average Flow Velocity	$\leq$ 0.9 ft/s	
Swale Width	8 ft	2 ft
Swale Length	200 ft	100 ft
Swale Slope	~ 2 - 6%	~ 1%
Side Slope Ratio (horizontal:vertical)	4 : 1	2 : 1

* Criteria at or below minimum values can be used when compensatory adjustments are made to the standard design. Specific guidance on implementing these adjustments will be discussed in the design section.

The procedures described below were set forth by Horner, and unless otherwise cited, are set forth in *Biofiltration for Stormwater Runoff Quality Control*, published in 1993. The following steps are recommended to be conducted in order to complete a swale design:

(1) Determine the flow rate to the system.
(2) Determine the slope of the system.
(3) Select a swale shape (skip if filter strip design).
(4) Determine required channel width.
(5) Calculate the cross-sectional area of flow for the channel.
(6) Calculate the velocity of channel flow.
(7) Calculate swale length.
(8) Select swale location based on the design parameters.
(9) Select a vegetation cover for the swale.
(10) Check for swale stability.

Recommended procedures for each task are discussed in detail below.

1. *Determine Flow Rate to the System.* Calculate the flow rate of stormwater to be mitigated by the vegetated swale using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*. Runoff from larger events should be designed to bypass the swale, consideration must be given to the control of channel erosion and destruction of vegetation. A stability analysis for larger flows (up to the 100-yr 24-hour) must be performed. If the flow rate approaches or exceeds 1 ft^3/s, one or more of the design criteria in Table 1 may be violated, and the swale system may not function correctly (Washington State Department of Transportation, 1995). Alternative measures to lower the design flow should be investigated. Possibilities include dividing the flow among several swales, installing detention to control release rate upstream, and reducing developed surface area to reduce runoff coefficient value and gain space for biofiltration (Horner, 1993).
2. *Determine the Slope of the System.* The slope of the swale will be somewhat dependent on where the swale is placed, but should be between the stated criteria of one and six percent.
3. *Select a Swale Shape.* Normally, swales are designed and constructed in a trapezoidal shape, although alternative designs can be parabolic, rectangular, and triangular. Trapezoidal cross-sections are preferred because of relatively wider vegetative areas and ease of maintenance (Khan, 1993). They also avoid the sharp corners present in V-shaped and rectangular swales, and offer better stability than the vertical walls of rectangular swales.
4. *Determine Required Channel Width.* Estimates for channel width for the selected shape can be obtained by applying Manning's:

$$Q = \frac{1.486 A R_h^{0.667} S^{0.5}}{n} \qquad (1)$$

Where:

Q	=	Flow (ft^3/s).
A	=	Cross-sectional area of flow (ft^2).
R_h	=	Hydraulic radius of flow cross section (ft).
S	=	Longitudinal slope of biofilter (ft/ft).
n	=	Manning's roughness coefficient.

A Manning's n value of 0.02 is used for routine swales that will be mowed with some regularity. For swales that are infrequently mowed, use a Manning's n value of 0.024. A higher n value can be selected if it is known that vegetation will be very dense (Khan, 1993).

Figure 1 presents channel geometry and equations for a trapezoidal swale, the most frequently used shape.

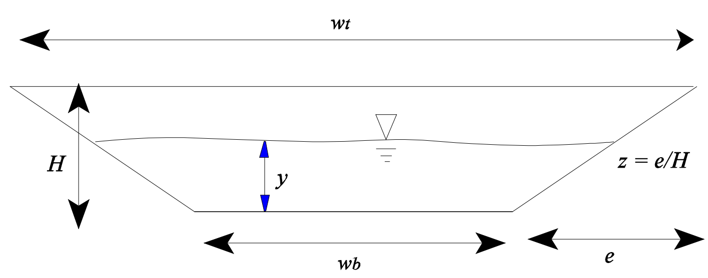

Figure 1. Channel geometry for a trapezoid swale.

$$Cross\ \ Sectional\ \ Area\,(A_x) = by + zy^2$$

$$Width\,(w) = b + 2yz$$

$$Hydraulic\ \ Radius\,(R_h) = \frac{by + zy^2}{by + 2y\sqrt{z^2 + 1}}$$

Substituting the geometric equations presented in Figure 1 into Manning's equation, the bottom width (w_b) and the top width (w_t) for the trapezoid swale can be computed using the following equations:

$$w_b \cong \frac{Qn}{y^{1.67} s^{0.5}} - zH \qquad (2)$$

$$w_t = w_b + 2zH \qquad (3)$$

Where:

Q = Flow rate in ft^3/s.

n	=	Manning's roughness coefficient.
y	=	Depth of flow.
H	=	The side slope in the form of z:1.

For trapezoidal and the limited case of V-shapes, the side slope (z) used should be at least 3:1 (horizontal:vertical). V-shaped swales should be double checked after computation of w_t to make sure that z = $2w_t$ is at least 3. If a slope steeper than 2:1 must be used, additional stabilization measures (i.e., lining the swale with riprap) may be needed.

Typically, the depth of flow in the channel (H) is set at 3 to 4 inches. Flow depth can also be determined by subtracting 2 inches from the expected grass height, if the grass type and the height it will be maintained is known. Values lower than 3 to 4 inches can be used, but doing so will increase the computed width (w_t or w_b) of the swale (Washington State Department of Transportation, 1995).

Swale width computed should be between 2 to 8 feet. Relatively wide swales (those wider than 8 feet are more susceptible to flow channelization and are less likely to have uniform sheet flow across the swale bottom for the entire swale length. The maximum widths for swales is on the order of 10 feet, however widths greater than 8 feet should be evaluated to consider the effectiveness of the flow spreading design used and the likelihood of maintaining evenness in the swale bottom. Since length may be used to compensate for width reduction (and vice versa) so that area is maintained, the swale width can be arbitrarily set to 8 feet to continue with the analysis. If b is less than 2 feet, set b = 2 feet and continue. Narrower widths can be used if space is very constrained. Sometimes when the flow rate is very low, the equation above can generate a negative value for w_b. Since this is not possible, the bottom width should be set to 1 feet when this occurs.

5. *Calculate Cross-Sectional Area.* Compute the cross-sectional area (A) for the swale, using the following equation:

$$A_x = (w_b + 2zH)yH \tag{4}$$

6. *Calculate the Velocity of the Channel Flow.* Channel flow velocity (U) can be computed using the continuity equation:

$$U = \frac{Q}{A_x} \tag{5}$$

This velocity should be less than 0.9 ft/s, a velocity that was found to cause grasses to be flattened, reducing filtration. A velocity lower than this maximum value is recommended to achieve the 9-minute hydraulic residence time criterion, particularly in shorter swales (at U = 0.9 ft/s, a 485-ft swale is needed for a 9-min residence time and a 269-ft swale for a 5-min residence time).

If the value of U suggests that a longer swale will be needed than space permits, investigate how the design flow Q can be reduced, or increase flow depth (H) and/or swale width (w_t) up to the maximum allowable values and repeat the analysis.

7. *Calculate Swale Length.* Compute the swale length (L) using the following equation:

$$L = Ut_r \ (60 \ s/\text{min}) \tag{6}$$

Where:

t_r = Hydraulic residence time (in minutes).

Use t_r = 9 min for this calculation.

If a swale length greater than the space will permit results, investigate how the design flow Q can be reduced. Increase flow depth (H) and/or swale width (w_b) up to the maximum allowable values and repeat the analysis. If all of these possibilities are checked and space is still insufficient, t can be reduced, but to no less than 5 minutes. If the computation results in L less than 100 ft, set L = 100 ft and investigate possibilities in width reduction. This is possible through recalculating U at the 100-ft length, recomputing cross-sectional area, and ultimately adjusting the swale width w_b using the appropriate equation.

8. *Select Swale Location.* Swale geometry should be maximized by the designer, using the above equations, and given the area to be utilized. If the location has not yet been chosen, it is advantageous to compute the required swale dimensions and then select a location where the calculated width and length will fit. If locations available cannot accommodate a linear swale, a wide-radius curved path can be used to gain length. Sharp bends should be avoided to reduce erosion potential. Regardless of when and how site selection is performed, consideration should be given to the following site criteria:

Soil Type. Soil characteristics in the swale bottom should be conducive to grass growth. Soils that contain large amounts of clay cause relatively low permeability and result in standing water, and may cause grass to die. Where the potential for leaching into groundwater exists, the swale bottom may need to be sealed with clay to protect from infiltration into the resource. Compacted soils will need to be tilled before seeding or planting. If topsoil is required to facilitate grass seeding and growth, use 6 inches of the following recommended topsoil mix: 50 to 80 percent sandy loam, 10 to 20 percent clay, and 10 to 20 percent composted organic matter (exclude animal waste).

Slope. The natural slope of the potential location will determine the nature and amount of regrading, or if additional measures to reduce erosion and/or increase pollutant removal are required. Swales should be graded carefully to attain uniform longitudinal and lateral slopes and to eliminate high and low spots. If needed, grade control checks should be provided to maintain the computed longitudinal slope and limit maximum flow velocity (Urbonas, 1992).

Natural Vegetation. The presence and composition of existing vegetation can provide valuable information on soil and hydrology. If wetland vegetation is present, inundated conditions may exist at the site. The presence of larger plants, trees and shrubs, may provide additional stabilization along the swale slopes, but also may shade any grass cover established. Most grasses grow best in full sunlight, and prolonged shading should be avoided. It is preferable that vegetation species be native to the region of application, where establishment and survival have been demonstrated.

9. *Select Vegetative Cover.* A dense planting of grass provides the filtering mechanism responsible for water quality treatment in swales. In addition, grass has the ability to grow through thin deposits of sediment and sand, stabilizing the deposited sediment and preventing it from being resuspended in runoff waters. Few other herbaceous plant species provide the same density and surface per unit area. Grass is by far the most effective choice of plant material in swales, however not all grass species provide optimum vegetative cover for use in swale systems. Dense turf grasses are best for vegetative cover. Table 2 lists several turf grasses, and their suitability in terms of cold tolerance, heat tolerance, mowing height adaptation, drought tolerance, and maintenance cost and effort.

In areas of poor drainage, wetlands species can be planted for increased vegetative cover. Use wetland species that are finely divided like grass and relatively resilient. Invasive species, such as cattails, should be avoided to eliminate proliferation in the swale and downstream.

Woody or shrubby plantings can be used for landscaping on the edge of side slopes, but not in the swale treatment area. Trees and shrubs can provide some additional stabilization, but also mature and shade the grass. In addition, leaf or needle drop can contribute unwanted nutrients, create debris jams, or interfere with waterflow through the system. If landscape plantings are to be used, selection and planting processes should be carefully planned and carried out to avoid these potential problems.

	Cold Tolerance	Heat Tolerance	Mowing Height	Drought Tolerance	Maintenance
High	Creeping bentgrass Kentucky bluegrass Red fescue Colonial bentgrass Highland bentgrass	Zoysia grass Hybrid bermuda grass Common bermuda grass St Augustine grass Kikuyu grass	Tall fescue	Hybrid bermuda grass Zoysia grass Common bermuda grass	Creeping bentgrass Dichondra
			Red fescue Kentucky bluegrass Perennial ryegrass Weeping alkali grass	St Augustine grass Kikuyu grass	Hybrid bermuda grass
		Tall fescue Dichondra Creeping bentgrass			
		Kentucky bluegrass	St. Augustinegrass Common bermudagrass		Kentucky bluegrass Colonial bentgrass Perennial ryegrass
	Tall fescue Weeping alkali grass	Highland bentgrass Perennial ryegrass Colonial bentgrass	Dichondra Kikuyugrass Colonial bentgrass Highland bentgrass Zoysiagrass	Tall fescue Red fescue	St. Augustine grass Highland bentgrass Zoysia grass
			Hybrid bermudagrass		
Low	Dichondra Zoysia grass Common bermuda grass Hybrid bermuda grass Kikuyu grass St. Augustine grass	Weeping alkaligrass Red fescue	Creeping bentgrass	Kentucky bluegrass Perennial ryegrass Highland bentgrass Creeping bentgrass Colonial bentgrass Weeping alkaligrass Dichondra	Tall fescue Common bermuda grass Kikuyu grass

Table 2. Criteria for turf grass cover
(Camp, Dresser and McKee, 1993.)

10. *Check Swale Stability.* The stability check is performed for the combination of highest expected flow and least vegetation coverage and height. Stability is normally checked for flow rate (Q) for the 100-yr, 24-h storm unless runoff from larger such events will bypass the swale. Q can be determined using the same methods mentioned for the initial design storm computation. The maximum velocity (U_{max}) in ft/s, that is permissible for the vegetation type, slope, and soil conditions should be obtained. Table 3 provides maximum velocity data for a variety of vegetative covers and slopes.

Table 3. Guide for selecting maximum permissible swale velocities for stability (adapted from Chow [1959], Livingston, et al., [1984], and Goldman, et al., [1986] from Horner [1993]).

		Maximum Velocity (ft/s)	
Cover Type	***Slope (%)***	***Erosion-resistant soils***	***Easily eroded soils***
Kentucky bluegrass Tall fescue	0 - 5	6	5
Kentucky bluegrass Ryegrasses Western wheat-grass	5 - 10	5	4
Grass-legume Mixture	0 - 5 5 - 10	5 4	4 3
Red fescue	0 - 5	3	2.5

The estimated degree of retardance for different grass coverage ("good" or "fair") should be obtained for the selected vegetation height. Estimation should be based on coverage and height will first receive flow, or whenever coverage and height are at their lowest. Table 4 provides qualitative degree of retardance for coverage and grass height.

Table 4. Grass coverage, height, and degree of retardance (Horner, 1993).

Average Grass Height (mm [inches])	***Degree of Retardance***
Coverage = "Good"	
> 760 (30)	A. Very high
280 - 610 (11 -24)	B. High
150 - 270 (6 - 10)	C. Moderate
50 - 150 (2 - 6)	D. Low
> 50 (>2)	E. Very low
Coverage = "Fair"	
> 760 (30)	B. High
280 - 610 (11 -24)	C. Moderate
150 - 270 (6 - 10)	D. Low
50 - 150 (2 - 6)	D. Low
> 50 (>2)	E. Very low

Select a trial Manning's n value for poor vegetation cover and low height. A good initial choice is n = 0.04. Using the alphabetic code assigned for the degree of retardance and the chosen n value, consult the following graph to obtain a first approximation for UR_h (velocity x hydraulic radius).

The graph in Figure 2 was derived based on English units. Compute the hydraulic radius, using the U_{max} determined for vegetation type and slope, by applying the following equation:

$$UR_h = \frac{UR_h}{U_{\max}} \tag{7}$$

Use Manning's equation to solve for the actual UR_h:

$$VR = \frac{1}{n} R^{1.67} s^{0.5} \tag{8}$$

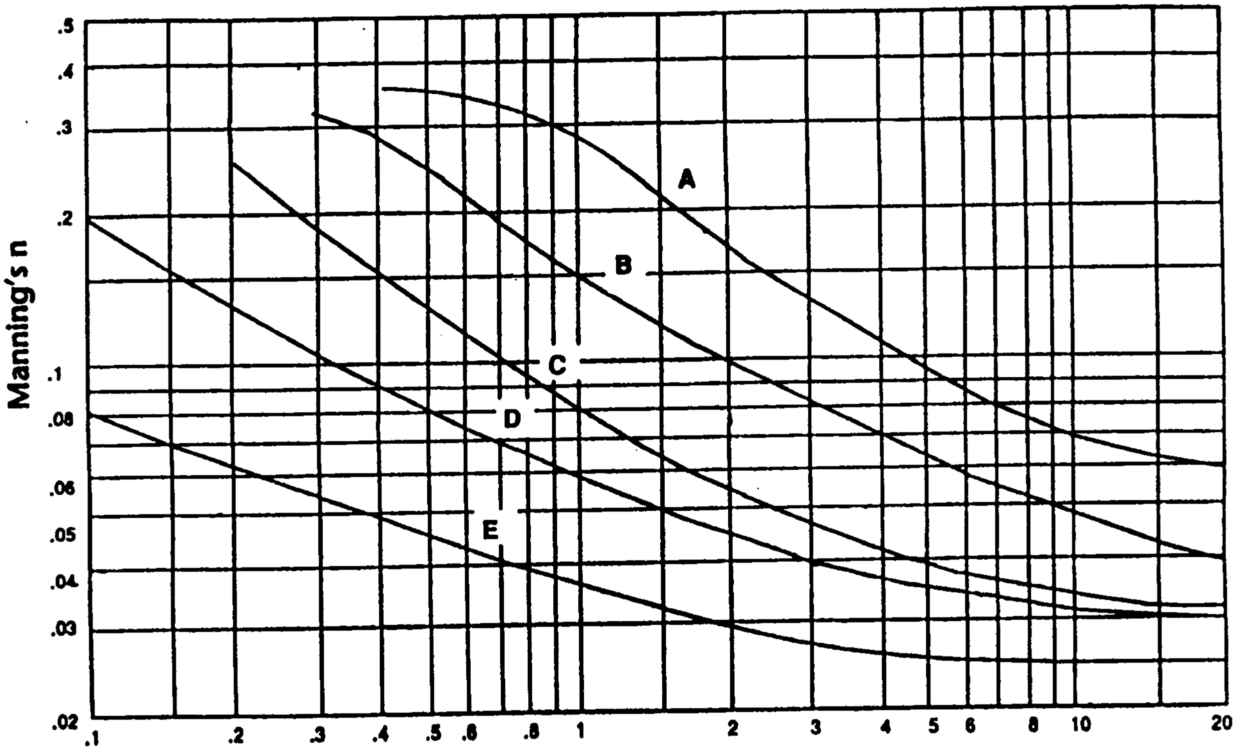

Figure 2. Relationship of Manning's n with UR_h for various degrees of flow retardance.

Once the actual UR_h is determined, compare this value with the first approximation for UR_h obtained through Figure 2. If they do not agree within five percent, adjust Manning's n value and repeat the process until acceptable agreement is reached. If $n < 0.033$ is needed to get agreement, set $n = 0.033$, solve UR_h again using Manning's equation above, and proceed.

The actual velocity for the final design conditions should be computed using the following equation:

$$U = \frac{UR_h}{R_h} \tag{9}$$

The actual velocity U should be less than the U_{max} value obtained from Table 3.

The area (A_x) required for stability should be computed from the following equation:

$$A_x = \frac{Q}{U} \tag{10}$$

The area value obtained in this procedure should be compared with the area (A_x) value obtained in the capacity analysis. If less area is required for stability than is provided for capacity, the design is acceptable. If more area is required for stability, use the area (A_x) value obtained in the stability analysis to recalculate channel dimensions.

The depth of flow at the stability check design flow rate then needs to be computed for the final dimensions of the swale by solving for y in the area equations provided on Figure 2. Compare this flow depth to the depth used in the capacity design. The larger of the two values should be used, plus 1 ft of freeboard, to obtain the total depth of the swale. The top width for the full depth of the swale should than be recalculated.

As a final check for capacity should be performed based on the stability check design storm, maximum vegetation height and cover to ensure that capacity is adequate if the largest expected event coincides with the greatest retardance. Using Manning's equation, the Manning's n value used for capacity design, and the calculated channel dimension (including freeboard) to compute the flow capacity of the channel. If the flow capacity is less than the stability check design storm flow rate, increase the channel cross-sectional area as needed for this conveyance, and specify the new channel dimensions.

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12. Washington State Department of Transportation, 1995. *Highway Runoff Manual*, Washington State Department of Transportation.

The following is a list of known locations where a Vegetated Swale was installed. The design of the installed swale in each location may vary from what is recommended in this SUSMP due to its specific circumstances. Los Angeles County does not endorse nor warranty any design used in the locations herein. Each individual case may require that the design be tailored to perform properly.

Installed Location (City/Address)	Brand/Manufacturer	Owner/Client
Cerritos Maintenance Station	N/A	Caltrans
I-605/Del Amo Ave.	N/A	Caltrans

B.14 WET PONDS

DESCRIPTION

The wet pond or retention pond is a facility which removes sediment, Biochemical Oxygen Demand (BOD), organic nutrients, and trace metals from stormwater runoff. This is accomplished by slowing down stormwater using an in-line permanent pool or pond effecting settling of pollutants. The wet pond is similar to a dry pond, except that a permanent volume of water is incorporated into the design. The drainage area should be such that an adequate base flow is maintained in the pond. Biological processes occurring in the permanent pond pool aid in reducing the amount of soluble nutrients present in the water, such as nitrate and ortho-phosphorus (Schueler, 1987).

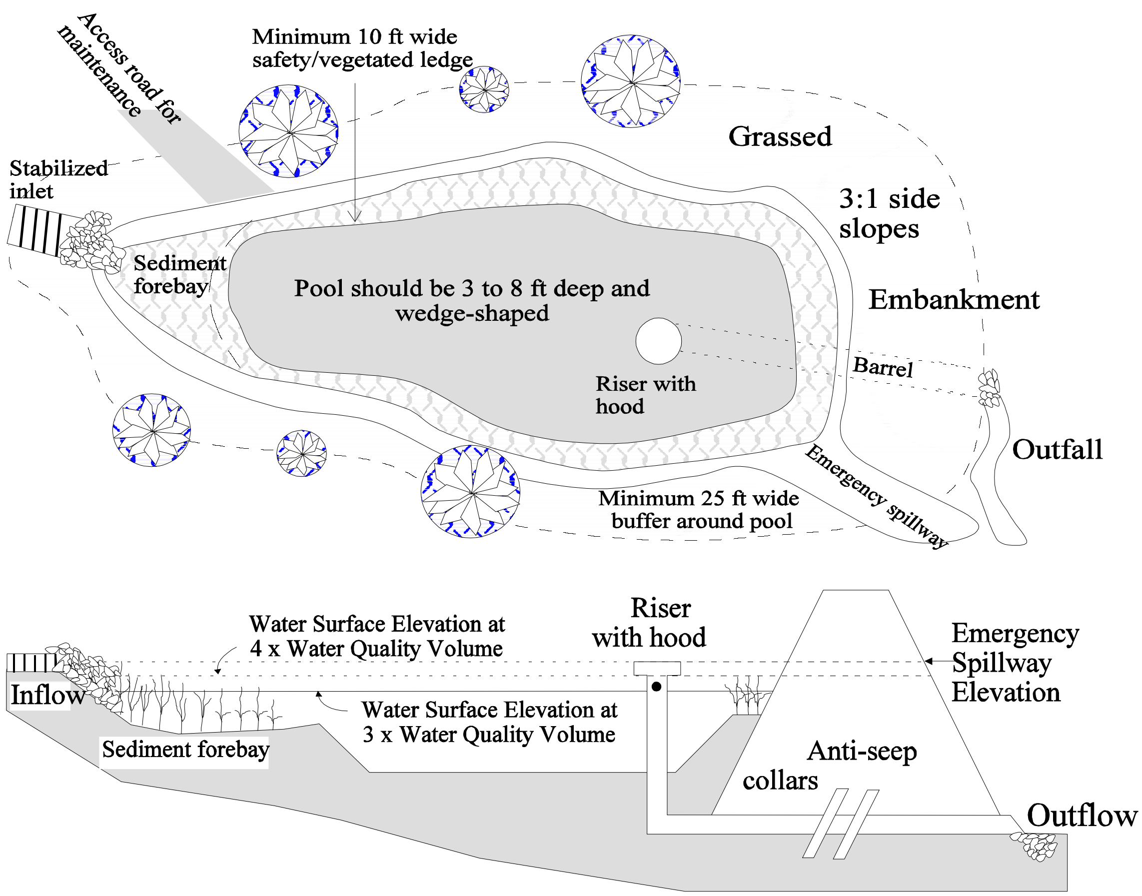

Figure 1. Typical wet pond schematic.

The basic elements of a wet pond are shown in Figure 1. A stabilized inlet prevents erosion at the entrance to the pond. It may be necessary to install energy dissipators. The permanent pool is usually maintained at a depth between 3 and 8 ft. The shape of the pool can help improve the performance of the pond. Maximizing the distance between the inlet and outlet provides more time for mixing of the new runoff with the pond water and settling of pollutants. Overflow from the pond is released through outlet structures to discharge flows at various elevations and peak flow rates. The outfall channel should be protected to prevent erosion from occurring downstream of the outlet.

Soil conditions are important for the proper functioning of the wet pond. The pond is a permanent pool, and thus must be constructed such that the water must not be allowed to infiltrate from the permanent portion of the pool. It is difficult to form a pool in soils with high infiltration rates soon after construction. Eventually, however, deposition of silt at the bottom of the pond will help slow infiltration. If extremely permeable soils exist at the site (type A or B), a geotextile or clay liner may be necessary.

ADVANTAGES

1. Wet ponds have recreational and aesthetic benefits due to the incorporation of permanent pools in the design.
2. Wet ponds offer flood control benefits in addition to water quality benefits.
3. Wet ponds can be used to handle a maximum drainage area of 10 mi^2.
4. High pollutant removal efficiencies for sediment, total phosphorus, and total nitrogen are achievable when the volume of the permanent pool is at least three times the water quality volume (the volume to be treated).
5. A wet pond removes pollutants from water by both physical and biological processes, thus they are more effective at removing pollutants than extended/dry detention basins.
6. Creation of aquatic and terrestrial habitat.

LIMITATIONS

1. Wet ponds may be feasible for stormwater runoff in residential or commercial areas with a combined drainage area greater than 20 acres but no less than 10 acres.
2. An adequate source of water must be available to ensure a permanent pool throughout the entire year.
3. If the wet pond is not properly maintained or the pond becomes stagnant; floating debris, scum, algal blooms, unpleasant odors, and insects may appear.
4. Sediment removal is necessary every 5 to 10 years.
5. Heavy storms may cause mixing and subsequent resuspension of solids.
6. Evaporation and lowering of the water level can cause concentrated levels of salt and algae to increase.
7. Cannot be placed on steep unstable slopes.
8. In California, the wet season in coincident with minimal plant growth.
9. Could be regulated as a wetlands or under Chapter 15, Title 23, California Code of Regulations regarding waste disposal to lands.
10. Pending volume and depth, pond designs may require approval from State Division of Safety of Dams.

DESIGN CRITERIA

1. *Hydrology*. If the device will also be used for stormwater quantity control, it will be necessary to reduce the peak flows after development to pre-development levels.
2. *Volume*. Calculate the volume of stormwater to be mitigated by the wet pond using the Los Angeles County Department of Public Works *Method for Calculating Standard Urban Stormwater Mitigation Plan (SUSMP) Flow Rates and Volumes Based on 0.75-inches of Rainfall*. The volume of the permanent pool should be 3 times the water quality volume.
3. *Pond Shape*. The pond should be long and narrow and generally shaped such that it discourages "short-circuiting." Short-circuiting occurs when storm flows by-pass the pond and do not mix well with the pool and simply by-pass the pond. Short-circuiting can be discouraged by lengthening the pond or by installing baffles which slow water down and lengthen the distance between the inlet and outlet. A length to width ratio of no less than 2:1, with 4:1 being preferred, will help minimize short circuiting. Also, the pond should gradually expand from the inlet and gradually contract toward the outlet. Several examples of ponds shaped to reduce short-circuiting are shown in Figure 2.
4. *Depth*. The depth of the pond is important in the design of the pond. If the pond is too shallow, sediment will be easily resuspended as a result of wind. Shallow ponds should not be used unless vegetation is adequate to stabilize the pond. If the pond is too deep, safety considerations emerge and stratification may occur, possibly causing anoxic conditions near the bottom of the pond. If the pond becomes anoxic, pollutants adsorbed to the bottom sediments may be released back to the water column. The average depth should be 3 to 6 ft, and depths of more than 8 ft should be avoided (Schueler, 1987). A littoral zone of 6 to 18 inches deep that accounts for 25 to 50 percent of the permanent pool surface for plant growth along the perimeter of the pool is recommended, the littoral shelf will also enhance safety.
5. *Vegetation.* Planting vegetation around the perimeter of the pond can have several advantages. Vegetation reduces erosion on both the side slopes and the shallow littoral areas. Vegetation located near the inlet to the pond can help trap sediments; algae growing on these plants can also filter soluble nutrients in the water column. Thicker, higher vegetation can also help hide any debris which may collect near the shoreline. Native turf-forming grasses or irrigated turf should be planted on sloped areas, and aquatic species should be planted on the littoral areas (Urbonas, et al., 1992). Vegetation can benefit wildlife and waterfowl by providing food and cover at the marsh fringe. A shallow, organic-rich marsh fringe provides an area which enables bacteria and other microorganisms to reduce organic matter and nutrients (Schueler, 1987).
6. *Side Slopes.* Gradual side slopes of a wet pond enhance safety and help prevent erosion and make it easier to establish dense vegetation. If vegetation cannot be established, the unvegetated banks will add to erosion and subsequently the

sediment load. It is recommended that side slopes be no greater than 3:1. If slopes are greater than this, riprap should be used to stabilize the banks (Schueler, 1987).

7. *Hydraulic Devices*. An outlet device, typically a riser-pipe barrel system, should be designed to release runoff in excess of the water quality volume and to control storm peaks. The outlet device should still function properly when partial clogging occurs. Plans should provide details on all culverts, risers, and spillways. Calculations should depict inflow, storage, and outflow characteristics of the design. Some frequently used design details for extending detention times in wet ponds are shown in Figure 3 and are described below (Schueler, 1987):

   a. *Slotted Standpipe from Low-Flow Orifice, Inlet Control (dry pond, shallow wet pond, or shallow marsh) [Figure 3 (a)].* An "L"-shaped PVC pipe is attached to the low-flow orifice. An orifice plate is located within the PVC pipe which internally controls the release rate. Slots or perforations are all spaced vertically above the orifice plate, so that sediment deposited around the standpipe will not impede the supply of water to the orifice plate.
   b. *Negatively Sloped Pipe from River (wet ponds or shallow marshes) [Figure 3 (b)].* This design was developed to allow for extended detention in wet ponds. The release rate is governed merely by the size of the pipe. The risk of clogging is largely eliminated by locating the opening of the pipe at least 1 ft below the water surface where it is away from floatable debris. Also, the negative slope of the pipe reduces the chance that debris will be pulled into the opening by suction. As a final defense against clogging, the orifice can be protected by wire mesh.
   c. *Hooded Riser (wet ponds) [Figure 3 (c)].* In this design, the extended detention orifice is located on the face of the riser near the top of the permanent pool elevation. The orifice is protected by wire mesh and a hood, which prevents floatable debris from clogging the orifice.

8. *Inlet and Outlet Protection.* The inlet pipe should discharge at or below the water surface of the permanent pool. If it is above the pool, an outlet energy dissipator will protect the banks and side slopes of the pond to avoid erosion. The stream channel just downstream of the pond outlet should be protected from scouring by placing riprap along the channel. Also, the slope of the outlet channel should be close to 0.5 percent. Riprap between 18 and 30 inches should be used. If the outlet pipe is less than 24 inches, 9 to 12 inches riprap may be used. Stilling basins may also be installed to reduce flow velocities at the outfall (Schueler, 1987).
9. *Forebay.* A forebay may be installed as part of the wet pond to capture sand and gravel sediment. The forebay should be easily accessible for dredging out the sediment when necessary and access to the forebay for equipment should be provided.

10. *Emptying Time*. A 12 to 48 hour emptying time may be used for the water quality volume above the permanent pool (Urbonas, et al., 1992).
11. *Freeboard.* The pond embankment should have at least 1 ft of freeboard above the emergency spillway crest elevation (Schueler, 1987).

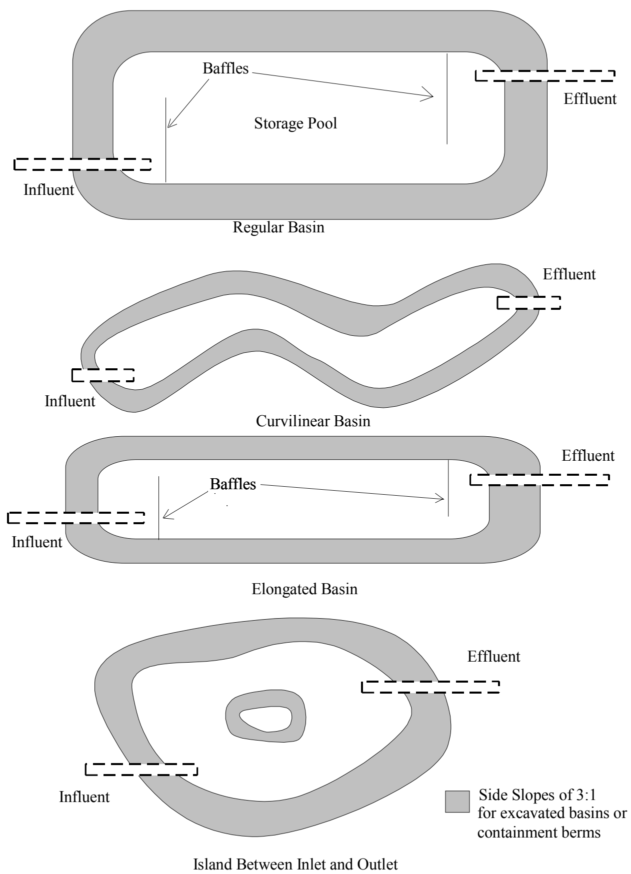

Figure 2. Methods of increasing the length to width ratio.

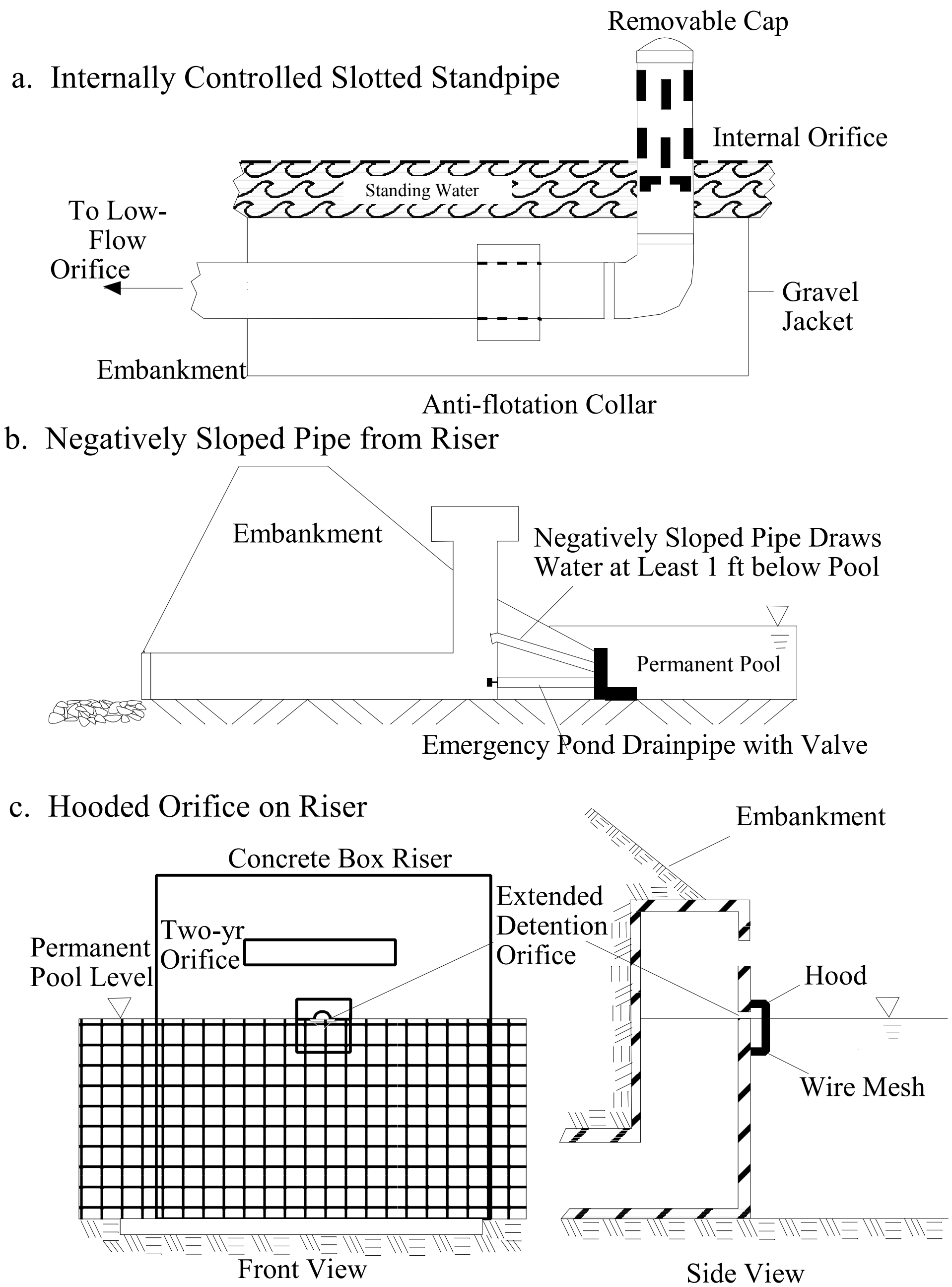

Figure 3. Designs or approaches for extending detention times in wet ponds.

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Exhibit 4

Low Impact Development (LID) Handbook

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.

Table of Contents

Part II:
Making LID Work for Los Angeles

Appendices

[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]

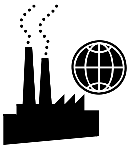
In addition, each ¼-acre of hardscape in Los Angeles has the potential to collect 100,000 gallons of rainwater per year.[7] A separate study by the Natural Resource Defense Council from January 2009[8] found that an increased use of LID practices throughout residential and commercial properties in L.A. 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.

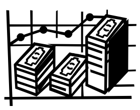
Water Supply & Demand

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]

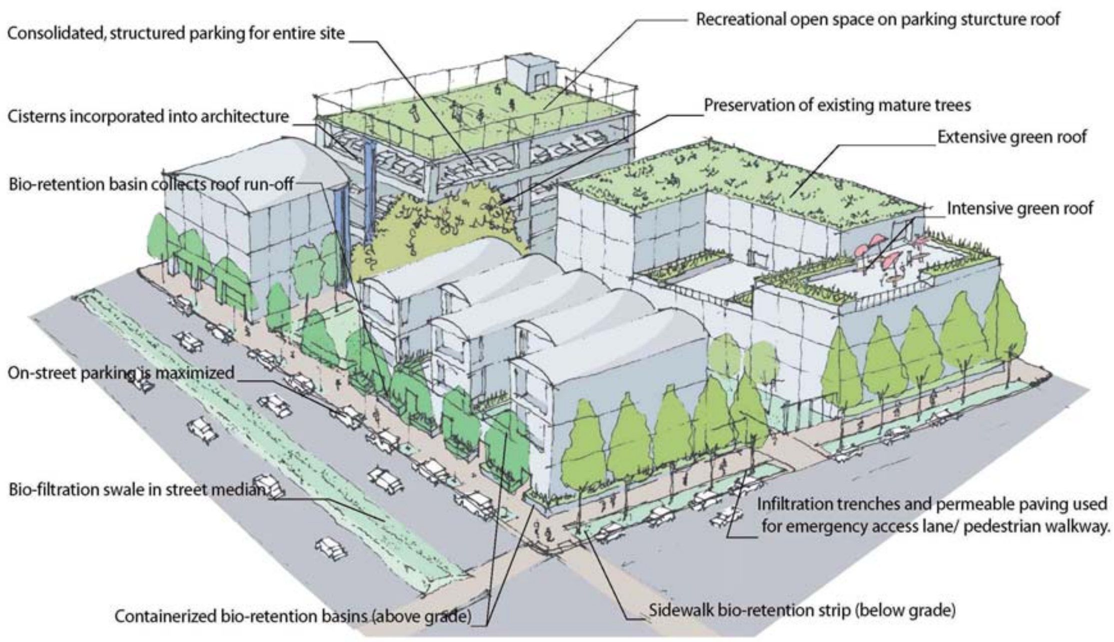


Illustration from the City of Emeryville's *"Stormwater Guidelines for Green, Dense Redevelopment"* manual depicting what LID might look like for a commercial development. *Credit: City of Emeryville / Community, Design + Architecture*

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.)
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

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[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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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.

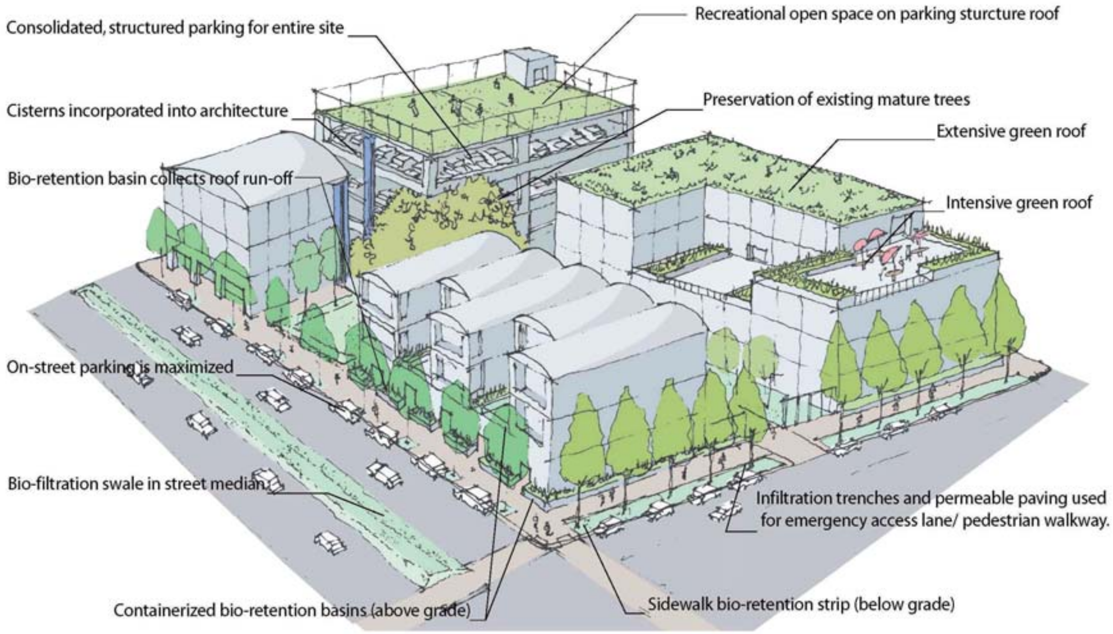


Illustration from the City of Emeryville's *"Stormwater Guidelines for Green, Dense Redevelopment"* manual depicting what LID might look like for a commercial development. *Credit: City of Emeryville / Community, Design + Architecture*

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]

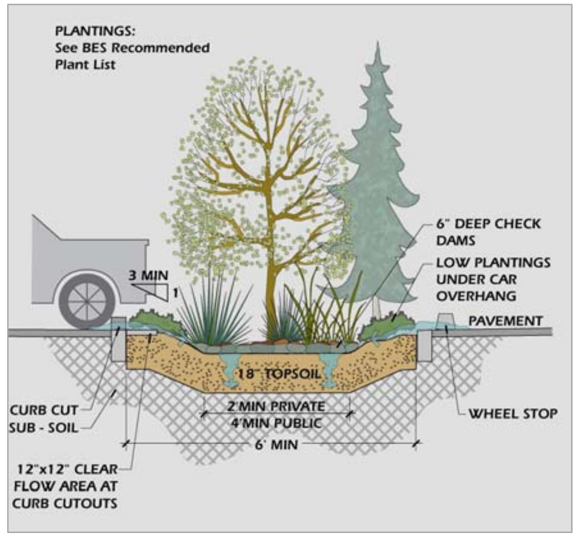
In either case, a city with a robust green infrastructure system can reap multiple benefits from the increased services that nature provides, especially with regards to stormwater management, increased

[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

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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 <u>potential</u> 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

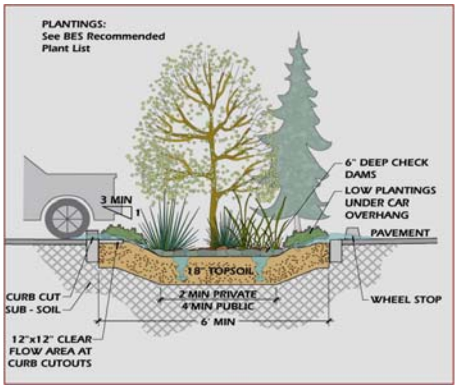
The 6,500 miles of streets[7] and 914 miles[8] of alleys in the City of Los Angeles have tremendous potential for reducing the velocity of water flows, decreasing polluted runoff and augmenting water infiltration. In general, Los Angeles is highly urbanized, and the ability to apply relevant street and 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 aestethic improvements to the local neighborhood.

	**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*
	**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*
	**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*

	**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]

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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 2030, LID projects could save L.A. County 74,600–152,500 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 131,700–428,000 MWH of energy per year by 2030.[c]

Additional LID Benefits

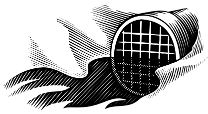
- Better flood control
- Reduced need for wastewater treatment
- Money saved on water management infrastructure
- Increased green space and wildlife habitat
- Reduced urban heat island effect
- Community beautification
- Emphasis on green jobs and economy

Sources: a) Community Conservancy International 2008, b) NRDC 2009, c) NRDC 2009 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.

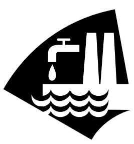
Flood Control & Wastewater Management

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]



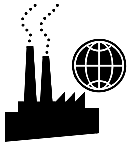
River & Ocean Pollution

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]

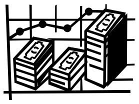


Climate Change

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

[1] 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

[2] *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."

[3] 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.

[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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[10] Seattle Public Utilities Commission. *Street Edge Alternatives (SEA Streets) Project.* Accessed 12/31/08, http://www.seattle.gov/UTIL/About_SPU/Drainage_&_Sewer_System/Natural_Drainage_Systems/Street_Edge_Alternatives/index.asp

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[12] ibid.
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[17] 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

[18] Wise, Steve. "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning,* the magazine of the American Planning Association. August/September 2008. Pages 14-19.

[19] ibid.

[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."

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

[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.

[24] Wise, Steve. "Green Infrastructure Rising: Best Practices in Stormwater Management." *Planning,* the magazine of the American Planning Association. August/September 2008. Pages 14-19.

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[28] *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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[32] E. Gregory McPherson, Center for Urban Forest Research, US Forest Service, Davis, CA; and J. R. Simpson, Q. Xiao, and C. Wu. "Million Trees LA Canopy Cover Assessment." Accesed on 4/1/09, http://ams.confex.com/ams/7Coastal7Urban/techprogram/paper_126994.htm

[33] City of Los Angeles Department of Recreation and Parks. *Sepulveda Basin Wildlife Reserve.* Accessed on 1/6/09, http://www.laparks.org/dos/horticulture/sepulvedabasin.htm

[34] Traffic Safety Center. *Can Pedestrian-friendly Planning Encourage Us to Walk?* Online newsletter Volume 2, Number 1, Spring 2004. Accessed on 1/9/09, http://www.tsc.berkeley.edu/newsletter/Spring04/planning.html

[35] Lerner, Joel M. "A Property's Value Can Grow on Its Trees," *Washington Post* Saturday, September 23, 2006; Page F26. Accessed on 1/9/09, http://www.washingtonpost.com/wp-dyn/content/article/2006/09/21/AR2006092102046.html

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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

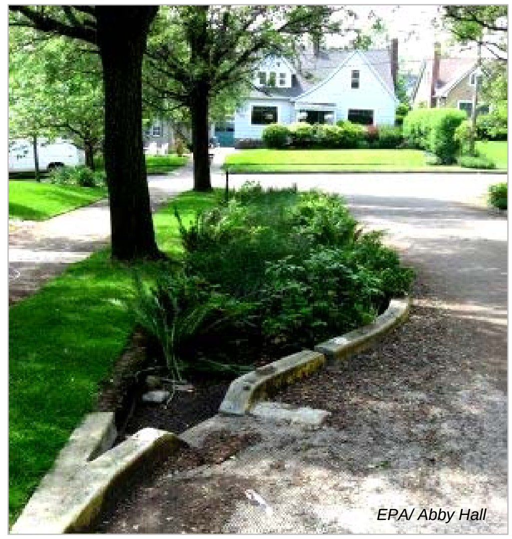
Element	Multiplier
Vegetated walls	0.7
Rain garden	0.7
Lawn – deep	0.7
Green roofs	0.7
Permeable pavement	0.6
Exceptional trees	0.5
Bigger trees	0.4
Smaller trees	0.3
Shrubs-deep	0.3
Shrubs – shallow	0.3
Lawn – shallow	0.2
Visibility (aesthetics) - bonus	0.1
Drought tolerant - bonus	0.1
Conventional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



EPA/ Abby Hall

Nevue Ngan Assoc / Kevin Robert Perry

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

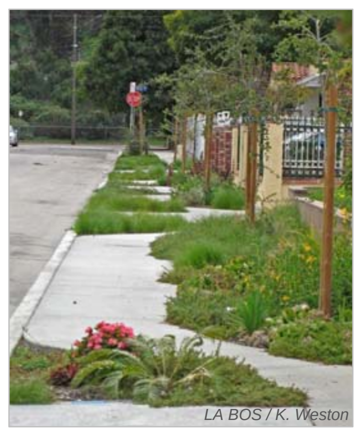
Contaminated runoff is the largest source of ocean pollution in Southern California,[28 29] and the city's street infrastructure plays a major role in flushing these pollutants out to sea. The city has approximately 6,500 miles of streets[30] with 10,000 miles of sidewalk[31] and 34,000 catch basins.[32] 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.

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[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

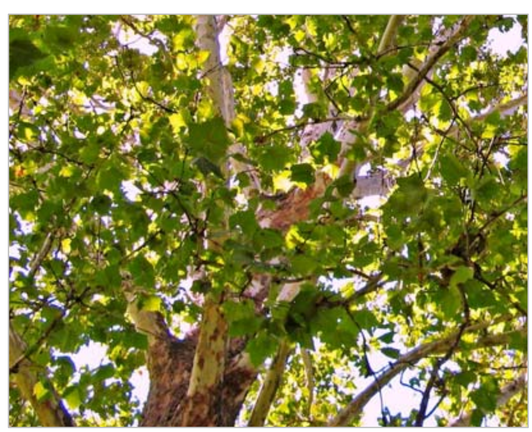
Contaminated stormwater runoff is the largest source of ocean pollution in Southern California,[34] and the city's street infrastructure plays a major role in flushing these pollutants out to sea. The city has approximately 6,500 miles of streets with 10,000 miles of sidewalk and 34,000 catch basins.[35] 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.



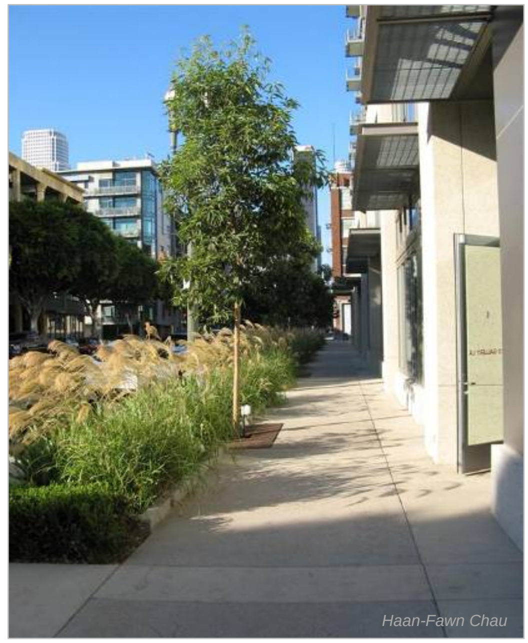
Canopy of a native sycamore tree. *Credit: Haan-Fawn Chau*

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


Haan-Fawn Chau

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)*

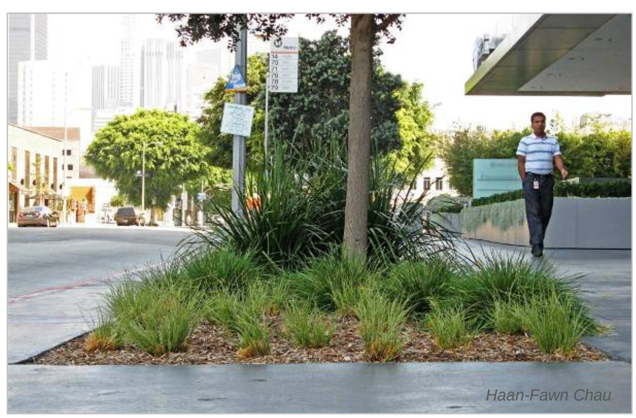
In October 2007, the Stream Protection Task Force completed a draft for a proposed Stream Protection Ordinance. Its goals are to: "(1) protect a valuable natural resource; (2) protect and maintain the existing ephemeral, perennial, intermittent or seasonal streams located within the City of Los Angeles; (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.


Haan-Fawn Chau

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.

<u>*Drawbacks:*</u> (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.

<ins>*Drawbacks:*</ins> (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.

<ins>*Drawbacks:*</ins> (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]

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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.

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.

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

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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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:

for Leela Kapur
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)

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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

563934_2

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]

City of Ventura: Green Streets Matrix

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.

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

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.

City of Ventura: Green Streets Matrix

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.

City of Ventura: Green Streets Matrix

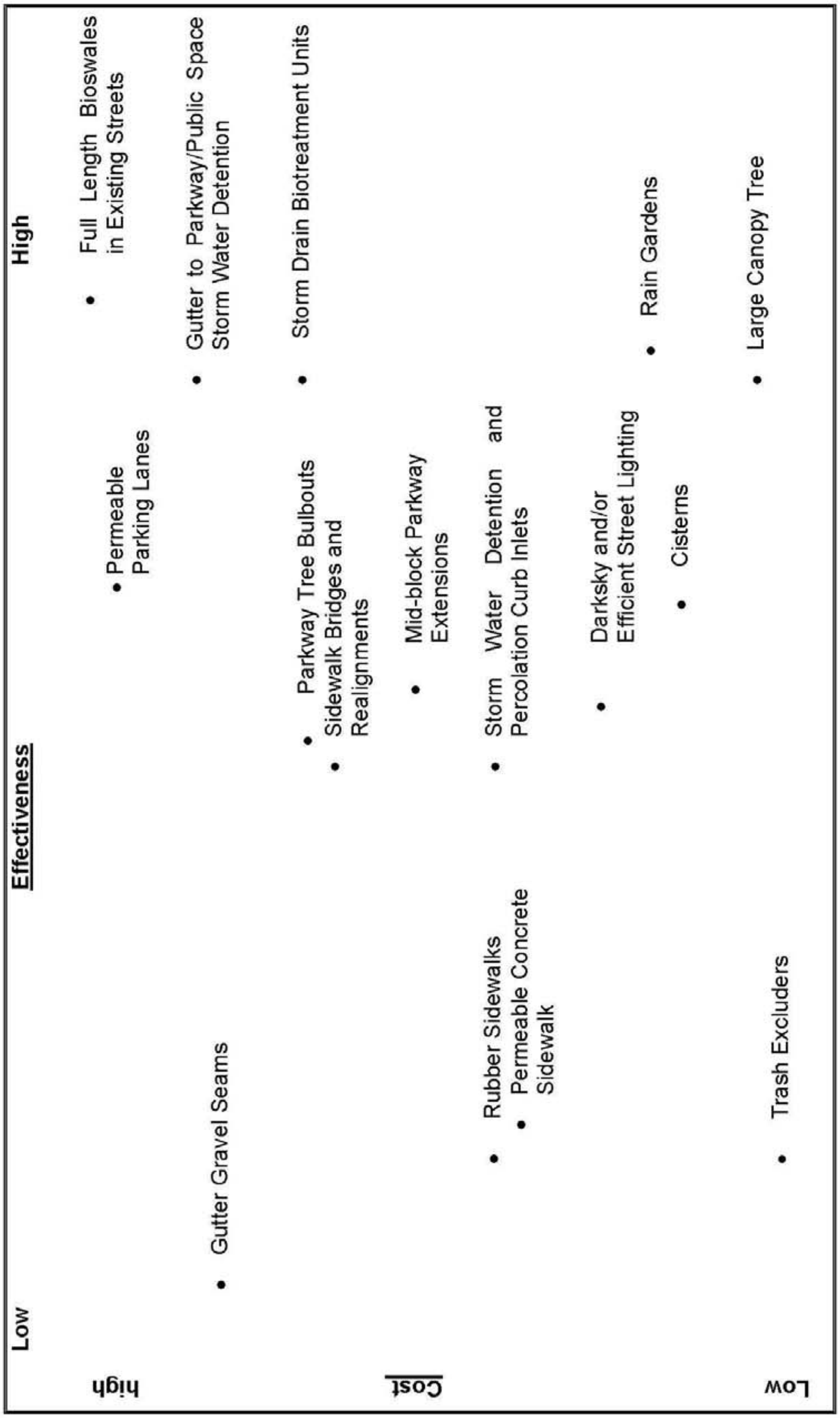
GREEN STREETS MATRIX **City of Ventura Department of Public Works, 2008**

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.

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

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.

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

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.

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

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.

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)

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.

Acknowledgements

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Thank you to **Abby Hall** of the U.S. Environmental Protection Agency for permission to use her photographs of green infrastructure projects, which can be viewed at http://picasaweb.google.com/buildgreeninfrastructure.

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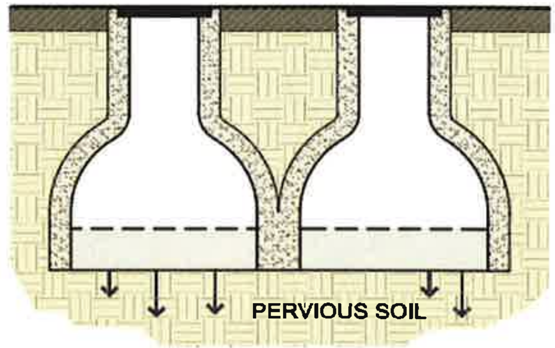
Exhibit 5

Typical LID BMPs for the Proposed Project

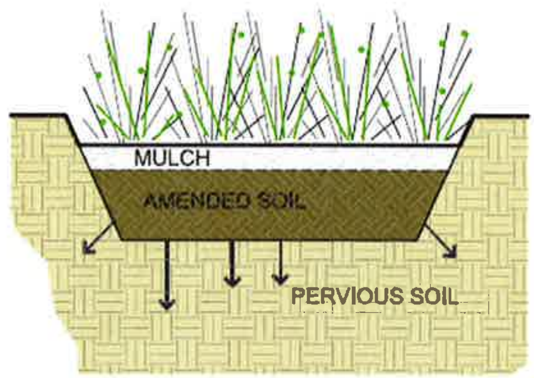
Infiltration Galleries

Infiltration galleries are open-bottom, subsurface vaults that store and infiltrate stormwater. A number of vendors offer prefabricated, modular infiltration galleries that provide subsurface storage and allow for infiltration. Infiltration galleries come in a variety of material types, shapes and sizes.



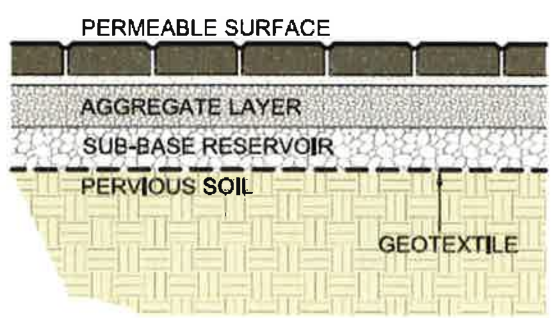
Bioretention

Bioretention stormwater treatment facilities are landscaped shallow depressions that capture and filter stormwater runoff. These facilities function as a soil and plant-based filtration device that removes pollutants through a variety of physical, biological, and chemical treatment processes. The facilities normally consist of a ponding area, mulch layer, planting soils, plantings, and, optionally, a subsurface gravel reservoir layer.

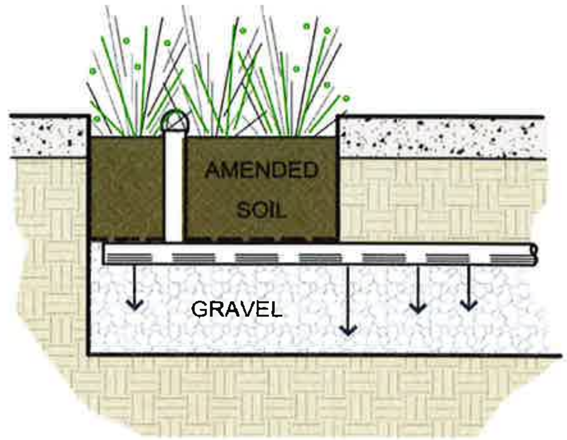


Permeable Pavements

Permeable (or pervious) pavements contain small voids that allow water to pass through to a stone base. They come in a variety of forms; they may be a modular paving system (concrete pavers, modular grass or gravel grids) or poured-in-place pavement (porous concrete, permeable asphalt). All permeable pavements with a stone reservoir base treat stormwater and remove sediments and metals to some degree by allowing stormwater to percolate through the pavement and enter the soil below.

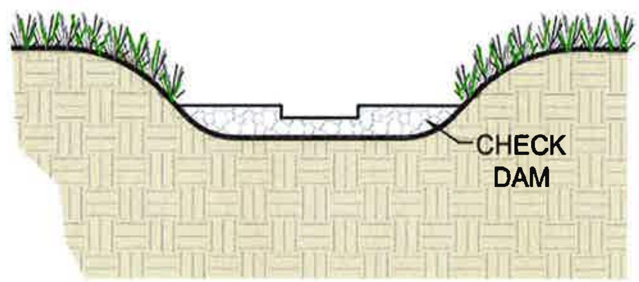


High-Flow Biotreatment with Raised Underdrain



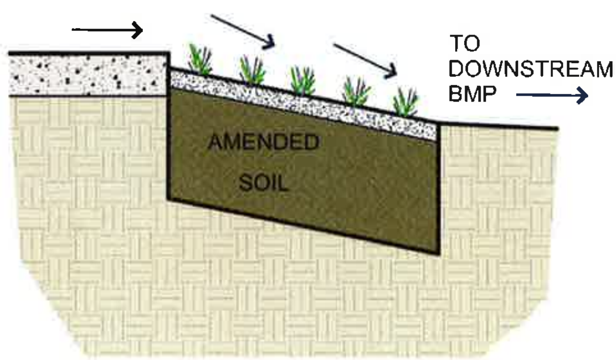
High-flow biotreatment devices are proprietary treatment BMPs that incorporate plants, soil, and microbes engineered to provide treatment at higher flow rates and with smaller footprints than their non-proprietary counterparts. Like bioinfiltration devices, they should incorporate a raised underdrain above a gravel sump to facilitate incidental infiltration where feasible.They must be shown to have pollutant removal efficiencies equal to or greater than the removal efficiencies of their non-proprietary counterparts. Proof of this performance must be provided by adequate third party field testing.

Vegetated Swales



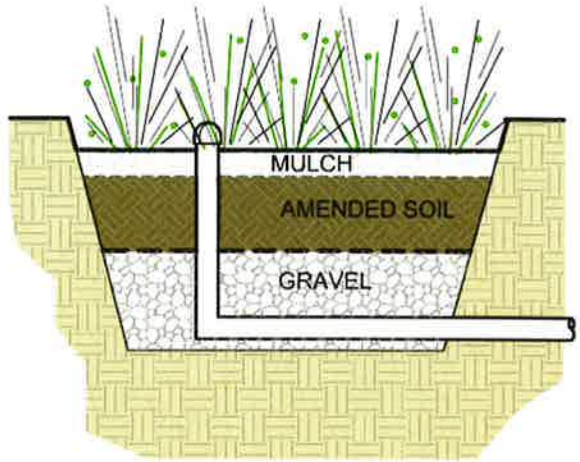
Vegetated swales are open, shallow channels with dense, low-lying vegetation covering the side slopes and bottom that collect and slowly convey runoff to downstream discharge points. An effective vegetated swale achieves uniform sheet flow through the densely vegetated area for a period of several minutes. The vegetation in the swale can vary depending on its location and is the choice of the designer. Most swales are grass-lined.

Filter Strips (to be used as part of a treatment train)



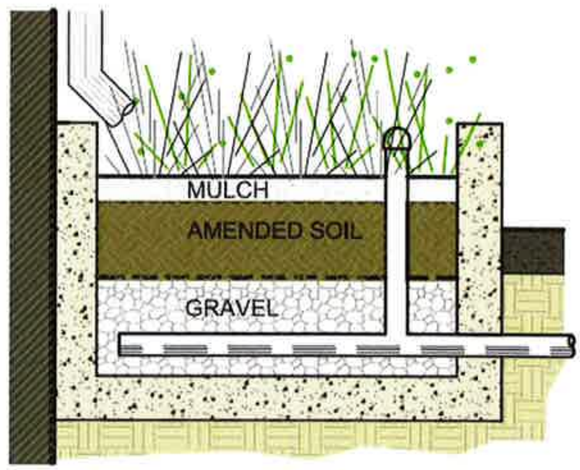
Filter strips are vegetated areas designed to treat sheet flow runoff from adjacent impervious surfaces such as parking lots and roadways, or intensive landscaped areas such as golf courses. While some assimilation of dissolved constituents may occur, filter strips are generally more effective in trapping sediment and particulate-bound metals, nutrients, and pesticides. Filter strips are more effective when the runoff passes through the vegetation and thatch layer in the form of shallow, uniform flow. Filter strips are primarily used to pretreat runoff before it flows to an infiltration BMP or another biofiltration BMP.

Bioretention with Underdrain



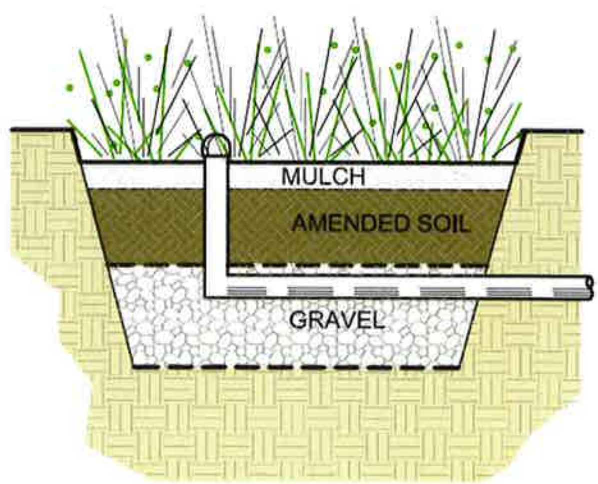
Bioretention facilities are landscaped shallow depressions that capture and filter stormwater runoff. As stormwater passes down through the planting soil, pollutants are filtered, adsorbed, and biodegraded by the soil and plants. Because they are not contained within an impermeable structure, they may allow for infiltration. For sites not passing the infiltration feasibility screening for reasons other than low infiltration rates (such as soil contamination, expansive soils, etc.), an impermable liner may be needed to prevent incidental infiltration.

Planter Boxes



Planter boxes are bioretention treatment control measures that are completely contained within an impermeable structure with an underdrain (they do not infiltrate). They are similar to bioretention facilities with underdrains except they are situated at or above ground and are bound by impermeable walls. Planter boxes may be placed adjacent to or near buildings, other structures, or sidewalks.

Bioinfiltration



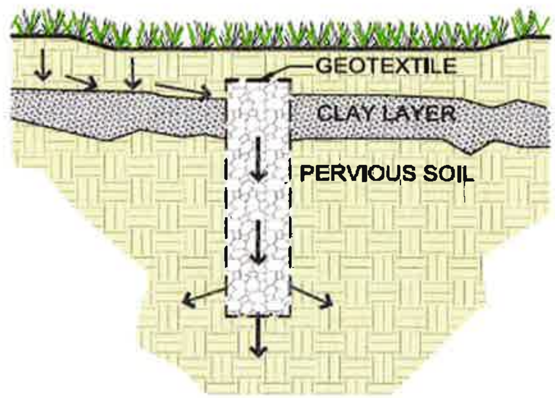
Bioinfiltration facilities are designed for partial infiltration of runoff and partial biotreatment. These facilities are similar to bioretention devices with underdrains but they include a raised underdrain above a gravel sump designed to facilitate infiltration and nitrification/denitrification. These facilities can be used in areas where there are little to no hazards associated with infiltration, but infiltration screening does not allow for infiltration BMPs due to low infiltration rates or high depths of fill.

Multi-Directional Infiltration BMPs

These BMPs take advantage of the hydraulic conductivities (K_{sat}) of multiple soil strata and infiltration in multiple directions. They may be especially useful at locations where low K_{sat} values are present near the surface and soils with higher permeabilities exist beneath. A Multi-Directional Infiltration BMP may be implemented to infiltrate water at these lower soil layers, thus allowing infiltration to occur at sites that otherwise would be infeasible. These infiltration BMPs typically have smaller footprints and include, but are not limited to:

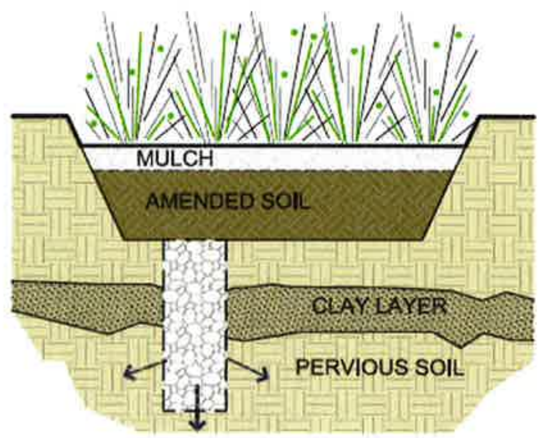
Dry Wells

A dry well is defined as an excavated, bored, drilled, or driven shaft or hole whose depth is greater than its width. Drywells are similar to infiltration trenches in their design and function, as they are designed to temporarily store and infiltrate runoff, primarily from rooftops or other impervious areas with low pollutant loading. A dry well may be either a drilled borehole filled with aggregate or a prefabricated storage chamber or pipe segment.



Hybrid Bioretention/Dry Wells

A bioretention facility with dry wells is useful in areas with low surface-level hydraulic conductivities that would normally deem a bioretention BMP infeasible but have higher levels of permeability in deeper strata. By incorporating drywells underneath the bioretention facility, water is able to be infiltrated at deeper soil layers that are suitable for infiltration, if present. This hybrid BMP combines the aesthetic and filtration qualities of a bioretention facility with the enhanced infiltration capabilities of a dry well.

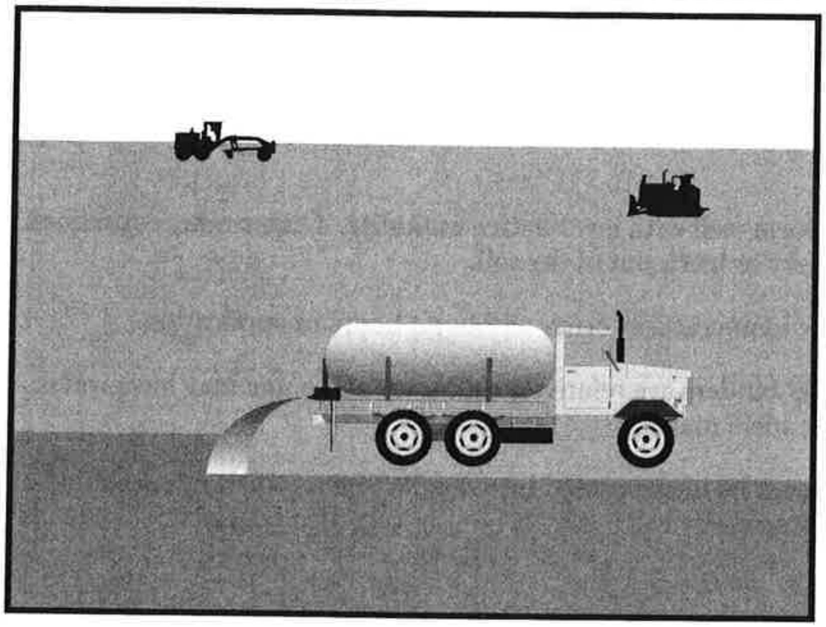


4.4.2 Siting Requirements and Opportunity Criteria

Drainage areas implementing infiltration BMPs must pass the Category 1 or Category 2 Screening in accordance with the siting requirements set forth in Table 4.1. This screening process must be approved by a site-specific geotechnical investigation report and/or hydrologic analysis conducted and certified by a State of California registered professional geotechnical engineer or geologist.

Exhibit 6

Typical SWPPP BMPs for the Proposed Project



Objectives

EC	Erosion Control	✓
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	✓
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

✓ **Primary Objective**

✓ **Secondary Objective**

Targeted Constituents

Sediment	✓
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-6 Straw Mulch

EC-7 Geotextiles and Mats

EC-8 Wood Mulching

CASQA California Stormwater Quality Association

Description and Purpose

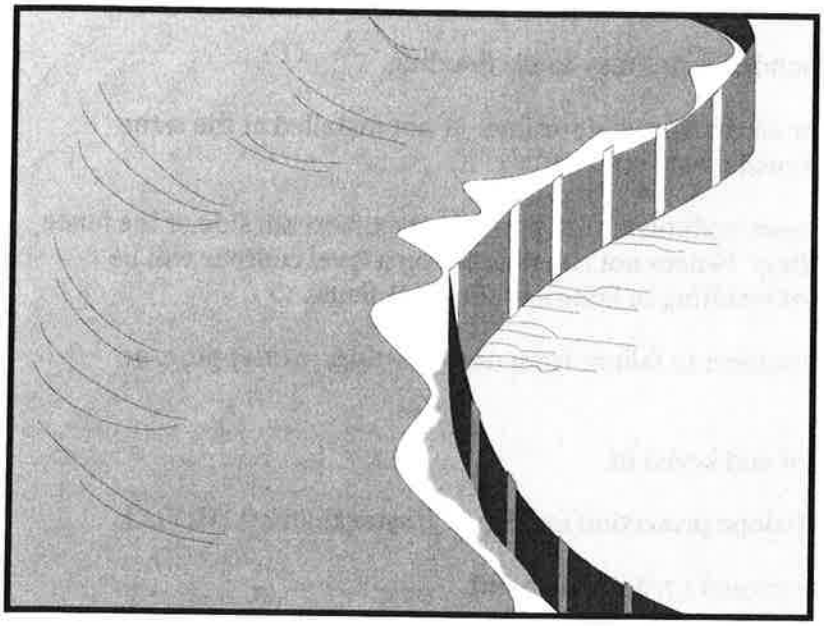
Soil binders consist of applying and maintaining a soil stabilizer to exposed soil surfaces. Soil binders are materials applied to the soil surface to temporarily prevent water induced erosion of exposed soils on construction sites. Soil binders also prevent wind erosion.

Suitable Applications

Soil binders are typically applied to disturbed areas requiring short term temporary protection. Because soil binders can often be incorporated into the work, they are a good alternative to mulches in areas where grading activities will soon resume. Soil binders are also suitable for use on stockpiles.

Limitations

- Soil binders are temporary in nature and may need reapplication.
- Soil binders require a minimum curing time until fully effective, as prescribed by the manufacturer. Curing time may be 24 hours or longer. Soil binders may need reapplication after a storm event.
- Soil binders will generally experience spot failures during heavy rainfall events. If runoff penetrates the soil at the top of a slope treated with a soil binder, it is likely that the runoff will undercut the stabilized soil layer and discharge at a point further down slope.



Objectives

EC	Erosion Control	✓
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
✓ **Primary Objective**
✓ **Secondary Objective**

Targeted Constituents

Sediment	✓
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls
SE-6 Gravel Bag Berm
SE-8 Sandbag Barrier
SE-9 Straw Bale Barrier

Description and Purpose

A silt fence is made of a filter fabric that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They should also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.

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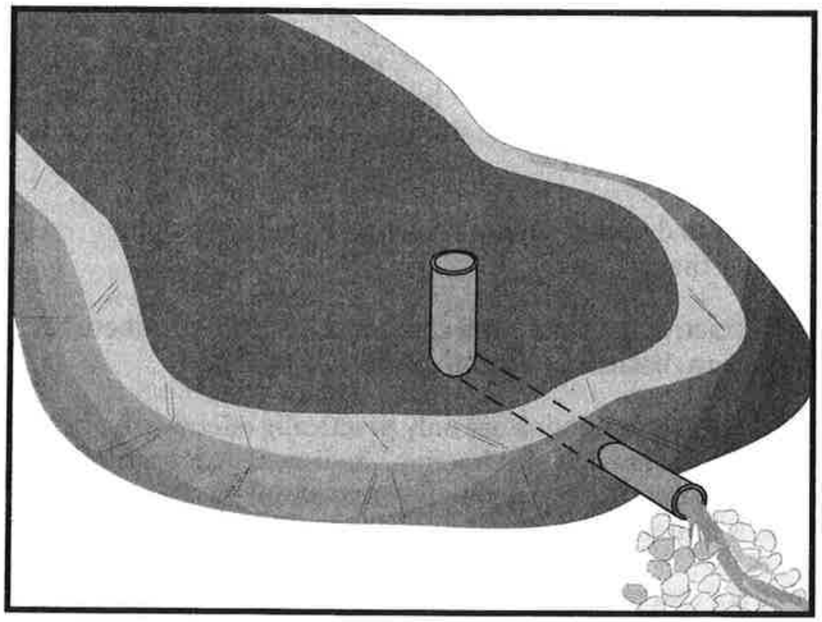


Objectives

EC	Erosion Control	
SE	Sediment Control	✓
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

✓ **Primary Objective**

✓ **Secondary Objective**

Targeted Constituents

Sediment	✓
Nutrients	
Trash	✓
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

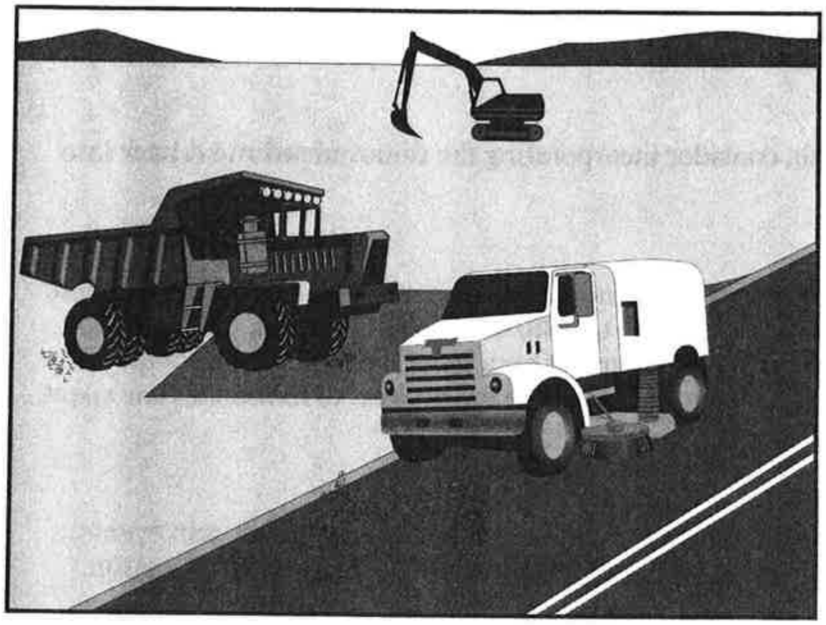
- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres
- At the outlet of large disturbed watersheds, as necessary
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of

CASQA California Stormwater Quality Association

Street Sweeping and Vacuuming SE-7



Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways, and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused, and perhaps save money.
- Inspect potential sediment tracking locations daily.
- Visible sediment tracking should be swept or vacuumed on a daily basis.

Objectives

EC	Erosion Control	
SE	Sediment Control	✓
TC	Tracking Control	✔
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
✔ **Primary Objective**
✓ **Secondary Objective**

Targeted Constituents

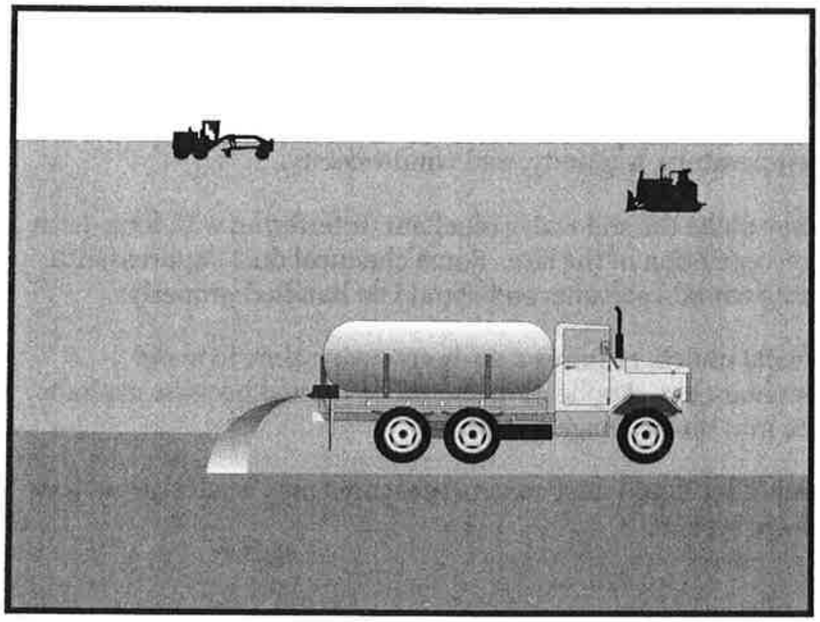
Sediment	✔
Nutrients	
Trash	✔
Metals	
Bacteria	
Oil and Grease	✔
Organics	

Potential Alternatives

None

CASQA
California Stormwater Quality Association

Wind Erosion Control WE-1



Objectives

EC	Erosion Control	
SE	Sediment Control	✓
TC	Tracking Control	
WE	Wind Erosion Control	✔
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

✔ **Primary Objective**

✓ **Secondary Objective**

Targeted Constituents

Sediment	✔
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

CASQA California Stormwater Quality Association

Description and Purpose

Wind erosion or dust control consists of applying water or other dust palliatives as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

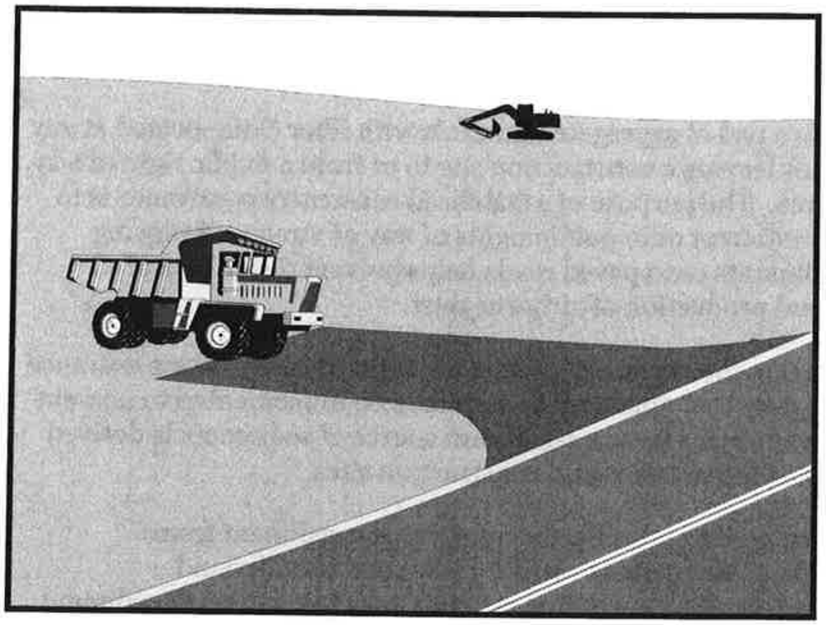
Suitable Applications

Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Sediment tracking onto paved roads
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period and should be applied daily (or more often) to be effective.
- Over watering may cause erosion.



Objectives

EC	Erosion Control	✓
SE	Sediment Control	✓
TC	Tracking Control	✓
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

✓ **Primary Objective**

✓ **Secondary Objective**

Targeted Constituents

Sediment	✓
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

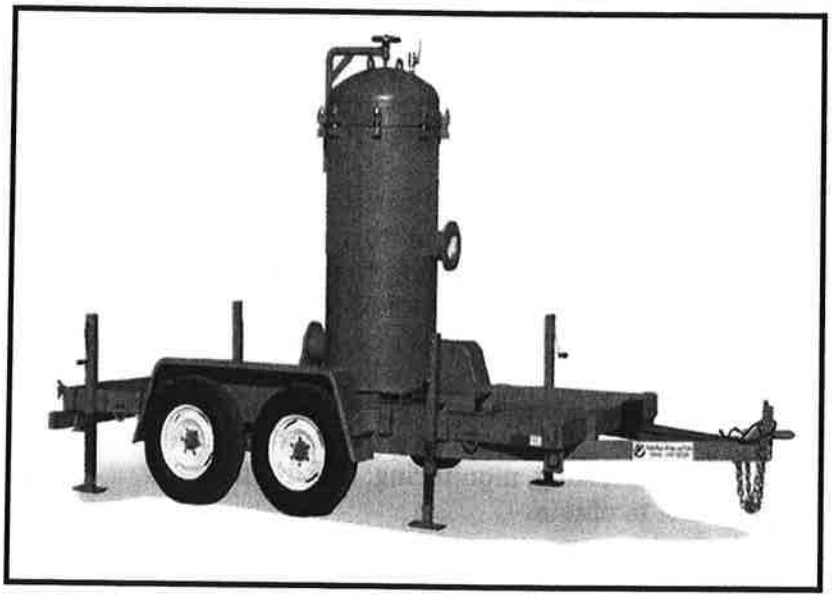
Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.



Objectives

EC	Erosion Control	
SE	Sediment Control	✓
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	✓
WM	Waste Management and Materials Pollution Control	

Legend:
✓ **Primary Objective**
✓ **Secondary Objective**

Targeted Constituents

Sediment	✓
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	✓
Organics	

Potential Alternatives

SE-5: Fiber Roll

SE-6: Gravel Bag Berm

SE-9: Straw Bale Barrier

Description and Purpose

Dewatering operations are practices that manage the discharge of pollutants when non-stormwater and accumulated precipitation must be removed from a work location so that construction work may be accomplished.

Suitable Applications

These practices are implemented for discharges of non-stormwater from construction sites. Non-stormwaters include, but are not limited to, groundwater, water from cofferdams, water diversions, and waters used during construction activities that must be removed from a work area.

Practices identified in this section are also appropriate for implementation when managing the removal of accumulated precipitation (stormwater) from depressed areas at a construction site.

Limitations

- Site conditions will dictate design and use of dewatering operations.
- The controls discussed in this best management practice (BMP) address sediment only.
- The controls detailed in this BMP only allow for minimal settling time for sediment particles. Use only when site conditions restrict the use of the other control methods.
- Dewatering operations will require, and must comply with, applicable local permits.

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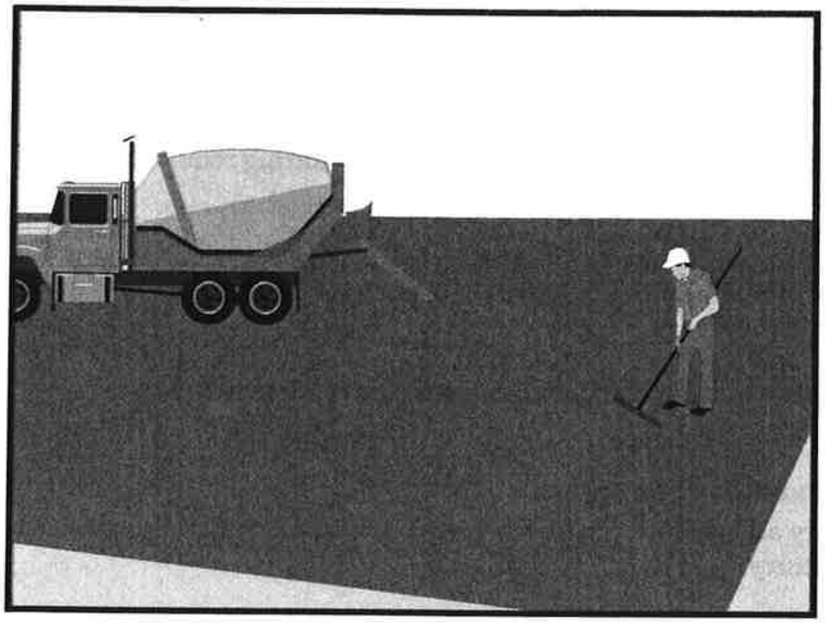
Paving and Grinding Operations NS-3



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	✔
WM	Waste Management and Materials Pollution Control	✓

Legend:

✔ **Primary Objective**

✓ **Secondary Objective**

Targeted Constituents

Sediment	✔
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	✔
Organics	

Potential Alternatives

None

Description and Purpose

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

Suitable Applications

These procedures are implemented where paving, surfacing, resurfacing, or sawcutting, may pollute stormwater runoff or discharge to the storm drain system or watercourses.

Limitations

- Finer solids are not effectively removed by filtration systems.
- Paving opportunities may be limited during wet weather.

Implementation

General

- Avoid paving during the wet season when feasible.
- Reschedule paving and grinding activities if rain is in the forecast.
- Train employees and sub-contractors in pollution prevention and reduction.
- Store materials away from drainage courses to prevent stormwater runon (see WM-1, Material Delivery and Storage).

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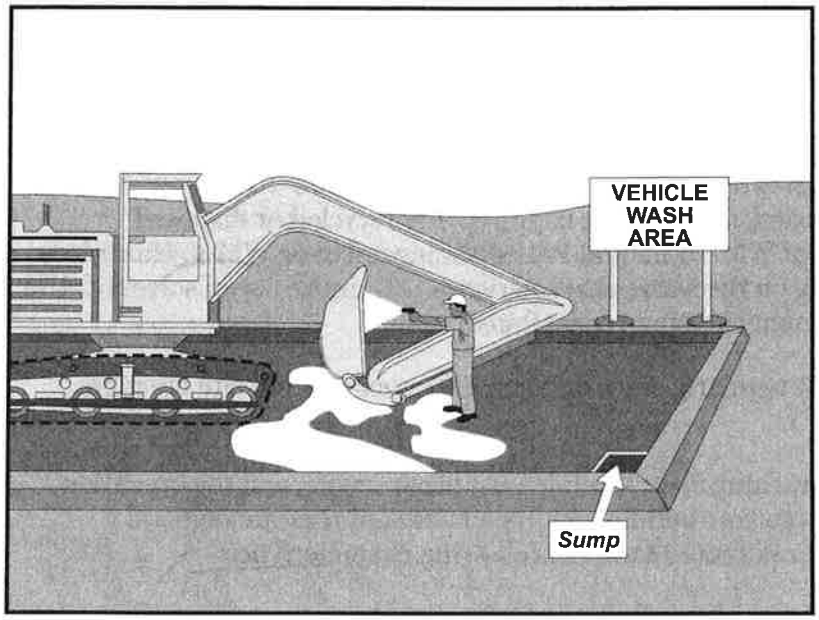
Vehicle and Equipment Cleaning NS-8



Description and Purpose

Vehicle and equipment cleaning procedures and practices prevent or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning by using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/ Exit.

Implementation

Use an offsite commercial washing business as much as possible. These businesses are better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.

Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	✓
WM	Waste Management and Materials Pollution Control	

Legend:

✓ **Primary Objective**

✓ **Secondary Objective**

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	
Metals	
Bacteria	
Oil and Grease	✓
Organics	✓

Potential Alternatives

None

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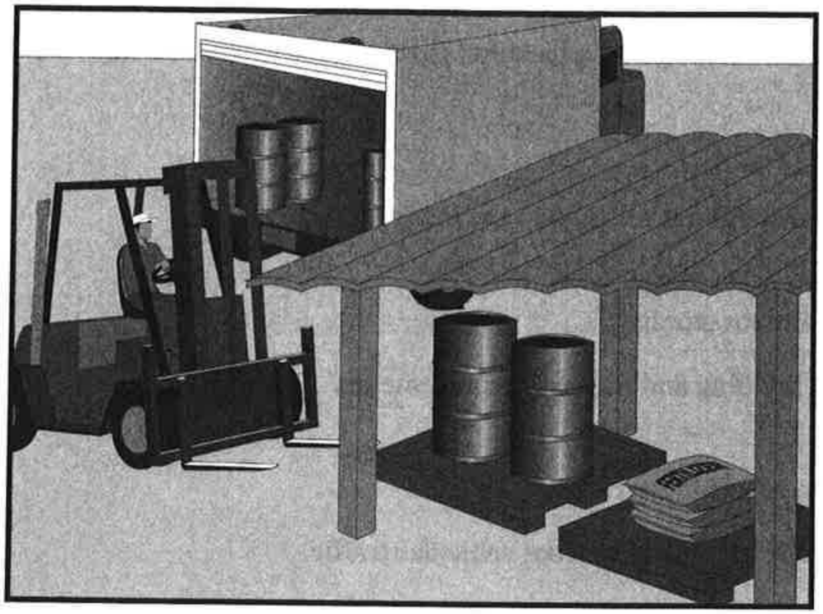
Material Delivery and Storage WM-1



Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	✓

Legend:
✓ **Primary Objective**
✓ **Secondary Objective**

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Potential Alternatives

None

Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in a designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2, Material Use, or WM-4, Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease
- Asphalt and concrete components

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Stockpile Management WM-3

Objectives

EC	Erosion Control	
SE	Sediment Control	
TC	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	✓

Legend:
✓ Primary Objective
✓ Secondary Objective

Description and Purpose

Stockpile Management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, paving materials such as portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, asphalt minder (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

Implement in all projects that stockpile soil and other materials.

Limitations

None identified.

Implementation

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

- Locate stockpiles a minimum of 50 ft away from concentrated flows of stormwater, drainage courses, and inlets.
- Protect all stockpiles from stormwater runon using a temporary perimeter sediment barrier such as berms, dikes, fiber rolls, silt fences, sandbag, gravel bags, or straw bale barriers.

Targeted Constituents

Sediment	✓
Nutrients	✓
Trash	✓
Metals	✓
Bacteria	
Oil and Grease	✓
Organics	✓

Potential Alternatives

None

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