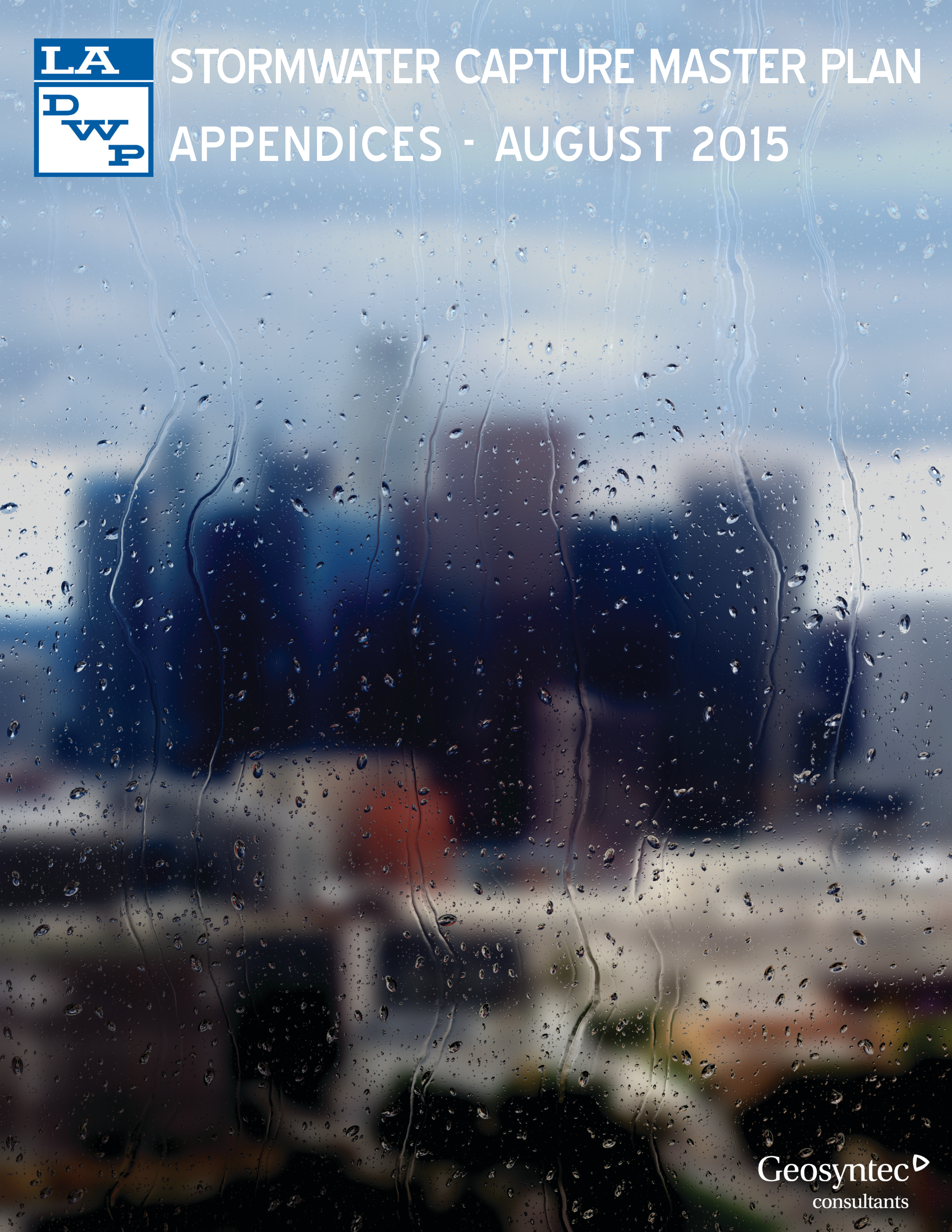
# STORMWATER CAPTURE MASTER PLAN

## APPENDICES - AUGUST 2015



LA DWP

Geosyntec consultants

*Prepared for the Los Angeles Department of Water and Power in partnership with TreePeople*

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*Geosyntec Consultants*
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*Council for Watershed Health*
*CWE*
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*MWH*
*Murakawa Communications*
*M2 Resource Consulting*
*Ron Gastelum*

# APPENDIX A. PUBLIC OUTREACH PLAN

*Prepared for*

**Los Angeles Department of Water and Power**
111 North Hope Street
Los Angeles, CA 90012

# Stormwater Capture Master Plan

# Public Outreach Plan

*Prepared by*

Geosyntec consultants

3415 South Sepulveda Blvd, Suite 500
Los Angeles, CA 90034

Project Number LA0282

September, 2013

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# INTRODUCTION

This public outreach plan proposes a process that the Los Angeles Department of Water and Power (Department) Stormwater Capture Master Plan (SCMP) team may use to gather ideas, and disseminate information for review with interested stakeholders during the development of the SCMP.

This plan identifies potential community opportunities and concerns that should be anticipated for consideration regarding the planning and implementation of the SCMP.

This plan was directed by and prepared for the Department by Murakawa Communications in association with Geosyntec Consultants. This plan details specific activities recommended to raise awareness and educate the public about the development and implementation of the SCMP as well as to encourage public engagement.

The plan consists of a general description of the project background, the plan's objectives, anticipated concerns, target audiences, the tools and materials that may be used to implement the plan, the outreach strategy, approach and appendices that include other information pertinent to the plan.

The objectives and activities discussed in this plan are based on past experience, the project team's expertise, anticipated concerns and an assessment of experiences with previous outreach programs conducted by or for the Department for similar projects targeting similar or overlapping audiences.

It is important to note that this is a plan. All or parts of the plan may or may not be implemented depending on the staffing and budget resources available for the SCMP as well as the Department's priorities at any given time during the SCMP's development.

# PROJECT BACKGROUND

The Los Angeles Department of Water and Power has aggressively pursued stormwater capture to maintain a reliable source of local water supply. From the implementation of the Narrows Infiltration Gallery in 1902 through the purchase and development of the Tujunga Spreading Grounds in the 1950s to now, the development of a Stormwater Capture Master Plan, the Department has shown leadership in securing reliable local water supplies for more than a century.

In the last six years, the Department has invested millions of dollars to significantly increase the amount of stormwater captured through projects like the Hansen Spreading Grounds Enhancement Project, the Big Tujunga Dam Retrofit and the Woodman Avenue Stormwater Capture Project.

The Department is building upon these projects and has invested internally, developing the Watershed Management Group within the Water Resources Division, to provide technical leadership in the Department. The Watershed Management Group works closely with the Flood Control District, the City's Department of Public Works' Bureaus of Sanitation, Engineering and

Street Services and has a Memorandum of Understanding with TreePeople, in part, to address the issue of stormwater in Los Angeles.

The SCMP is the Department's next major undertaking to demonstrate the opportunity to increase the yield of stormwater captured to increase the local water supply. The objective of the Stormwater Capture Master Plan is to help understand the total potential of stormwater that can feasibly and realistically be captured to augment the City's water supply portfolio.

Public participation will be a critical element of the development of the SCMP to ensure that the plan has the full backing of key stakeholders and is fully integrated with other regional stormwater management efforts. Investing in public awareness and approval of the plan during development will facilitate its future implementation and acceptance as a normal and essential part of ensuring a sustainable and consistent local water supply, therefore, including the public's input in the development of the plan is essential.

# PUBLIC OUTREACH PLAN BACKGROUND AND APPROACH

## OBJECTIVES

The objectives of the public outreach effort are to:

- Increase awareness of local water supply
- Inform the public about the SCMP project
- Solicit input on options
- Obtain support for project and options
- Inform and support other City initiatives
- Raise awareness of existing opportunities for participation

## APPROACH

The public outreach strategy for the SCMP is to create a controlled set of meetings targeting stakeholders at various levels of involvement emphasizing information and education about the SCMP, encouraging engagement and soliciting input in the development of the SCMP.

## OUTREACH EFFORTS FOR PREVIOUS AND CONCURRENT PROJECTS

There are a number of similar or related outreach efforts for ongoing and completed projects conducted by the Department or other public agencies that are important to note in the development of this outreach plan. These efforts are important to consider because they set the context for best practices for the SCMP outreach program, may have the same or overlapping target audiences and relationships and partnerships may be leveraged to enhance the reach of this effort.

Alternatively, if there is indeed overlap with the audiences and they are fatigued, that could have an effect on the level of engagement with the SCMP and strategies and tactics to gain support and involvement may need to be reconsidered.

### *Recycled Water Master Plan*

The Department, in collaboration with the Department of Public Works Bureau of Sanitation, developed a Recycled Water Master Plan to outline strategies and identify projects to increase the total amount of recycled water used in Los Angeles six-fold by 2019 – from the current one percent to six percent of annual water demand. The goal is 50,000 acre-feet of recycled water delivered annually by 2019.

This plan is now complete, and calls for significant expansion of the recycled water distribution system and implementation of a groundwater replenishment project with highly purified wastewater utilizing advanced treatment.

The outreach program for this plan was a very intensive process and the Department leadership and Bureau of Sanitation leadership were very involved. The outreach effort included regular meetings and briefings with Council offices and key stakeholders, community leaders and Neighborhood Councils to solicit their input, identify key concerns and solicit help and support for the larger outreach efforts. An advisory group was created. The advisory group was comprised of 60 stakeholders although 200 were invited to participate. The advisory group supported the public outreach efforts including five to eight workshops per year over a four year period.

### *Urban Water Management Plan*

The California Urban Water Management Planning (UWMP) Act (California Water Code Division 6, Part 2.6 Sections 10610-10656) requires water suppliers to develop urban water management plans every five years to identify short-term and long-term water resources management strategies for meeting growing water demands during normal, single dry, and multiple dry years.

The main goals of the UWMP are to forecast future water demands and water supplies under average and dry year conditions, identify future water supply projects such as recycled water, provide a summary of water conservation best management practices (BMPs), and provide a single and multi-dry year management strategy.

The Department's UWMP includes discussion of the following:

- Existing and planned sources of water
- Water demand forecasting
- Conservation efforts to reduce water demand
- Activities to develop alternative sources of water
- Assessment of reliability and vulnerability of water supply
- Water shortage contingency analysis

While serving as a valuable resource for information, this plan update, which was completed in 2010, provides the basic policy principles that will guide the Department's decision-making process to secure a sustainable water supply for Los Angeles. Furthermore, this plan serves as a master plan for water supply and resources management consistent with the City's goals and policy objectives.

Public outreach for this plan included two public workshops per year for two years to present the plan and receive public comment and a final public hearing to present the final UWMP. Workshops were publicized by email that included a meeting flyer to key stakeholders including Neighborhood Councils and homeowner associations, through news releases to the media (including non-English media outlets), posts on the LADWP website and social media.

*CITY OF LOS ANGELES INTEGRATED RESOURCE PLAN*

The Integrated Resources Plan (IRP) is a plan that recognizes the interdependency of the three water systems—wastewater, storm water and runoff and recycled water, and was the first plan of its kind to be stakeholder driven.

The IRP was an intensive four-year process that was built on stakeholder preferences. It was a multi-phase program.

- Phase I – Integrated Plan for the Wastewater Program (IPWP) [completed in 2001]: Focused on defining the future vision for the City by developing a set of guiding principles to direct future, more detailed water resources planning. Stakeholders helped identify primary objectives for the IRP. During Phase I, stakeholders also developed a set of principles to guide developing a detailed facilities plan for Phase II.
- Phase II – Integrated Resources Plan [completed in 2006]: Developed a detailed facilities plan for wastewater and urban runoff management, an environmental impact report, and a financial plan. In addition, a separate recycled water master plan was also prepared for the LADWP.
- Phase III – Project Implementation [2006 and beyond]: Includes future concept reports, studies, demonstration and pilot projects, and design and construction projects to implement the capital improvement program (CIP) developed as part of Phase II.

As a stakeholder driven process, the goals of the outreach program were to educate the public about the IRP process, elements and potential effects; obtain input from various constituencies; inform those potentially impacted by the proposed facilities and to solicit their ideas for mitigation.

The outreach program was an intensive four-year effort with 140 public workshops and meetings; monthly meetings with two internal advisory committees (technical and management); three levels of very large public participation advisory groups with very involved stakeholders; and outreach meetings and presentations to neighborhood and community organizations.

Collateral materials were developed for the project and information was distributed via the LADWP website, email, media and through partnerships with stakeholder organizations.

Many of the internal and external stakeholder organizations for this project may cross over with the SCMP public outreach program: various City of Los Angeles departments, U.S. Army Corps of Engineers, Los Angeles County departments, TreePeople, Heal the Bay, Council for Watershed Health, Neighborhood Councils and other community organizations.

### *GROUNDWATER SYSTEM IMPROVEMENT STUDY*

The Department is currently working on this study, a comprehensive groundwater study for the San Fernando Basin. This study is a necessary step to evaluate the groundwater quality in the San Fernando Basin and recommend treatment options to maximize the utility of the groundwater supply. This study will provide vital information to develop long-term strategies to remediate groundwater contamination in the San Fernando Basin.

Groundwater monitoring wells will be constructed in various areas of the easterly portion of the San Fernando Valley. Water samples will be collected from the new wells, along with a network of existing wells, to analyze the contamination in the underground water supply and determine the nature and extent of the pollution.

The Groundwater System Improvement Study (GSIS) will ultimately result in projects that will remove contamination from the groundwater, allowing the City to reduce its reliance on imported water and provide Los Angeles with a more stable and reliable source of water.

The outreach effort includes the development of collateral materials, including fact sheets and a map of well locations.

## ANTICIPATED ISSUES, CHALLENGES AND COMMUNITY CONCERNS

In addition to considering outreach efforts for similar projects, the following community concerns and potential challenges and issues should be anticipated to set the context and help make strategic decisions for outreach activities and message development for meetings, presentations and collateral material for the public outreach program. These issues include:

- Geographic/geologic concerns
- Water quality concerns
    - End use dependent
    - MS4 related
- Finding funding for implementation
- Funding for projects, by whom, cost for all projects
    - Potential cost to developers
    - Potential cost to customers
- Environmental clearance for the SCMP and/or for each project recommended
- Legal concerns
- Oversight and monitoring issues/concerns during implementation
- Regulatory issues/concerns for projects once built
- Impact of projects on wildlife and the environment
- General Department/water industry/City of LA issues not related to project but that could potentially dominate or sabotage project
    - union negotiations
    - competition among water agencies

- Property acquisition
- Land use
- Blight or visual issues for projects
- Department realignment (merge of Planning, Building and Safety, creation of a new Economic Development Department)
- Construction impacts for large-scale projects
- Internal Department and/or consultant team concerns

# Target Audiences

The target audiences will be grouped into three major categories: 1) internal audience; 2) key regional stakeholders and 3) the general public and the media.

## Internal Audience

This audience includes the categories of the internal audience.

- Mayor and City Councilmembers and/or their identified staff
- Key LADWP staff
- City departments
- County, state and federal departments
- TreePeople

## Key Stakeholders

This audience includes key opinion leaders and leaders of environmental, neighborhood, civic and community organizations – those individuals and organizations expected to have a high level of interest and/or engagement in this project. Below are the categories of the audiences in this group:

- Environmental
- Neighborhood
- Civic, business and community
- Higher education institutions (i.e., environmental, engineering, planning programs)
- Business

## General Public

This audience will include the citywide audience, constituents of the key stakeholders mentioned above as well as the media. The general public will be targeted through the citywide public meetings.

# Public Outreach Activities

The public outreach task is an ongoing task that will occur throughout the project.

### Mayor's and Council Office Briefings

In areas of the City expected to have a significant number of SCMP projects, the Department may choose to conduct briefings with the Council staff in district offices to raise awareness about the project, its impact and gain further support for participation in the public meetings from broader audiences like homeowner, neighborhood, community, service, business and religious organizations.

### Meetings with the SCMP Technical Advisory Team

The Department and the project consultant team will meet on a regular basis as needed with the SCMP Technical Advisory Team. This group consists of internal Department and City staff, and representatives from other government agencies with planning level interests overlapping with the Department's master planning process. For a listing of the SCMP Technical Advisory Team, please see Appendix B.

The role of the SCMP Technical Advisory Team is to provide input and counsel on the technical development of the SCMP. The SCMP Technical Advisory Team will be involved throughout the development of the SCMP over a two-year period.

### Meetings/Presentations with Key Stakeholders

Meetings or presentations will be held with key stakeholder organizations to inform these groups about the SCMP, solicit their input on the project and the development of the SCMP, inform them about the public outreach program and obtain their support and assistance for participation and turnout for the public meetings to ensure there are ample opportunities to learn about and to be engaged in the development of the SCMP and provide input. These meetings and/or presentations will occur at strategic times during the SCMP development process. For a listing of the SCMP Key Stakeholders, please see Appendix C.

### Briefings with Department Speakers Bureau

The Department has a Speakers Bureau comprised of key Department staff who give speeches and make presentations to civic, service, professional, neighborhood and other community organizations on a number of topics relevant to the Department. This cadre of Department professionals will be briefed by Department staff about the SCMP and the public meeting schedule so they can help inform their audiences about the SCMP and how the public can participate in its development.

### Public Meetings

Public meetings will be coordinated in three phases of the development of the SCMP. Phase 1, information and awareness about the SCMP; Phase 2, presentation of the Draft SCMP and solicitation for comments and input; and Phase 3, presentation of the Final SCMP.

The objectives of the Phase 1 public meeting are to:

- provide information about the City water supply and Department programs and efforts to increase the local water supply;

- address the future of the local water supply; and
- raise awareness about the SCMP, what its benefits are and how the public can be engaged and provide input on its development.

The recommended format for this first meeting is a presentation with questions and answers.

The objectives of the Phase 2 public meeting are to:

- provide information about the City water supply and Department programs and efforts to increase local water supply;
- address future water supplies and how the SCMP plays a role;
- provide information about centralized stormwater;
- provide information and models of distributed stormwater in areas prime for groundwater recharge and less prime for groundwater recharge;
- present the draft SCMP with specific projects;
- solicit input and comments for the SCMP; and
- provide information about next steps.

If a significant number of projects are concentrated in particular areas of the City, the venue for the Phase 2 meeting may be in one of those areas in the City rather than (or in addition to) in a downtown location.

The recommended format for this meeting is a presentation with a question and answer session with a panel consisting of not only LADWP representatives, but also representatives of agencies and organizations involved in efforts directly related to the SCMP to give the public an opportunity to understand how these efforts will be coordinated.

The objectives of the Phase 3 public meeting are to:

- provide information about the City water supply and Department programs and efforts to increase local water supply;
- address future water supplies and how the SCMP plays a role; and
- present the Final SCMP and its implementation plan.

The recommended format for this meeting is a presentation with a question and answer session with a panel consisting of representatives from multiple agencies, similar to the format of the second public meeting. The location will be determined after the first two public meetings have occurred.

These public meetings could be webcast live to allow the public to view the presentation and participate in the question and answer session remotely without being physically present at the meetings.

## Other Communication Activities

Other methods of outreach or communication may also be used to promote the SCMP and how the public can obtain information and provide input. These other activities include:

- **Neighborhood newswire blast**
  The Department uses a newswire e-blast. This e-blast could be used to raise awareness about the SCMP, the public engagement process and public meeting schedule and direct stakeholders to the LADWP website to allow for public comment and input on the Draft SCMP.
- **LADWP website**
  A page on the Department website could provide information about the SCMP, the public meeting schedule, collateral material, a link to the Draft SCMP and allow stakeholders to provide public comment and input on the draft. It could also include progress or project update information.
- **Media relations**
  LADWP Communications will complement SCMP's public information and community relations activities with Departmental media relations.
- **Social media**
  Social media outlets may also be used to inform the general public and followers about the SCMP and promote public meetings. These may include the LADWP Facebook page and LADWP Twitter as well as TreePeople's social media.

All appropriate information and collateral will be shared with the SCMP Technical Advisory Team, the key stakeholders and other Department partners to ensure the broadest reach possible for public engagement and input on the SCMP.

## SCHEDULE

The schedule of the outreach activities will correspond with the overall work for the development of the Stormwater Capture Master Plan.

The Mayoral and Council briefings, and briefings with the members of the Department's Speakers Bureau will occur in early phases of the project. This will likely occur from October 2013 to December 2013.

The SCMP Technical Advisory Team will meet quarterly or semi-annually depending upon the need beginning in September 2013.

Meetings and presentations with key stakeholders will occur throughout the development of the SCMP. A kickoff meeting will be held in the fourth quarter of 2013 for all key stakeholders, with a follow up meeting to be held in 2014. Two focused stakeholder group meetings will be held in the fourth quarter of 2013 and/or the first quarter of 2014 depending on how the SCMP development occurs.

The public meetings will follow thereafter and likely occur in the first quarter of 2014, the first quarter of 2015, and the second quarter of 2015.

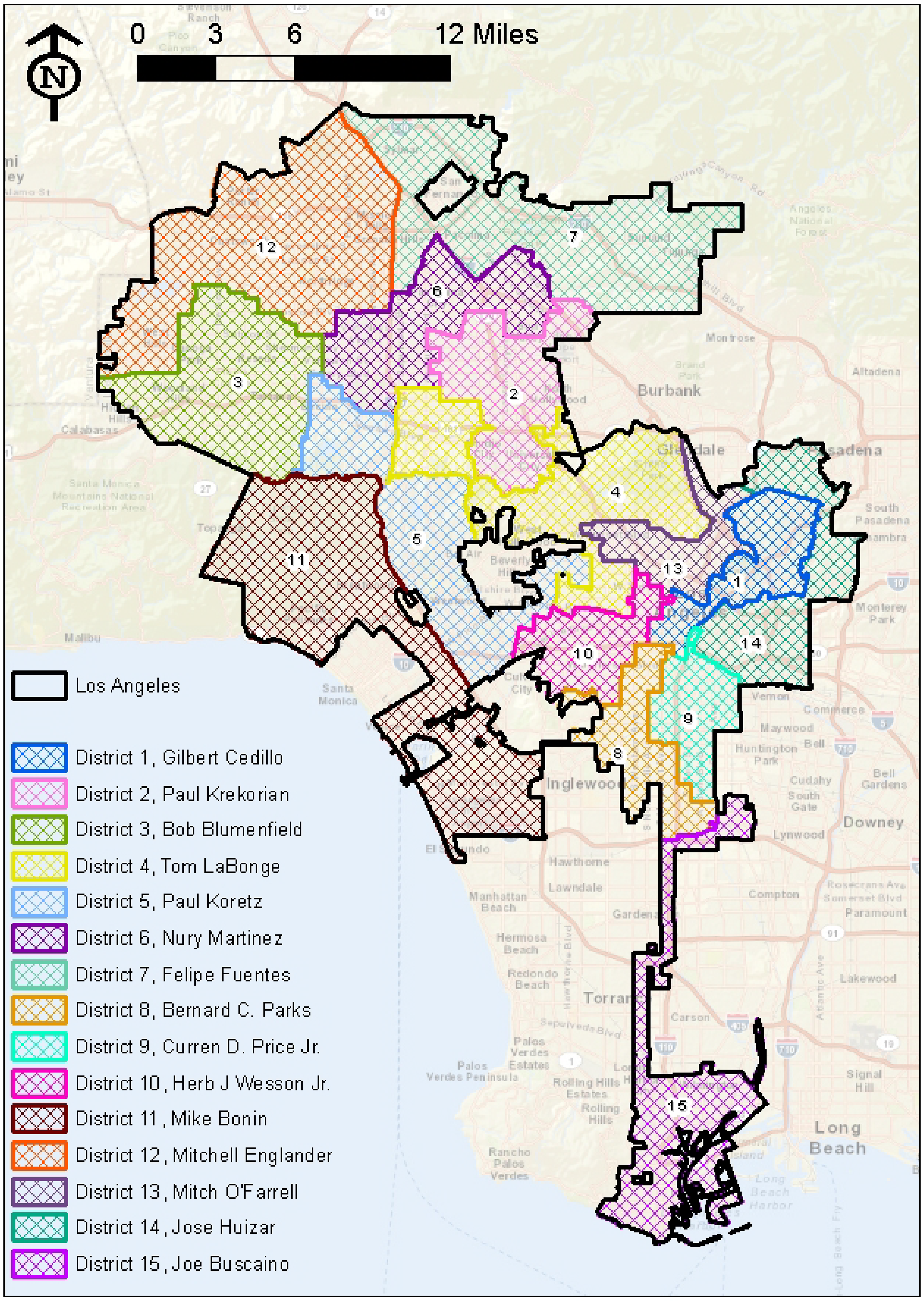
# COLLATERAL MATERIALS

The collateral development effort will be led by Department staff and developed in collaboration with TreePeople. Collateral materials may include:

- Fact sheets
- Meeting notices
- Slideshow Presentations
- Project updates to specific audiences sent via email
- Updates on the LADWP website, TreePeople website and other agencies' and project partners websites as appropriate
- Exhibit/Displays for Community Events (water supply)

# APPENDICES

# A. MAP OF CITY/AREAS



## B. SCMP Technical Advisory Team

| **DWP** | **LA County Flood Control District** |
|---|---|
| David Pettijohn | Ken Zimmer |
| Andy Niknafs | Cung Nguyen |
| Rafael Villegas | Richard Gomez |
| Virginia Wei | Russ Bryden |
| Stephanie Spicer | Lee Alexanderson |
| Michelle Vargas | **Bureau of Street Services** |
| **LA Sanitation** | Alice Gong |
| Sharam Kharaghani | **TreePeople** |
| Hubertus Cox | Deborah Bloom |
| Wing Tam | Edith de Guzman |
| Steve Nikaido | **United States Army Corps of Engineers** |
| **DPW Bureau of Engineering** | David Van Dorpe |
| Michael Brown | Josephine Axt |
| Susan Shu | Eduardo Demesa |
| Carol Armstrong | Theresa Kaplan |
| Department of Planning | Rene Vermeeren |
| Claire Bowin | **US Bureau of Reclamation** |
| Deborah Kahen | Amy Whitherall |
| **Building and Safety** | Jack Simes |
| Osama Younan | **Metropolitan Water District** |
| Dana Prevost | Grace Chan |
| Aldo Ubau | Kathy Kunyz |
| **Department of Rec & Parks** | Stacey Takaguchi |
| Michael Shull | Matt Hacker |
| Darryl Ford | **SF Basin Watermaster** |
| Tom Gibson | Richard Slade |
| Craig Raines | Anthony Hicke |
| **Water Replenishment District** | |
| Jason Weeks | |
| Cathy Chang | |
| Ted Johnson | |

## C. KEY STAKEHOLDERS

| |
|---|
| Arroyo Seco Foundation |
| Ballona Creek Renaissance |
| Ballona Wetlands Land Trust |
| Climate Resolve |
| Coastal Conservancy |
| Council for Watershed Health |
| Friends of Ballona Wetlands |
| Friends of the Los Angeles River |
| Friends of the Sepulveda Basin |
| Green LA Coalition (see other sheet for list of member orgs) |
| *Heal the Bay |
| Los Angeles Alliance of Neighborhood Councils |
| *Los Angeles Conservation Corps |
| Los Angeles Beautification Team |
| Los Angeles Department of Water and Power Nonprofit Grantees |
| Los Angeles Waterkeeper |
| LADWP Recycled Water Advisory Group (RWAG) |
| Los Angeles River Revitalization Corp |
| Mountains Recreation Conservation Authority |
| *Natural Resources Defense Council |
| Neighborhood Councils |
| NorthEast Trees |
| Pacoima Beautiful |
| San Fernando Valley Audobon Society |
| Santa Monica Bay Restoration Commission |
| Santa Monica Mountains Conservancy |
| *Sierra Club |
| Silver Lake Conservancy |
| Southern California Water Committee |
| *Southern California Watershed Alliance |
| Southern California Wetland Recovery Project |
| *Surfrider Foundation |
| The Nature Conservancy |
| *The River Project |
| Topanga Watershed Committee |
| *TreePeople |
| *Trust for Public Land |
| *Urban Semillas |
| Valley Alliance of Neighborhood Councils |

*Also members of GreenLA Coalition

## D. GreenLA Coalition

| GreenLA Coalition |
|---|
| California League of Conservation Voters Education Fund |
| CicLAvia |
| City Vida |
| CleanTech LA |
| Climate Plan |
| Coalition for a Safe Environment |
| Coalition for Clean Air |
| Communities for a Better Environment |
| Community Health Councils, Inc. |
| Desal Response Group |
| East LA Community Corporation |
| East Yard Communities for Environmental Justice |
| Environment Now |
| Environmental Justice Coalition for Water |
| Environmental Water Caucus |
| Food & Water Watch |
| Friends of the Los Angeles River |
| From Lot to Spot |
| Generation Water |
| Greenpeace |
| Harbor Vision Task Force/Livable Cities Committee |
| Heal the Bay |
| Hollywood Beautification Committee |
| ICLEI |
| LA Community Garden Council |
| LA County Bicycle Coalition |
| LA Walks |
| LAANE |
| Labor Strategy Center/Bus Riders Union |
| Latino Urban Forum |
| Long Beach Alliance for Children with Asthma |
| Long Beach Interfaith Community Organization |
| Los Angeles Conservation Corps |
| Los Angeles Neighborhood Land Trust |
| Los Angeles Taxi Workers Alliance |
| Natural Resources Defense Council |
| People for Parks |
| Public Counsel |
| Ryan Lehman |
| Ryan Snyder |
| SCOPE/LA Apollo Alliance |

| |
|---|
| SEIU Local 721 |
| Shared Spaces Landscape Architecture |
| Sierra Club - Beyond Coal Campaign |
| Sierra Club Angeles Chapter |
| Southern California Watershed Council |
| Surfrider Foundation |
| The Regenerative Communities Project |
| The River Project |
| Transportation 4 America |
| TreePeople |
| Trust for Public Land |
| UCLA Institute for the Environment |
| UCLA Law School - Emmett Center on Climate Change and the Environment |
| Union de Vecinos |
| Urban & Environmental Policy Institute, Occidental College |
| Urban Semillas |

# E. Prospective List of Repository Locations for SCMP

| Location | Address |
|---|---|
| Central Library | 630 W. 5th Street, Los Angeles 90071 |
| Angeles Mesa Library | 2700 W. 52nd Street, Los Angeles 90043 |
| Arroyo Seco Regional Library | 6141 N. Figueroa Street, Los Angeles 90042 |
| Ascot Library | 120 W. Florence Avenue, Los Angeles 90003 |
| Atwater Village Library | 3379 Glendale Boulevard, Los Angeles 90039 |
| Baldwin Hills Library | 2906 S. La Brea Avenue, Los Angeles 90016 |
| Benjamin Franklin Library | 2200 E. 1st Street, Los Angeles 90033 |
| Donald Bruce Kaufman Library | 11820 San Vicente Boulevard, Los Angeles 90049 |
| Cahuenga Library | 4591 Santa Monica Boulevard, Los Angeles 90029 |
| Canoga Park Library | 20939 Sherman Way, Canoga Park 91303 |
| Chatsworth Library | 21052 Devonshire Street, Chatsworth 91311 |
| Chinatown Library | 639 N. Hill Street, Los Angeles 90012 |
| Cypress Park Library | 1150 Cypress Avenue, Los Angeles 90065 |
| Will & Ariel Durant Library | 7140 W. Sunset Boulevard, Los Angeles 90046 |
| Eagle Rock Library | 5027 Caspar Avenue, Los Angeles 90041 |
| Echo Park Library | 1410 W. Temple Street, Los Angeles 90026 |
| Edendale Library | 2011 W. Sunset Boulevard, Los Angeles 90026 |
| El Sereno Library | 5226 S. Huntington Drive, Los Angeles 90032 |
| Encino - Tarzana Library | 18231 Ventura Boulevard, Tarzana 91356 |
| Exposition Park - Cr. Mary McLeod | 3900 S. Western Avenue, Los Angeles 90062 |
| Fairfax Library | 161 S. Gardner Street, Los Angeles 90036 |
| Felipe de Neve Library | 2820 W. 6th Street, Los Angeles 90057 |
| Granada Hills Library | 10640 Petit Avenue, Granada Hills 91344 |
| Harbor City - Harbor Gateway Library | 24000 S. Western Avenue, Harbor City 91710 |
| Frances Howard Goldwyn Hollywood | 1623 N. Ivar Avenue, Los Angeles 90028 |
| Hyde Park Miriam Matthews Branch | 2205 W. Florence Avenue, Los Angeles 90043 |
| Jefferson Library | 2211 W. Jefferson Boulevard, Los Angeles 90018 |
| John C. Fremont Library | 6121 Melrose Avenue, Los Angeles 90038 |
| John Muir Library | 1005 W. 64th Street, Los Angeles 90044 |
| Junipero Sera Library | 4607 S. Main Street, Los Angeles 90037 |
| Lakeview Terrace Library | 12002 Osborne Street, Sylmar 91342 |
| Lincoln Heights Library | 2530 Workman Street, Los Angeles 90031 |
| Little Tokyo Library | 203 S. Los Angeles Street, Los Angeles 90012 |
| Los Feliz Library | 1874 Hillhurst Avenue, Los Angeles 90027 |
| Malabar Library | 2801 Wabash Avenue, Los Angeles 90033 |
| Mar Vista Library | 12006 Venice Boulevard, Los Angeles 90066 |
| Mark Twain Library | 9621 S. Figueroa Street, Los Angeles 90003 |
| Memorial Library | 4625 W. Olympic Boulevard, Los Angeles 90019 |
| Mid-Valley Regional Library | 16244 Nordhoff Street, North Hills 91343 |
| North Hollywood Regional Library | 5211 Tujunga Avenue, North Hollywood 91601 |

| Location | Address |
|---|---|
| Northridge Library | 9051 Darby Avenue, Northridge  91325 |
| Pacoima Library | 13605 Van Nuys Boulevard, Pacoima  91331 |
| Palisades Library | 861 Alma Real Drive, Pacific Palisades  90272 |
| Palms - Rancho Park Library | 2920 Overland Avenue, Los Angeles  90064 |
| Pico - Union Library | 1030 S. Alvarado Street, Los Angeles  90006 |
| Pio Pico - Koreatown Library | 694 S. Oxford Avenue, Los Angeles  90005 |
| Platt Library | 23600 Victory Boulevard, Woodland Hills  91367 |
| Playa Vista Library | 6400 Playa Vista Drive, Los Angeles  90094 |
| Porter Ranch | 11371 Tampa Avenue, Northridge  91326 |
| Robert Louis Stevenson Library | 803 Spence Street, Los Angeles  90023 |
| Robertson Library | 1719 S. Robertson Boulevard, Los Angeles  90035 |
| San Pedro Regional Library | 931 S. Gaffey Street, San Pedro  90731 |
| Sherman Oaks Martin Pollard Library | 14245 Moorpark Street, Sherman Oaks  91423 |
| Silver Lake Library | 2411 Glendale Boulevard, Los Angeles  90039 |
| Studio City Library | 12511 Moorpark Street, Studio City  91604 |
| Sun Valley Library | 7935 Vineland Avenue, Sun Valley  91352 |
| Sylmar Library | 1456 Polk Street, Sylmar  91342 |
| Valley Plaza Library | 12311 Vanowen Street, North Hollywood  91605 |
| Van Nuys Library | 6250 Sylmar Avenue, Van Nuys  91401 |
| Venice - Abbot Kinney Memorial Library | 501 S. Venice Boulevard, Venice  90291 |
| Vermont Square Library | 1201 W. 48th Street, Los Angeles  90037 |
| Vernon - Leon H. Washington, Jr. | 4504 S. Central Avenue, Los Angeles  90011 |
| Washington Irving Library | 4117 W. Washington Boulevard, Los Angeles  90018 |
| Alma Reaves Woods - Watts Library | 10205 Compton Avenue, Los Angeles  90002 |
| West Los Angeles Regional Library | 11360 Santa Monica Boulevard, Los Angeles  90025 |
| West Valley Regional Library | 19036 Vanowen Street, Reseda  91335 |
| Westchester - Loyola Village Library | 7114 W. Manchester Avenue, Los Angeles  90045 |
| Westwood Library | 1246 Glendon Avenue, Los Angeles  90024 |
| Wilmington Library | 1300 N. Avalon Boulevard, Wilmington  90744 |
| Wilshire Library | 149 N. Saint Andrews Place, Los Angeles  90004 |
| Woodland Hills Library | 22200 Ventura Boulevard, Woodland Hills  91364 |

# # #

# APPENDIX B. TM 1.2 BACKGROUND INFORMATION

Geosyntec consultants

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# Technical Memorandum 1.2

| | |
|---|---|
| Date: | December 4, 2013 |
| To: | Rafael Villegas, LADWP |
| From: | Mark Hanna, Geosyntec Los Angeles |
| Subject: | Stormwater Capture Master Plan: Task 1.2 – Gather and Review Background Information<br>Geosyntec Project: LA0282 |

## INTRODUCTION

Under Agreement 47173-3 with the Los Angeles Department of Water and Power (LADWP), Geosyntec conducted Task 1.2 (Gather and Review of Background Information) of the Stormwater Capture Master Plan (SCMP) project. LADWP conceived the SCMP to evaluate and characterize the role that increased distributed and centralized local stormwater capture can play in the City of Los Angeles (City) and its water supply portfolio. The overarching objective of the project is to evaluate and analyze existing stormwater capture efforts and provide recommendations for future stormwater capture opportunities to increase the beneficial use of stormwater as a water supply. This information will be presented in the Stormwater Capture Master Plan and preceding interim deliverables.

The SCMP is divided into five tasks with various technical deliverables that culminate in a final report (Stormwater Capture Master Plan). Each technical memorandum (TM) documents specific activities associated with a task and subtask(s). In turn, the TM's will form the foundation of the Stormwater Capture Master Plan. This Technical Memorandum (TM 1.2) represents the deliverable for Task 1.2, which is to gather and review related background information necessary to conduct the analyses for the SCMP.

## PURPOSE AND OBJECTIVE

The purpose of this subtask was to gather datasets necessary to analyze existing stormwater capture efforts and evaluate benefits of future stormwater capture opportunities. Additionally, this task involved gathering and reviewing datasets that relate to opportunities and constraints for stormwater capture approaches (i.e., their geographic and institutional applicability).

The modeling approach to be used in the development of the SCMP is discussed in the Geosyntec Memorandum titled: "Stormwater Capture Master Plan: Recommended Hydrologic Modeling Approach" (9/30/2013). This analysis involves use of the Load Simulation Program in C++ (LSPC) and the Ground Water Augmentation Model (GWAM) to evaluate existing levels of capture, potential future levels of capture, and evaluate the benefits of stormwater capture approaches. Additionally, this approach includes geospatial analysis in a geographic information system (GIS) to evaluate the geographic applicability (i.e., opportunity, feasibility, and desirability) of stormwater capture projects.

Data necessary for these models and analyses were collected and extracted from various public datasets and other datasets available to Geosyntec. The LSPC and GWAM models also each have a substantial amount of geographic and meteorological data built in to them, as well as data that were used to calibrate them and their respective model estimates. These datasets and their sources are discussed in this memorandum, but no further manipulation was required to evaluate or use these data for this project.

The relevant hydrologic areas for which data were collected include the City of Los Angeles (City) boundaries and all areas which drain to the City of Los Angeles boundaries (SCMP Study Area). Shapefiles for the city boundaries were obtained from Los Angeles County's Spatial Information Library http://dpw.lacounty.gov/general/spatiallibrary/index.cfm?agree=agree. Datasets that encompassed areas outside of the SCMP Study Area were clipped to only include data within this area as necessary.

## SUMMARY OF INFORMATION COLLECTED

This section provides a summary of background information that was gathered and reviewed. It is organized by the following technical areas:

- Surface Hydrology and Hydrologic Features
- Groundwater Basins and Related Datasets
- Soil Conditions and Slope
- Land Use and Related Datasets

- Potential Datasets for Identifying Opportunities for Stormwater Capture
- Potential Datasets for Identifying Constraints for Stormwater Capture

**Surface Hydrology and Hydrologic Features**

Precipitation and Evapotranspiration Data

Both the LSPC and GWAM models require precipitation and evapotranspiration data as inputs in order to determine runoff, infiltration, evapotranspiration, and deep percolation rates and volumes. As both of these models were created and calibrated for the City and beyond, both have the necessary precipitation and evapotranspiration data built-in to the model from various selected precipitation gauges, evaporation pan gauges, and evapotranspiration zones. Thiessen polygons were used to assign the appropriate gauges and zones to each subbasin (LSPC) or polygon (GWAM) within each model.

Table 1 shows the precipitation, evaporation, and evapotranspiration datasets used in the models. Figure 1 shows the rain gauges and evaporation pan locations used in the LSPC model that are within the SCMP Study Area. Both models used rain gauges from the United States Geological Survey (USGS), the Los Angeles County Department of Public Works (LACDPW), the Los Angeles County Flood Control District (LACFCD), and various other private and public entities. Both models also used California Irrigation Management Information System (CIMIS) evapotranspiration zones to estimate evapotranspiration rates, but LSPC used these only to get coefficients for converting evaporation pan data from local gauges to evapotranspiration rates (U.S. Bureau of Reclamation, 2007; LACDPW, 2010a). As these gauges are already built into the models, no further manipulation or use of them is anticipated for the modeling effort. Representative precipitation and ET records will be chosen when conducting unit area modeling analysis of distributed stormwater capture alternatives in order to characterize the large-scale precipitation patterns for the City and upstream areas. Longer periods of record (POR) are also available at some gages, which can be used to help evaluate the representativeness of using shorter records in some cases.

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**Table 1. Precipitation and Evapotranspiration Datasets in SCMP Area**

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| LA County pan evaporation data (1987-2012) | Evaporation data from 15 locations in LA County | Built in to LSPC model |
| Computed pan evaporation using CIMIS evaporation transpiration data for LA County (1987-2012) | Computed using CIMIS zones and 6 NCDC gages | Built in to LSPC model and GWAM model |
| LACDPW monthly pan coefficients for LA County for stations | Coefficients used to convert all pan evaporation data to evapotranspiration | Built in to LSPC model |
| National Climate Data Center hourly and daily rainfall data for selected LA County stations (1987-2012) | 4 stations around LA County selected for quality of data, location, and POR (POR for individual gages varies) | Built in to LSPC and/or GWAM models; representative gages will be chosen for BMP unit response curve analysis |
| LACDPW 5-minute and daily rainfall data (2000-2012 for 5-minute, 1987-2012 for daily) | 7 stations around LA County selected for quality of data, location, and POR (POR for individual gages varies) | |
| LACFCD daily rainfall data (1987-2012) | 83 stations around LA County selected for quality of data, location, and POR (POR for individual gages varies) | |
| OBSERVER daily rainfall data (1987-2012) | 9 stations around LA County selected for quality of data, location, and POR (POR for individual gages varies) | |
| Daily rainfall data from private and other sources gages (1987-2012) | 22 stations around LA County selected for quality of data, location, and POR (POR for individual gages varies) | |

Subbasins and Drainage Systems

Watershed boundaries, subbasin delineations and connectivity used in the LSPC model are based on those used for the NPDES permit documentation for LA County. These are based primarily on the storm drain system and stream networks and secondarily on the location of flow and water quality monitoring stations. These are already built into the LSPC model, as appropriate, so the only manipulation required was to select only those subbasins that are within or partially within City boundaries or that drain to City boundaries. This was done using the City boundaries shapefile in GIS and the connectivities in the LSPC model. This resulted in 1001 subbasins being included. There are 81 terminal subbasins ("outfalls") from this area which includes portions of Ballona Creek, the Los Angeles River, Dominguez Channel, Malibu Creek, and many small, coastal subbasins (Figure 1). Sub-basins will be further categorized into major subwatershed groups, based on their proximity and their respective groundwater basin, for the purpose of tabulating stormwater capture totals.

Stormwater Management Facilities

Existing and proposed stormwater management facilities in the City boundaries and upstream of the City boundaries are described in detail in Technical Memorandum 1.3 "Evaluate Existing Stormwater Capture Facilities". Briefly, a number of centralized stormwater facilities, including reservoirs, spreading grounds (SG), and debris basins, exist within the SCMP area. These are discussed in the Los Angeles Basin Stormwater Conservation Study (Bureau of Reclamation, LACDPW, and LACFCD 2012). In addition, a number of existing distributed facilities exist within the SCMP areas including Green Streets, bioswales, rain barrels, and infiltration galleries. The reservoirs and spreading grounds are shown in Table 2 and in Figure 1. The LSPC model has each of these built in to the model except for Lopez Dam and Tujunga Gallery SG. Lopez SG is included, but the dam is not included because it is essentially a large debris basin and is virtually always open. There appears to be no information regarding the status and operation of the Tujunga Gallery SG. No further manipulation or use of any of these facilities will be done for the SCMP at this time, except for their use in the LSPC model. Existing distributed facilities and debris basins are not explicitly included in the LSPC model, but their effect is currently likely to be small compared to the centralized facilities. The current stormwater capture benefits of these facilities, if applicable, can be estimated using the same methods proposed to estimate the benefits of future distributed capture alternatives.

In addition to these existing facilities, a number of stormwater management projects have been proposed within the SCMP area. These are covered in detail in TM 1.3 and are listed in Table 2. These facilities will be considered in evaluating future capture potential in the SCMP.

**Table 2. Existing and Proposed Stormwater Capture Facilities**

| Existing Centralized Facilities | Proposed Centralized Facilities | Proposed Distributed Facilities |
|---|---|---|
| • Sepulveda Dam<br>• Tujunga SG<br>• Branford SB<br>• Hansen SG<br>• Hansen Dam<br>• Pacoima SG<br>• Lopez SG<br>• Pacoima Dam<br>• Big Tujunga dam<br>• Devil's Gate Dam<br>• Tujunga Gallery SG*<br>• Lopez Dam*<br>• Debris Basins (multiple)* | • Boulevard Pit Multiuse<br>• Branford Spreading Basin Upgrade<br>• Canterbury Power Line Easement<br>• Hansen Dam Water Conservation Project<br>• Lopez Spreading Grounds Upgrade<br>• Old Pacoima Wash<br>• Pacoima Dam Sediment Removal<br>• Pacoima Spreading Grounds Upgrade<br>• Sheldon Pit Multiuse<br>• Strathern Wetlands Park<br>• Tujunga Dam Sediment Removal<br>• Tujunga Spreading Grounds Upgrade<br>• Valley Generating Station Stormwater Capture<br>• Van Norman Stormwater Capture | • Burbank Boulevard BMP<br>• Chase Street Stormwater Greenway<br>• Coldwater Canyon Ave. Pocket Park & Parkway<br>• East Valley District Yard<br>• Erwin Well Lot Infiltration Basin<br>• Glenoaks/Sunland Stormwater Capture Project<br>• Laurel Canyon Parkway Infiltration Swale<br>• Other Distributed Recharge Projects<br>• Rain Barrel/Cistern Rebates & LID Incentives<br>• Rain Garden Installation/Rebate Program<br>• San Fernando Road Swales<br>• Sun Valley Parking Lot Infiltration<br>• Van Nuys Boulevard Median<br>• Victory-Goodland Median<br>• Victory-Nettleton Median<br>• Water System Facilities BMP and LID Projects<br>• Whitnall Gardens<br>• Whitnall Hwy Power Line Easement<br>• Woodman Avenue Stormwater Capture Project |

* Not modeled in LSPC

Flow and Water Quality Monitoring Data

Various flow and water quality monitoring stations are located on waterways within the SCMP area and within Los Angeles County. Many of these were used to calibrate the LSPC and GWAM models. All of the stormwater flow datasets within LA County were considered for calibration of the LSPC model, including 70 gages from USGS and LACDPW. Of these, 30 were chosen for the calibration effort, all of which were USGS gauges. Each had a robust, but varying period of record (LACDPW, 2010a). In addition, flow records from each reservoir were used in the model as a time-series input in order to account for discharges from the reservoirs downstream. The GWAM model was calibrated using 7 LACDPW gauges using a period of record between 1980 and 2003 (U.S. Bureau of Reclamation, 2007). No other stream gauge data is believed to be needed for the SCMP, and no manipulation of this data will be done.

Water quality data has been collected at mass emission sites and at various other sites using grab samples within the SCMP area and within Los Angeles County. These monitoring data are collected regularly by various agencies in NPDES and other permit compliance efforts, research efforts, and trend analysis efforts. The water quality parameters measured are numerous, but the LSPC model currently only has the capability to model total nitrogen, total phosphorus, total copper, total lead, total zinc, fecal coliforms, and total suspended solids. As part of the LSPC calibration effort, numerous water quality samples from various locations around Los Angeles County were compiled. These included primarily grab samples and data from mass emission sites collected by the Southern California Coastal Water Research Project (SCCWRP) between 2001 and 2004 as well as samples from various other sources from dates ranging between 1955 and 2008 (LACDPW, 2010b).

A portion of the Los Angeles County monitoring dataset is from land use-based monitoring stations, which were operated between 1994 and 2001 to collect runoff from catchments with approximately homogenous land uses. Data from these monitoring stations have been analyzed and used to predict runoff event mean concentrations (EMCs) as part of the Structural BMP Prioritization and Analysis Tool (SBPAT) (Geosyntec, 2008). The data that have been summarized include 12 common pollutants: total suspended solids (TSS), total phosphorous (TP), total kjeldahl nitrogen (TKN), nitrate as nitrogen (NO3-N), ammonia as nitrogen (NH3-N), dissolved copper (DCu), total copper (TCu), dissolved zinc (DZn), total zinc (TZn), total lead (TPb), total dissolved solids (TDS), and fecal coliform (FC).

Since the LSPC model and SBPAT models were constructed, additional water quality data has been collected that was not used for model calibration, especially bacteria data in coastal watersheds. Los Angeles County issues an annual stormwater monitoring report that outlines the data collected. However, the only use of water quality data in the SCMP is to calibrate the LSPC model. No attempt will be made to recalibrate the model using the additional data. The model will be used in its current calibration to maintain consistency with other regional stormwater efforts using the LSPC model. Table 3 summarizes the flow and water quality data currently available.

The calibrated GWAM and LSPC models will create a robust and adaptable dataset for characterizing existing flows, capture rates, infiltration, water quality, etc. as part of analyses to be conducted in Task 2 and 3.

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**Table 3. Flow and Water Quality Monitoring Datasets**

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| USGS flow data 1970-2008 overall, but POR varies by location | Flow data collected at USGS stream gauges within LA County | Used to calibrate LSPC model |
| LACDPW flow data 1980-2003 | Flow data collected at LACDPW stream gauges within LA County | Used to calibrate LSPC and GWAM models |
| LA County reservoir discharge data | Records of flow rate and volume discharged over POR from certain reservoirs | Used in LSPC for reservoirs with available data |
| SCCWRP monitoring data (2001-2004 overall, but POR varies by location and parameter) | Water quality samples collected at various locations around LA County | Used to calibrate land use-specific pollutant parameters in LSPC |
| SCCWRP mass emission data ME01-ME-08 (2001-2004 overall, but POR varies by location and parameter) | Water quality data collected at mass emission sites within LA County | Used to calibrate LSPC model |
| Water quality data collected by various agencies 1955-2008 overall, but POR varies by location and parameter) | Water quality samples collected at various locations around LA County | Considered in LSPC calibration effort, but ultimately unused |
| Water quality data collected post 2008 | Water quality data collected since calibration of LSPC model by LA County, SCCWRP, and various other agencies | Likely will not be used directly. |
| LA County Land Use EMC Database (1994-2001), via SBPAT | Land-use based monitoring data from 8 stations, collected between 1994 and 2001. Summarized as average and standard deviation of EMCs for 12 pollutants. | May be used to fill in for pollutants not addressed by LSPC. |

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**Groundwater Basins and Related Datasets**

A spatial dataset delineating the extent of regional groundwater basins was obtained from the Los Angeles County GIS data portal and is presented in Figure 2 and Table 4. Groundwater basins intersecting the Los Angeles City boundary include: Sylmar, San Fernando, Hollywood, Santa Monica, West Coast, and Central.

A spatial dataset delineating estimated depth to groundwater data was also obtained and will be employed to identify areas where shallow groundwater may render infiltration infeasible or inadvisable (i.e. infiltration projects should not be pursued in areas where groundwater is shallower than a depth of 10 feet). Point datasets identifying the location of permitted dewatering activities and production wells were obtained from State and Federal resources. These datasets are presented in Figure 3 and Table 4.

A series of datasets characterizing surface and subsurface geology were obtained from Water Replenishment District of Southern California (WRD) as part of previous work. A dataset presenting the distribution of classified geologic formations shows that the study area has been characterized as Quaternary sedimentary deposits though infiltration feasibility is expected to vary significantly based between formations based on grain size. This formation-oriented dataset may be useful in supplementing soils data from LA County discussed in subsequent sections. An overview of these datasets referenced in this section is presented in Table 4.

A series of datasets characterizing aquifer conditions, outputs from a regional MODFLOW groundwater model, were also obtained from WRD and address the distribution of horizontal hydraulic conductivity, leakance, and specific yield at a large grid scale. An additional dataset identifying areas where groundwater basins are unconfined was obtained from a previous study with carried out by Geosyntec on behalf of WRD (Stormwater Recharge Feasibility and Pilot Project Development Study, 2012), will be incorporated into the analysis, and is presented in Figure 4. A brief definition of these terms and an overview of their potential use are presented in Table 4.

**Table 4. Groundwater or Hydrogeologic Datasets**

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| Groundwater Basins (2005, LA County GIS Portal) | Spatial extent of 24 groundwater basins within Los Angeles County and associated area. | Assessment of spatial relationship between stormwater capture projects and mapped groundwater basins. |
| Depth to Groundwater (LARWQCB, 2003) | Contours representing estimated depth to groundwater throughout the City of Los Angeles. | Identification of constraints associated with shallow groundwater. |
| Dewatering Permits (LARWQCB, 2013) | Permitted dewatering locations | Identification of areas where infiltrated water may be extracted in a relatively short time frame. |
| Production Wells (WRD, 2013) | Locations of production wells utilized by WRD | Identification of productive aquifers; buffer for stormwater infiltration. |
| National Hydrography Dataset, Wells layer | Location of major wells (likely partial inventory). | |
| Geologic Classification | Spatial extent of surficial geologic classes. | Potentially used to establish feasibility of infiltration. |
| Horizontal Hydraulic Conductivity (kh) (WRD, 2013) | Spatial extent of horizontal hydraulic conductivity (kh) presented as a grid defining the rate of movement of water through a porous medium such as a soil or aquifer in the horizontal direction. | High horizontal hydraulic conductivity is an indicator of areas of transmissive aquifers where water that is added quickly moves away instead of mounding making potential recharge more feasible. |
| Leakance (kv) (WRD, 2013) | Spatial extent of leakance values presented as a grid describing the flow potential in the vertical direction in the subsurface layers. | Typically, the higher the leakance the more likely deep percolation into the drinking water aquifers is to occur making potential recharge more feasible. |
| Specific Yield (Sy) and Storativity (S) (WRD, 2013) | Spatial extent of indicators of whether an aquifer is confined or unconfined presented as a grid. | Unconfined aquifers are described by Specific Yield while confined aquifers are described by Storativity. Unconfined aquifers represent the most promising areas for potential recharge. |
| Unconfined Groundwater Basins (Geosyntec, 2013) | Spatial extent of unconfined groundwater basins in the San Fernando, Sylmar, and Raymond basins. Coverage for the Central, Santa Monica, and West Coast basins are not present. | Unconfined aquifers represent the most promising areas for potential recharge |

**Soil Conditions and Slope**

Soil properties greatly affect the ability to infiltrate stormwater and recharge groundwater aquifers. Soil data is used as an input to both the LSPC and GWAM models, and will also be a significant factor in identifying opportunities for infiltration and recharge capacity to be expanded in the SCMP area. Slope is another significant factor affecting runoff and infiltration which is used in the LSPC model and will be a significant factor in ranking SCMP areas for infiltration and capture potential.

The Natural Resources Conservation Service (NRCS) has conducted extensive soil surveys throughout the United States. However, because their focus was primarily for agricultural purposes, many urban areas were not included in the surveys, and consequently data for soils in these areas is not available from NRCS. Most of Los Angeles County falls into this category. However, NRCS has recently been adding more urban areas to their database, and spatial and physical soils data for more the urbanized areas of Los Angeles are expected to be available in the near future.

The only known publically available spatial and physical dataset available for most of the urban areas is the County-wide soils dataset maintained by LACDPW. This dataset divides the County into 180 NRCS classifications. Theses classifications can be converted to saturated hydraulic conductivity using runoff curves in the 2006 Los Angeles County Hydrology Manual (LACDPW, 2006) as was done in the development of SBPAT (Geosyntec, 2008). Other parameters such as suction head and initial moisture deficit can be estimated from the literature or through calibration of the model. The LACDPW soil dataset is shown in Figure 5 with the associated saturated hydraulic conductivity computed using this method. In developing the LSPC model, soils were divided into one of the four hydrologic soil groups (A-D). In creating LSPC, LACDPW used two NRCS data sets (State Soil Geographic [STATSGO] and Soil Survey Geographic ([SSURGO]) to get spatial and physical soil data for use in runoff and infiltration computations (LACDPW, 2010a). For urban areas, LSPC uses the soils dataset from LACDPW. The GWAM distills soils information into 10 classifications, ranging from sand to clay (Bureau of Reclamation, 2007).

No further manipulation of the soil dataset is required for the SCMP. The models have the appropriate soils data built in, and have been calibrated based, in part, on the parameters that are applicable to each model. The information contained in the datasets shown in Table 5 will be used as part of characterizing the relative infiltration and recharge capacity of land across the City. Areas with soils that have higher infiltration rates will be ranked higher than those with lower infiltration rates, all other factors being equal.

Slopes were calculated for use in the LSPC model using digital elevation maps from USGS. Slopes were classified into >10% and <10% to categorize hydrologic response units (HRUs, see following section). As the HRUs will be used in evaluating infiltration and recharge potential, these will incorporate the slope data, and no further use of the slope data is anticipated for the SCMP.

**Table 5. Soils and Slopes Datasets**

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| STATSGO and SSURGO (NRCS, various dates) | Soil types, properties, and locations from NRCS. Does not currently include most urbanized areas of SCMP area. | Was used for portions of the LSPC models. |
| Los Angeles County Soils (2006) | Map of soil types in LA County using 180 soil classifications based on NRCS classifications. | Used in LSPC and GWAM models. Will be used for ranking SCMP areas for infiltration potential. |
| County-wide slope classification | Created during LSPC development using digital elevation maps from USGS | Used in HRU development. Slope in HRUs is a factor that will be considered in ranking infiltration potential. |

## Land Use and Related Datasets

Existing Land Use Data

The primary source for high-resolution, publically available existing land use data for all of the SCMP Study Area is the Southern California Association of Governments (SCAG) which has several land use datasets, the most recent of which was based on the year 2005. The dataset divides Los Angeles County into over 210,000 features using 117 land use categories. Los Angeles County, as part of the 2006 Hydrology Manual (LACDPW, 2006), has assigned imperviousness values to each feature in this dataset, so that it includes both land use and imperviousness. This dataset was used as the basis for the land use in LSPC although the land uses in it were compiled into 12 land uses, and it was further modified as explained below (LACDPW, 2010a). Figure 6 shows the percent imperviousness of the SCMP study area using this dataset.

The GWAM documentation does not list where the land use data came from for that model, but does state that it is from 2001. There is a SCAG land use dataset from 2001, and there is also a medium-resolution National Land Cover Data from 2001 from USGS (which has since been replaced by 2006 release). The latter was used by LSPC for land uses outside of Los Angeles County. GWAM may have used either one, but used this data to classify each of the polygons into 100 land use codes based on their percent vegetation, whether irrigation is applied to the vegetation, and the type of vegetation (warm turf, cool turf, non-vegetated, other vegetation, imperviousness) (Bureau of Reclamation, 2007).

Each of these datasets is listed in Table 6. The two models have their land use data built into their input databases, so no further manipulation of these dataset will be needed for the SCMP modeling analyses. Los Angeles County's 2005 land use dataset (with its imperviousness values) will be used in evaluating areas for infiltration and capture potential. Additionally, the NLCD 2006 impervious cover dataset may be used should the need arise to verify/adjust impervious cover estimates, however this is not anticipated to be needed.

Parcel Data

Parcel data is useful for prioritization of infiltration and recharge facilities because public, open space may be more suitable for such facilities than private, developed space. Los Angeles County maintains a database and shapefile of all parcels within the County. A version of this parcel dataset is available via the SBPAT input database. This dataset includes private/public designation as well as developed/non-developed status of each parcel. This dataset was also used to refine the County's 2005 land use layer for use in the LSPC model. Figure 7 shows the parcel dataset categorized into six general categories for the SCMP study area. This is the only publically available dataset for parcel data in the SCMP study area. It is already built in to the LSPC model and SBPAT models as it was used to refine land uses and opportunity scores, respectively. It will also be used to determine high priority locations for siting infiltration/recharge facilities as well as to characterize right of ways areas.

Hydrologic Response Units

Hydrologic Response Units (HRUs) are distinct combinations of the attributes which have the largest effect on runoff (imperviousness, land use, soil characteristics, and slope) used in hydrologic watershed modeling. The LSPC model uses HRUs to determine runoff characteristics as well as water quality characteristics including buildup/washoff, surface roughness, accumulation rates, etc. The LSPC model divides the 12 composite land uses, 4 soil types (A-D), and two slope categories (<10% and >10%) into HRUs (Figure 8). This was done by first dividing the developed land uses into developed pervious and developed impervious. Thus, the impervious areas of these land uses need no soil designation. All undeveloped areas were assumed to be 100% pervious. After categorizing all County areas based on their land use, soil type, and slope category, it was observed that many land uses had only one predominant soil/slope combination. In these cases, minor categories were removed. This resulted in 21 HRUs. Attributes of each category were assigned based on calibration and based on assumed soil parameters from the literature LACDPW, 2010a,b).

The HRUs are built in to the LSPC model, and will not be manipulated further. However, the HRUs will be useful in prioritizing areas for infiltration/recharge.

Planned Land Use Policy and General Plan Datasets

As part of the SCMP, future land uses will be considered as part of evaluating the effect of land use changes which could affect infiltration/recharge in the SCMP study area. The City of Los Angeles General Plan was consulted for planned future land uses within the City of LA boundaries, and the Los Angeles County General Plan was consulted for planned future land uses in unincorporated areas within the SCMP study area (Figure 9). In addition, the zoning in the unincorporated areas of the County within the SCMP can be used to estimate future land uses.

The LSPC and GWAM models will not be altered to include future land uses as the effects of these changes can be considered using incremental methods. However, the future land uses will be used to identify opportunities for implementing stormwater capture programs and policies.

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**Table 6. Existing Land Use, Future Land Use, and Hydrologic Response Unit Datasets**

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| LA County 2005 Land use and Imperviousness/SCAG 2005 Land use | Divides the County into 117 land use categories based on their 2005 land use. Updated with imperviousness values by LA County for use in LSPC model. | Used in LSPC model, and will be used in prioritizing infiltration recharge locations. |
| SCAG 2001 Land use | Land use dataset replaced by updated 2005 land use dataset | Used in GWAM model, will not be used for other purposes |
| GWAM land use codes | Land uses categorized into 100 types based on vegetation and land cover | Used by GWAM model, will not be used for other purposes |
| 2005 Los Angeles County Parcel-based Composite Land Use and LSPC Hydrologic Response Units | Composited the 2005 SCAG data into 12 land uses and refined using parcel dataset | Used in LSPC model and will be used for prioritizing infiltration/recharge (i.e., public open-space parcels, or a market-based approach for private open-space parcels) |
| LACDPW Parcels Dataset (from LSPC/ SBPAT) | Development designation and private/public status for all parcels within LA County | Used in LSPC/SBPAT models and will be used to help identify location public-open space parcels suitable for infiltration/recharge facilities |
| USGS 2001 National Land Cover Dataset | National medium-resolution land cover (30 meter), percent imperviousness, and percent tree canopy. The 2001 data has since been replaced by the 2006 NLCD. | Used for non-County areas in LSPC. |
| USGS 2006 National Land Cover Dataset | Same as 2001, also with land cover change and impervious cover change dataset. | May serve as a resource for verification of land use estimated impervious, if needed. |
| City of LA General Plan | Planned Land uses from the General Plan until 2035 for City of LA | Used to identify extent of potential for development ordinance type of stormwater capture policy |
| LA County General Plan | Planned Land uses from the General Plan until 2035 for unincorporated LA County | |
| LA County Unincorporated Zoning | Zoning in unincorporated LA County | |

**Other Potential Datasets for Identifying Opportunities**

In addition to the resources described above, a variety of other datasets were gathered and evaluated in an effort to identify potential opportunities for the implementation of future stormwater capture programs, policies, or projects.  Opportunities for stormwater capture may present themselves where redevelopment and community revitalization is expected to occur – for example, through compliance with low impact development ordinances imposed on redevelopment as part of MS4 permit compliance or by coupling stormwater capture retrofit programs with other revitalization efforts, such as green streets. The Los Angeles Department of City Planning has posted a series of spatial datasets identifying areas where redevelopment is expected to occur or is being incentivized. Existing or planned bicycle lanes/corridors may also indicate areas where green streets stormwater capture approaches could be applied. Datasets identifying existing and planned bike lanes/paths were obtained from the County and SCAG. These planning zones and bikeway datasets are identified in Table 7 and presented in Figure 10.

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**Table 7. Planning Opportunity Datasets**

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| Federal Renewal Community Districts (FRCs) (2012, Los Angeles Department of City Planning) | The spatial extent of areas holding the designation of a "Federal Renewal Community."[1] | Potential indicator of areas where significant redevelopment is expected, where creation of a stormwater capture plan for the area, or imposing development ordinances may be possible. |
| State Enterprise Zones (SEZs) (2012, Los Angeles Department of City Planning) | The spatial extent of areas holding the designation of a "State Enterprise Zone."[2] | |
| Business Improvement Districts (BIDs) (2012, Los Angeles Department of City Planning) | The spatial extent of areas holding the designation of a "Business Improvement District."[3] | |
| Targeted Neighborhood Initiatives (TNIs) (2012, Los Angeles Department of City Planning) | The spatial extent of areas holding the designation of a "Targeted Neighborhood Initiative."[4] | |
| Transit Oriented Districts (TODs) (2012, Los Angeles Department of City Planning) | The spatial extent of areas holding the designation of a "Transit Oriented District."[5] | |

[1] A Federal Renewal Community is a federal designation for low-to-moderate income areas designed to encourage investment by businesses and developers to stimulate economic development and job creation. U.S. Department of Housing and Urban Development:
http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/economicdevelopment/programs/rc

[2] Areas where State tax credits and deductions are available to attract business and enhance growth within economically challenged areas of the City. City of Los Angeles
http://ewdd.lacity.org/bus_sez.html

3 Areas where "…services, activities and programs are paid for through a special assessment which is charged to all members within the district in order to equitably distribute the benefits received and the costs incurred to provide the agreed-upon services, activities and programs". City of Los Angeles
http://clerk.lacity.org/BusinessImprovementDistricts/WhatisaBusinessImprovementDistrict/index.htm

4 Targeted Neighborhood Initiative areas "…create the mechanisms and relationships necessary to implement a coordinated effort between City Departments and with area stakeholders. By creating these mechanism and relationships it is hoped that duplicate efforts will be minimized, and that the supplemental Community Development Block Grant (CDBG) dollars will be leveraged for greater impact." City of Los Angeles
http://planning.lacity.org/cwd/gnlpln/HsgElt/HE/Ch2Bkgnd.htm

5 Transit Oriented Districts aim to increase public transportation ridership by allowing communities to travel to employment and commercial areas in an efficient manor. City of Los Angeles
http://ctod.org/pdfs/2010LATOD.pdf

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| Pedestrian Oriented Districts (PODs) (2012, Los Angeles Department of City Planning) | The spatial extent of areas holding the designation of a "Pedestrian Oriented District."[6] | Areas where City incentives are present to incorporate mixed-used districts and pedestrian friendly features into redevelopment that may incorporate infiltration measures. |
| SCAG Existing Bikeways (2013, SCAG) | Mapped existing bikeways. | Bikeway presence may be used a proxy for wide streets that may be feasibly redeveloped to incorporate LID. |
| LA County Proposed Bikeways (2012, LA County) | Proposed bikeways identified in the County of Los Angeles Bicycle Master Plan | |

### Other Potential Datasets for Identifying Constraints

Datasets delineating the extent of landslide and liquefaction zones were obtained from the California Geological Survey at the quadrangle scale and integrated into a single coverage for Los Angeles County (Figure 11). Infiltration may be inadvisable in these areas due to geotechnical concerns and associated liability. An overview of these datasets is presented in Table 8.

**Table 8. Geotechnical Constraint Datasets**

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| Mapped Landslides (2005, California Geological Survey) | Spatial extent of mapped landslides within Los Angeles County and associated area[7]. | Indicator of infiltration constraints related to geotechnical instability due to landslide potential. |
| Liquefaction Potential (2007, California Geological Survey) | Spatial extent of areas with liquefaction potential within Los Angeles County and associated area[8]. | Identification of constraints associated with shallow groundwater and related liquefaction concerns. |

---

6 Pedestrian Oriented Districts are established with the goal of "encourage the establishment of commercial and mixed-use districts that promote pedestrian activity."  City of Los Angeles http://cityplanning.lacity.org/cwd/framwk/chapters/03/03211.htm

7 The "Landslide Zone" dataset identifies where the stability of hillslopes must be evaluated, and countermeasures undertaken in the design and construction of buildings for human occupancy. (http://egis3.lacounty.gov/dataportal/2013/06/26/seismic-hazards-la-county-from-state-of-ca/)

8 The "Liquefaction Zone" dataset identifies where the stability of foundation soils must be investigated, and countermeasures undertaken in the design and construction of buildings for human occupancy.

A dataset delineating the extent of a trapped saline plume in the West Coast basin was previously obtained from WRD representing an area where infiltration may be inadvisable due to issues associated with future use.  A spatial dataset identifying sites enrolled in EPA's Facility Registry Services (FRS) was obtained from EPA.  This geodatabase can be queried by sites registered under various environmental statutes addressing contaminated including but not limited to, National Priority List Super Fund (CERCLA) sites, other Super Fund sites, or Resource Conservation Recovery Act (RCRA). Additional datasets have been obtained from the California State Water Resources Control Board's (CAWRCB) Geotracker and the California Department of Toxic Substances Control (DTSC) Envirostor databases.  Figure 12 presents the spatial distribution of CERCLA sites and DTSC/CAWRB listed sites impacting groundwater.  These point data may be used to develop areal coverage delineating areas where, similar to the extent of the saline plume, infiltration may be inadvisable due to the potential to impact remedial actions or mobilize pollutants of concern associated with regulated sites (Table 9).

**Table 9. Environmental Constraint Datasets**

| Dataset | Summary | Anticipated/Potential Uses in SCMP |
|---|---|---|
| Mapped Saline Plume (LA WRD, 2008) | Dataset delineating the extent of a trapped saline plume in the West Coast Basin. | Infiltration may be inadvisable in this area as future use may be infeasible. |
| Facility Registry Services Geodatabase (2013, U.S. EPA) | Point dataset identifying sites within the Facility Registry Service by environmental statute. | Conversion of point datasets to area coverages through the application of a buffer or area where infiltration would be considered inadvisable due to regulatory constraints. |
| Geotracker (CAWRCB, 2012) | Point dataset identifying contaminated soil and groundwater sites. | |
| EnviroStor (DTSC, 2012) | Point dataset identifying contaminated soil and groundwater sites. | |

Identification of Potential Additional Data Needs

A number of potential additional data needs have been identified, including:

- Additional information to characterize groundwater basins.
- Information to help evaluate the suitability of street right of ways for infiltration-based systems.
- More detailed model representations of centralized facilities (beyond what is currently in LSPC).

**Groundwater Basin Characterization**

While the consultant is currently is in possession of a dataset delineating the spatial extent of groundwater basins within Los Angeles County, and is aware that other information exists, specific spatial information regarding the attributes of each basin have not been secured. Ideally, additional information would be obtained and used to help establish locations that should be the focus of targeted infiltration program. We are seeking datasets that would help answer the following questions on a spatial basis:

- Are data available to supplement the delineations developed by the Water Replenishment District (See Figure 4) regarding whether groundwater basins are confined or unconfined for the San Fernando, Central, West Coast, and Santa Monica basins?
- Are groundwater resources impaired or have they been rendered less viable in any manor (i.e. saltwater intrusion) in areas other than the trapped saline plumed in the West Coast Basin?
- What is the spatial extent of groundwater identified as contaminated in the annual Upper Los Angeles River Area Watermaster Report?
- Are there areas of rising groundwater or areas subject to perpetual dewatering not addressed in regional dewatering permits where infiltrated water is likely to re-enter the surface water conveyance system relatively quickly?

Ideally, these questions could be addressed via shapefiles that can be used in spatial analyses.

**Street Suitability Datasets**

There are a variety of factors that relate to the suitability of street right of ways for implementing infiltration-based BMPs, either as underground infiltration or as a green streets approach. Various types of data have been identified that may be useful for identifying right of ways with high opportunity. We would like the City’s input regarding the availability and potential usefulness of datasets related to:

- Average Annual Daily Traffic counts map
- Parking type and demand
- “Great Streets”, “Green Streets and Alleys”, and/or “Save our Streets” programs
- Condition of streets/CIP program (i.e., timing of anticipated maintenance/reconstruction)

**LSPC Centralized Facility Model Representations**

Los Angeles County, as part of continual updates to the WMMS framework and the Los Angeles Basin Stormwater Conservation Study, is currently in the process of including more detailed model representations of centralized facilities. The current version of the LSPC model provides adequate resolution for Task 2 analyses, however later analyses in Task 3 would benefit from obtaining updated model files from Los Angeles County, when available. The timing of this aspect of the County's work is tentatively set for late 2013 or early 2014.

## REFERENCES

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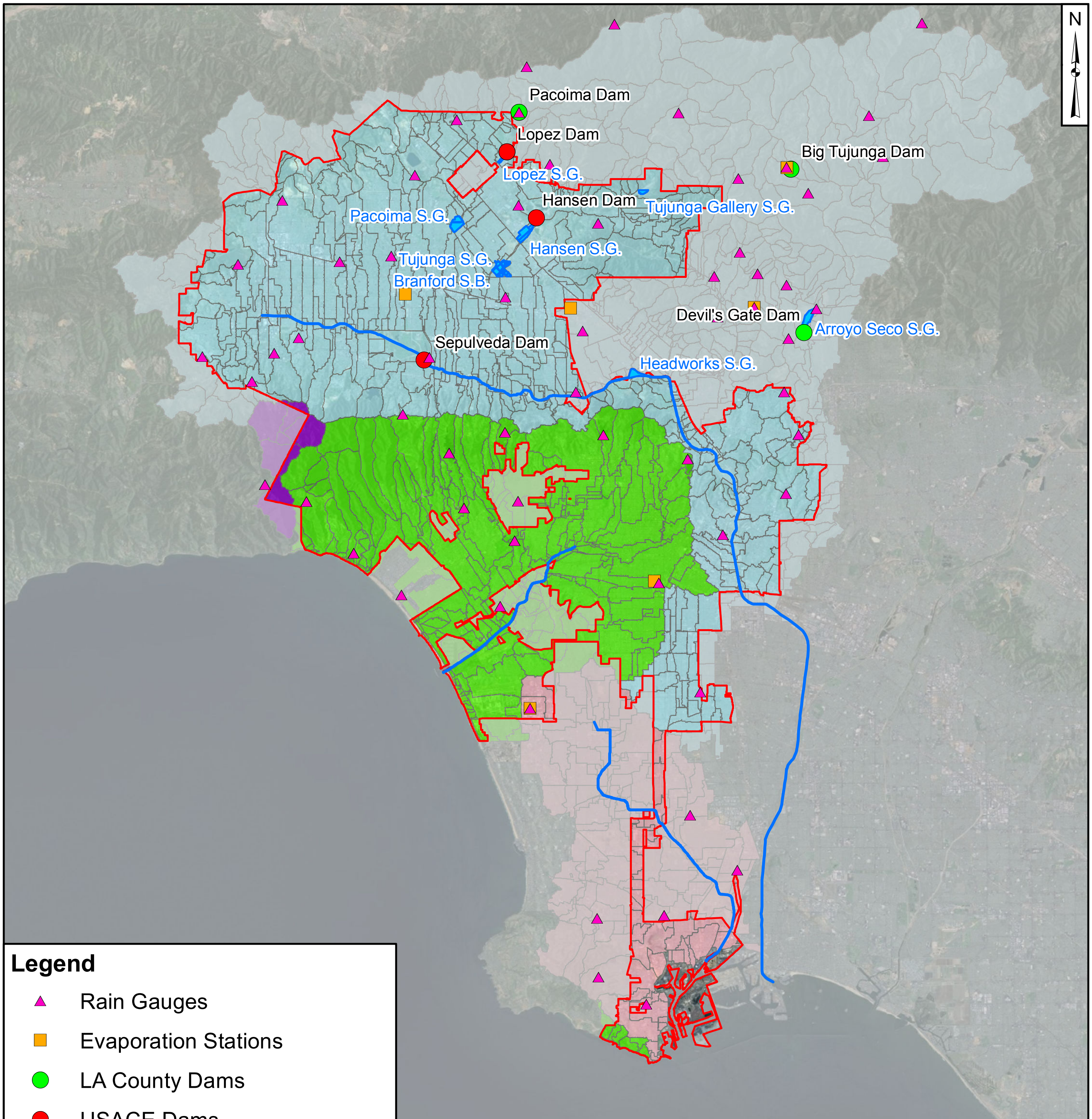
U.S. Department of the Interior, Bureau of Reclamation (2007) Los Angeles Basin Ground Water Augmentation Model Version 4.1.10 User's Manual and Technical Documentation, February, 2007.




Los Angeles P:\Users\Scott\LA_SCMP\LA_SCMP_Fig1-Hydrology.mxd SM 20131106

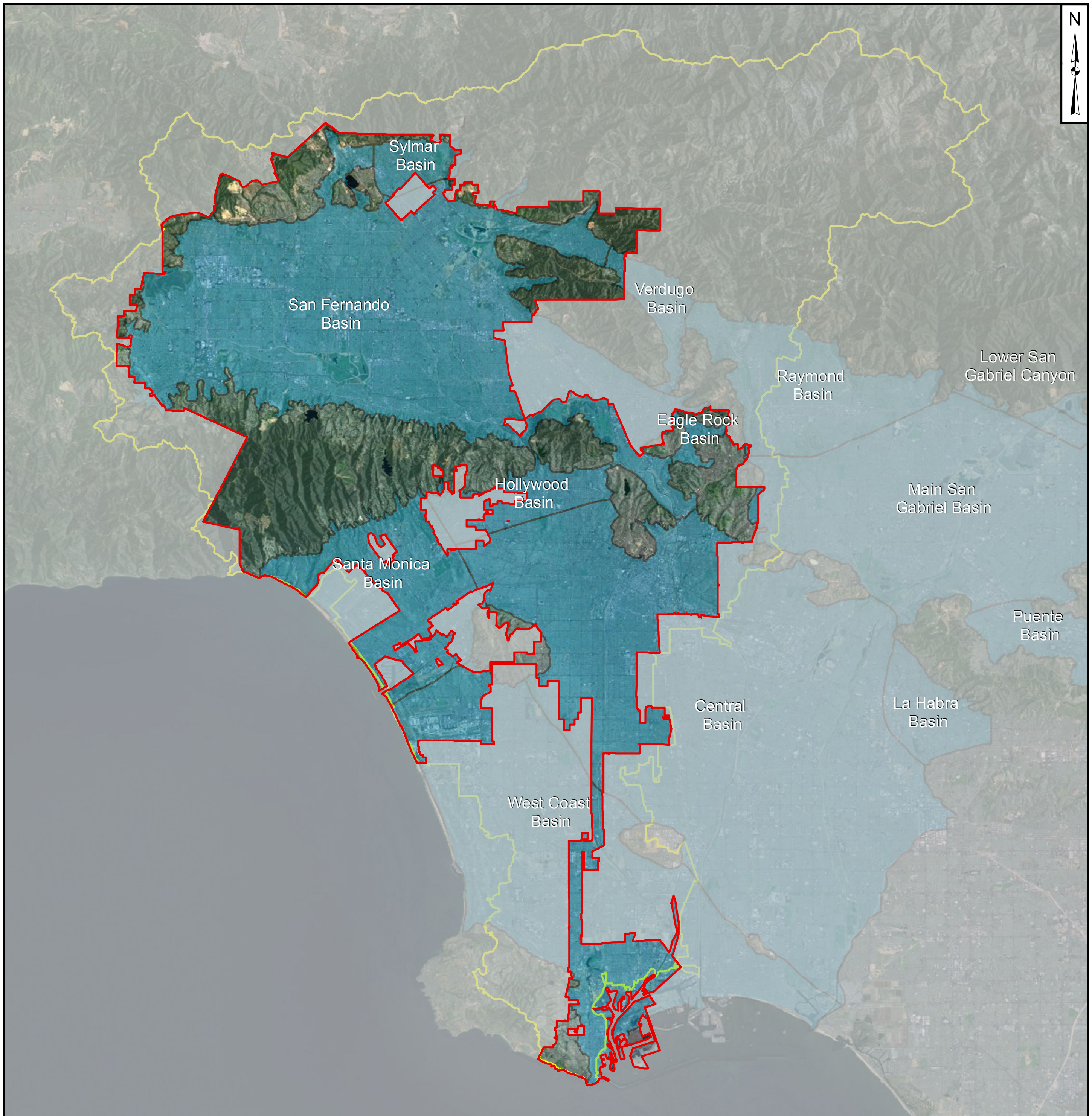
**Data Sources**
LA County LSPC Inputs Database, LA Basin Stormwater Conservation Study, LA County GIS Portal

**Hydrologic Features in the SCMP Study Area -DRAFT**

Los Angeles Stormwater Capture Master Plan

Geosyntec consultants

| Los Angeles | November 2013 | Figure 1 |
|---|---|---|




**Legend**

- Los Angeles City Boundary
- Groundwater Basin
- SCMP Study Extent

Data Sources
California Department of Water Resources via LA County GIS Data Portal

## Groundwater Basins in Proximity to SCMP Study Area - DRAFT

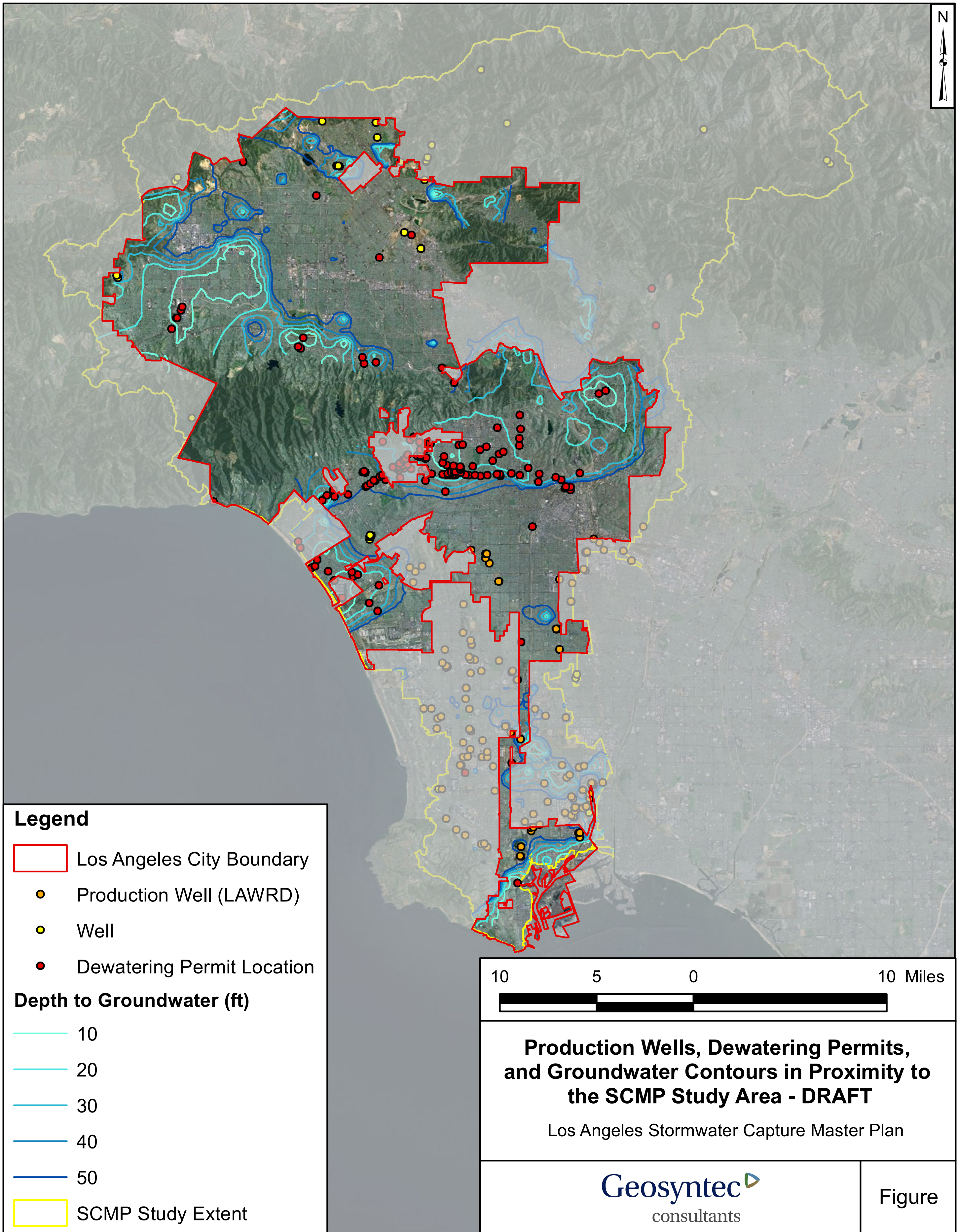
Los Angeles Stormwater Capture Master Plan

Geosyntec consultants

Los Angeles | November 2013

Figure 2

Los_Angeles P:\GIS\Projects\LA0282\Project_MXD\SCMP_GW_Basin.mxd SM 20131106




**Production Wells, Dewatering Permits, and Groundwater Contours in Proximity to the SCMP Study Area - DRAFT**

Los Angeles Stormwater Capture Master Plan

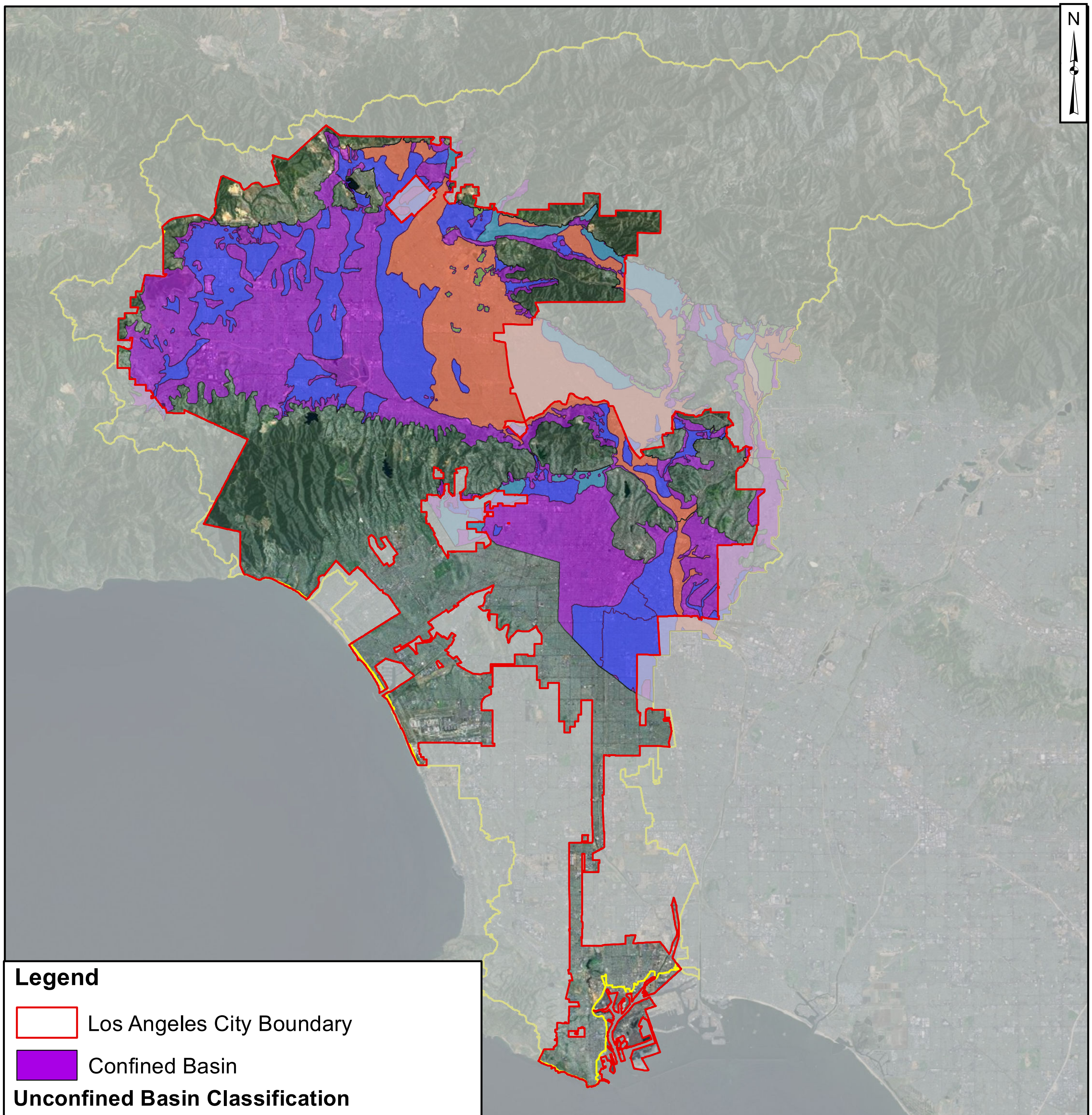
Geosyntec consultants

Figure 3

Los Angeles | November 2013

Data Sources
Los Angeles Water Reclamation District, USGS National Hydrography Dataset

Los_Angeles P:\GIS\Projects\LA0282\Project_MXD\SCMP_GW_Depth.mxd SM 20131106




## Legend

Los Angeles City Boundary

Confined Basin

**Unconfined Basin Classification**

Qoc; Pleistocene; Coarse-grained sediment (gravel)

Qovc; Pleistocene; Very coarse grained sediment (cobbles and boulders)

Qyc; Holocene; Coarse-grained sediment (gravel)

Qym; Holocene; Medium-grained sediment (sand)

Qyvc; Holocene; Very coarse grained sediment (cobbles and boulders)

SCMP Study Extent

10 5 0 10 Miles

**Unconfined Groundwater Basins in Proximity to SCMP Study Area - DRAFT**

Los Angeles Stormwater Capture Master Plan

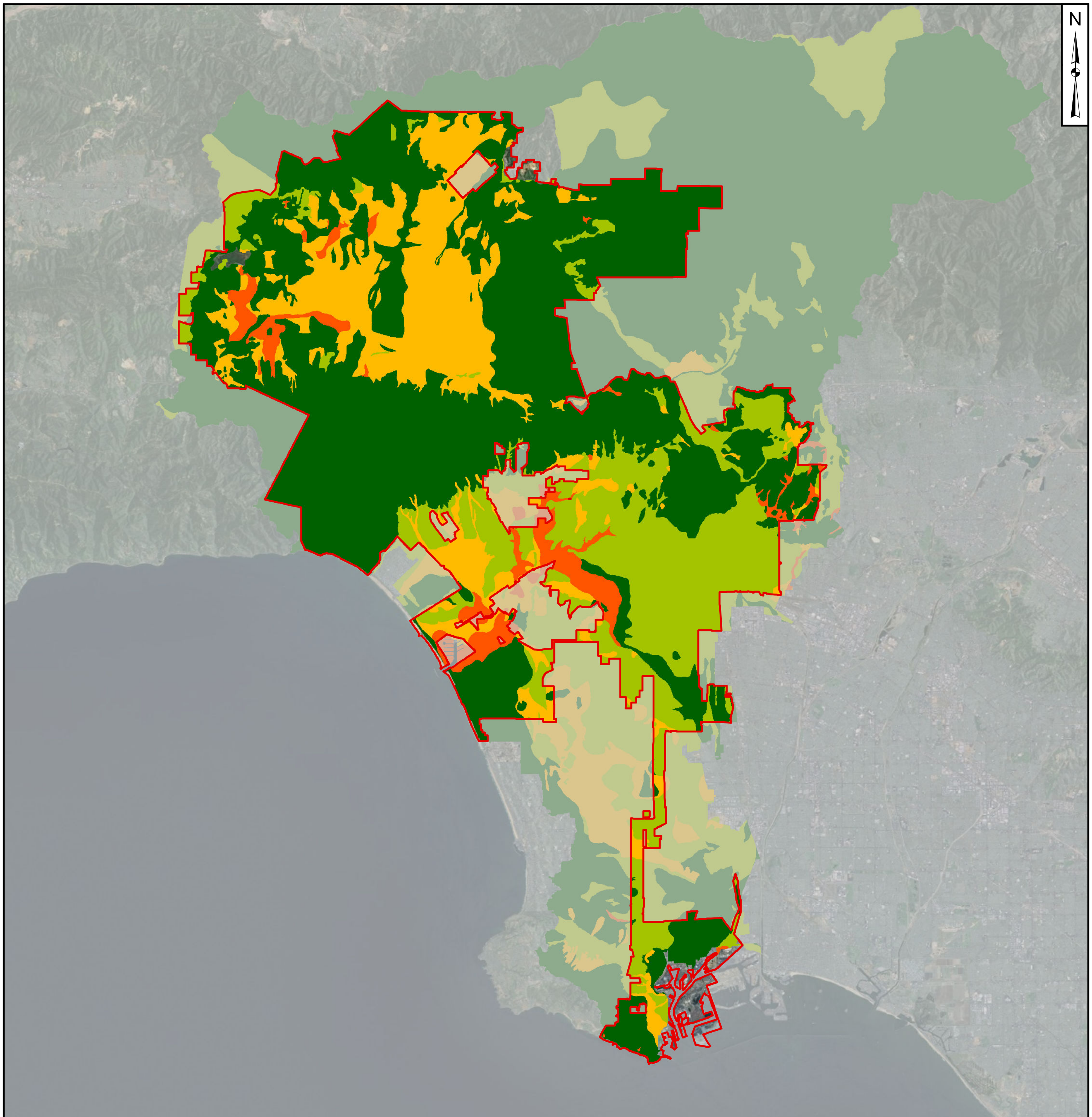
Geosyntec consultants

Figure 4

Los Angeles | November 2013

Data Sources
Geosyntec Consultants, 2013

Los_Angeles P:\GIS\Projects\LA0282\Project_MXD\SCMP_Unconfined_Basins_Class.mxd SM 20131114




**Legend**

Los Angeles City Boundary

**Hydrologic Soil Group**

- A
- B
- C
- D

10 5 0 10 Miles

**Soils Data in the SCMP Study Area-DRAFT**

Los Angeles Stormwater Capture Master Plan

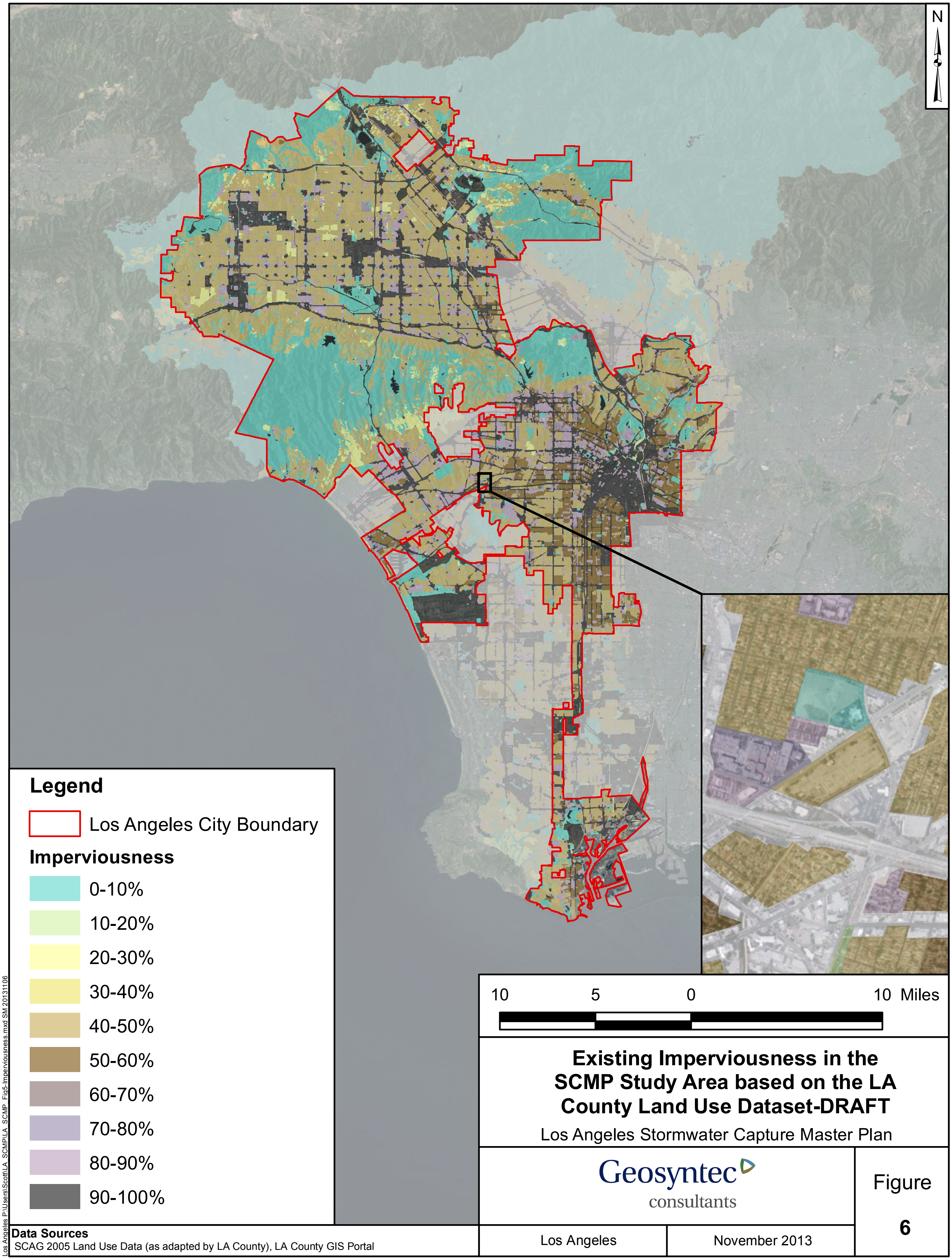
Geosyntec consultants

Figure 5

Los Angeles | November 2013

**Data Sources**
LA County LSPC Inputs Database, LA County GIS Portal

Los Angeles P:\Users\Scott\LA_SCMP\LA_SCMP_Fig4-Soils.mxd SM 20131106




**Existing Imperviousness in the SCMP Study Area based on the LA County Land Use Dataset-DRAFT**

Los Angeles Stormwater Capture Master Plan

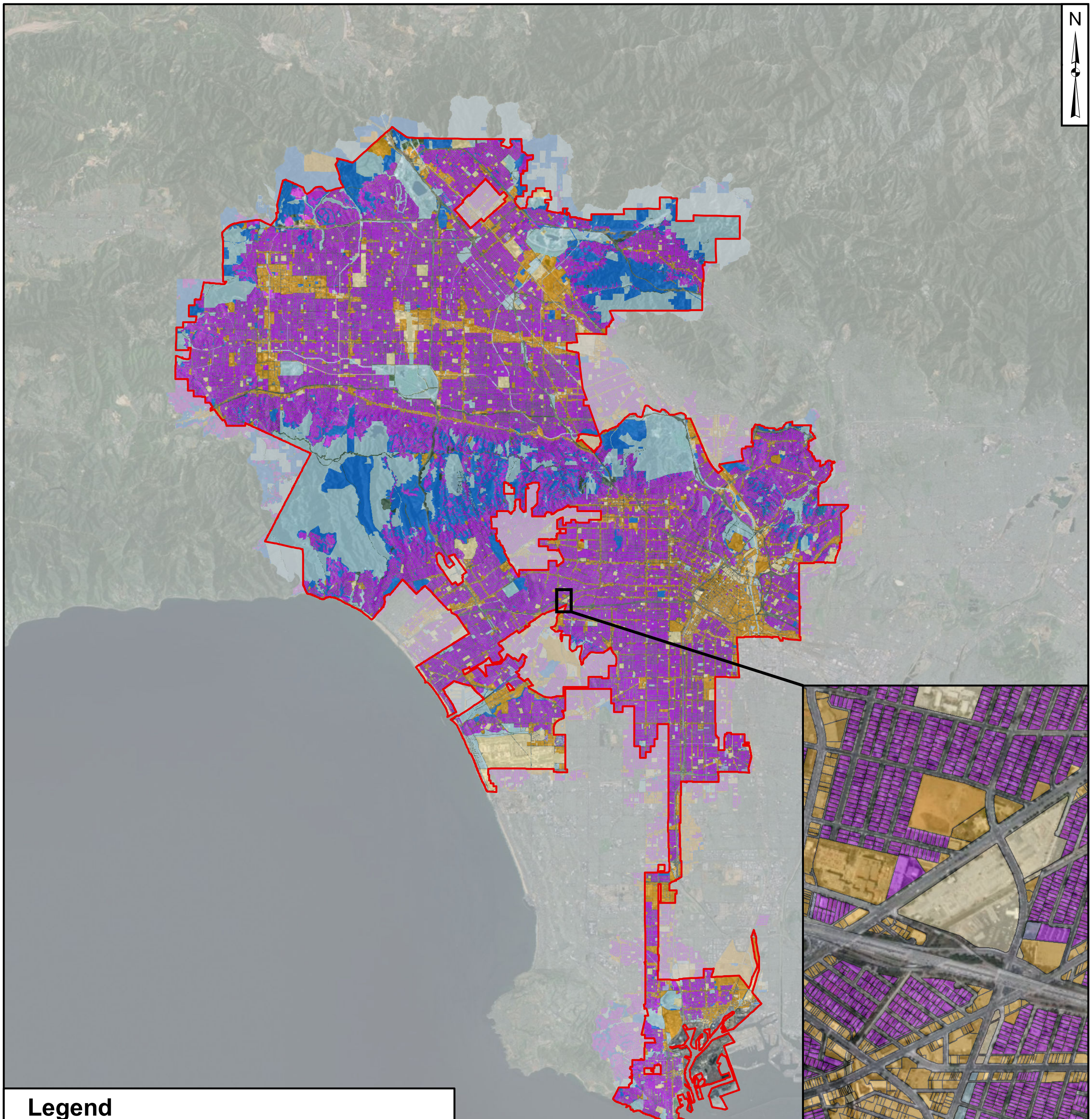
Geosyntec consultants

Figure 6

Los Angeles | November 2013

**Data Sources**
SCAG 2005 Land Use Data (as adapted by LA County), LA County GIS Portal

Los Angeles P:\Users\Scott\LA_SCMP\LA_SCMP_Fig5-Imperviousness.mxd SM 20131106




**Legend**

- Los Angeles City Boundary
- Private-Developed, non-residential
- Private-Developed, residential
- Private-Open Space
- Public-Developed, non-residential
- Public-Developed, residential
- Public-Open Space

10 5 0 10 Miles

**Parcel Data in the SCMP Study Area-DRAFT**

Los Angeles Stormwater Capture Master Plan

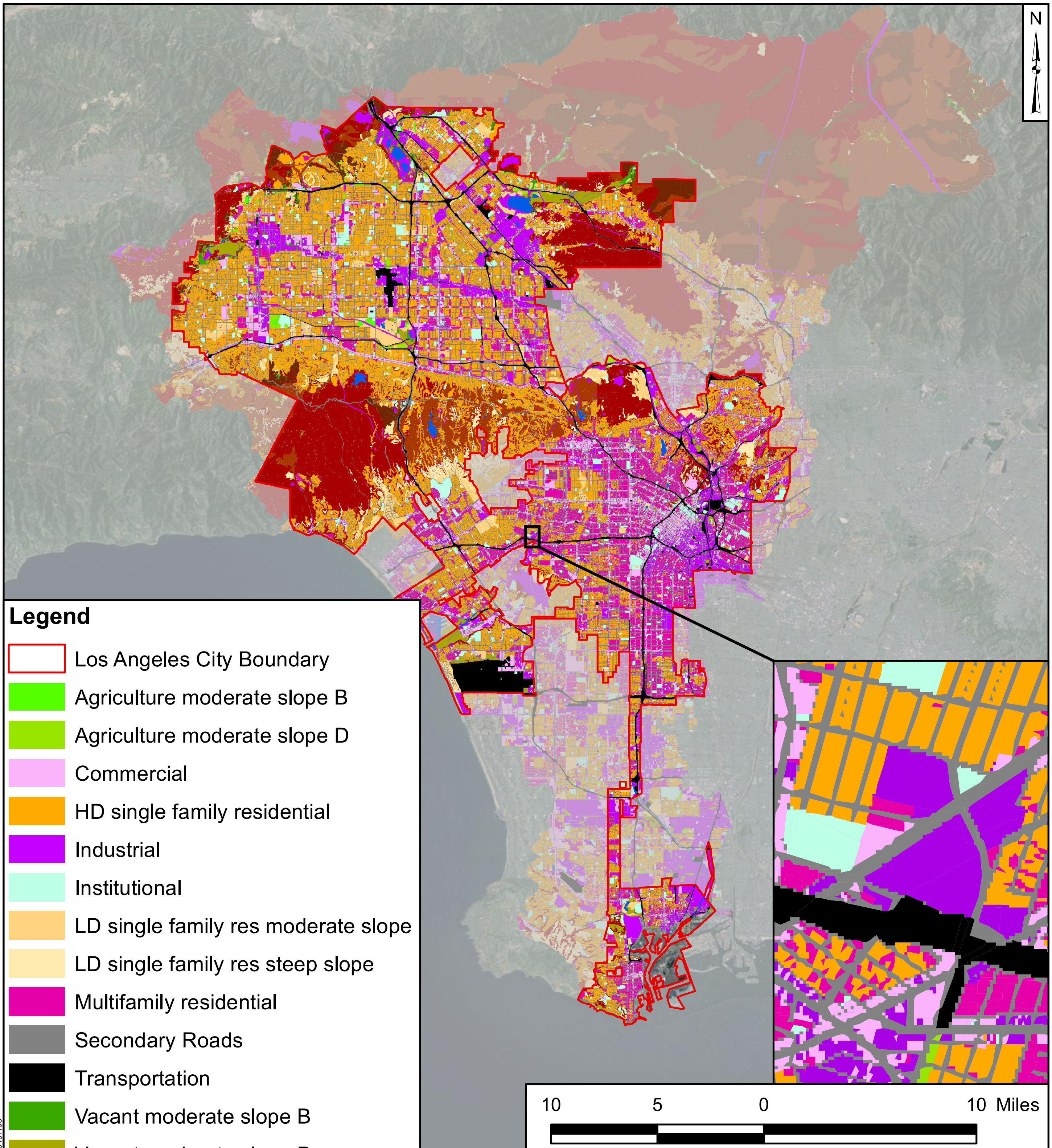
Geosyntec consultants

Figure 7

Los Angeles | November 2013

**Data Sources**
LA County Parcel Database, LA County GIS Portal

Los Angeles P:\Users\Scott\LA_SCMP\LA_SCMP_Fig6-parcels.mxd SM 20131106




**Hydrologic Response Units in the SCMP Study Area-DRAFT**

Los Angeles Stormwater Capture Master Plan

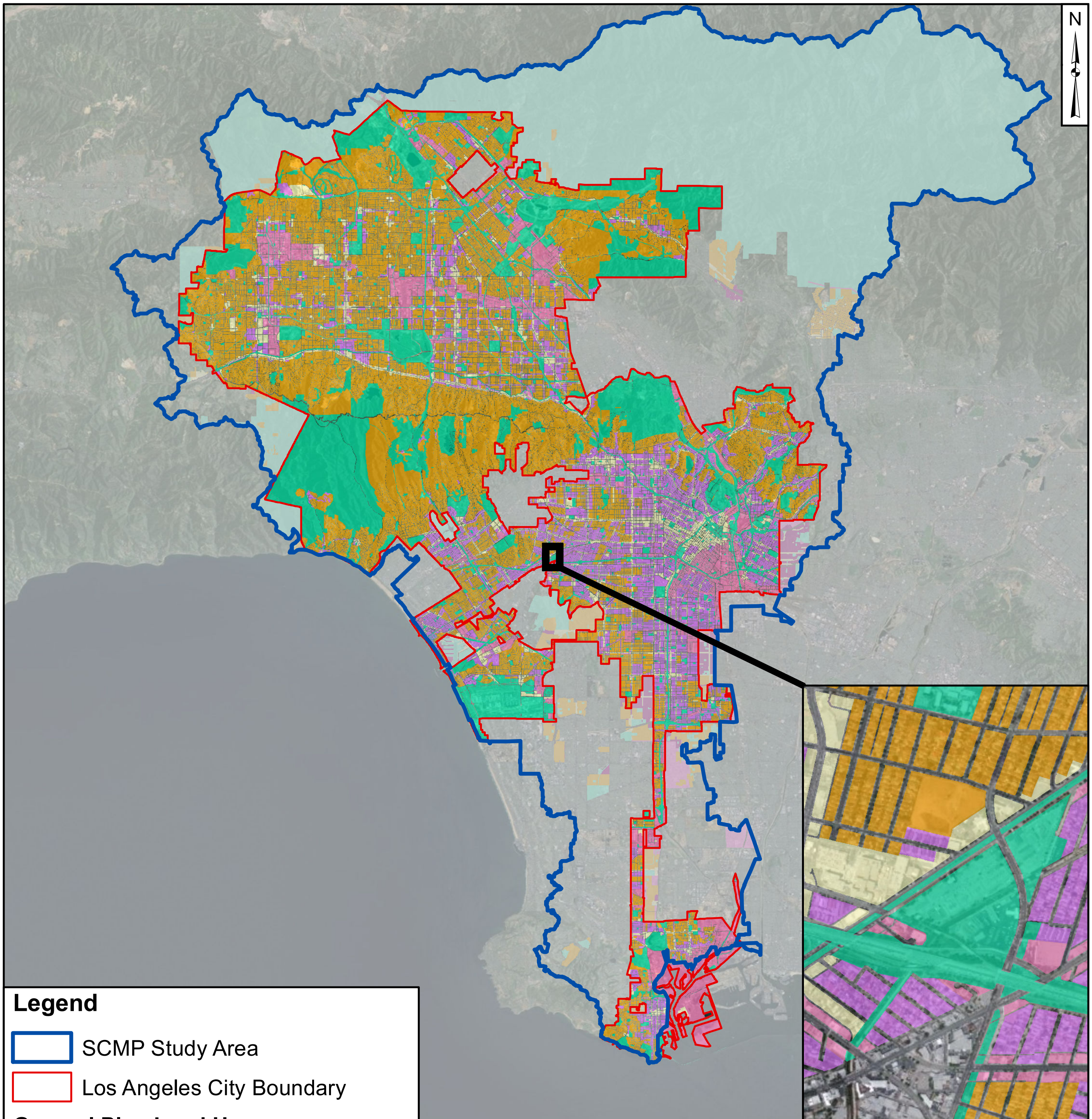
Geosyntec consultants

Figure 8

Los Angeles | November 2013

**Data Sources**
LA County LSPC Inputs Database, LA County GIS Portal

Los Angeles P:\Users\Scott\LA_SCMP\LA_SCMP_Fig7-HRUs.mxd SM 20131106




**Legend**

- SCMP Study Area
- Los Angeles City Boundary

**General Plan Land Use**

- Open Space and Public Facilities
- Commercial
- Industrial
- Mutli-Family Residential
- Single Family Residential
- Transportation

10 5 0 10 Miles

**Planned Land Uses in the SCMP Study Area from the City of LA and LA County General Plans-DRAFT**

Los Angeles Stormwater Capture Master Plan

Geosyntec consultants

Figure 9

Los Angeles | November 2013

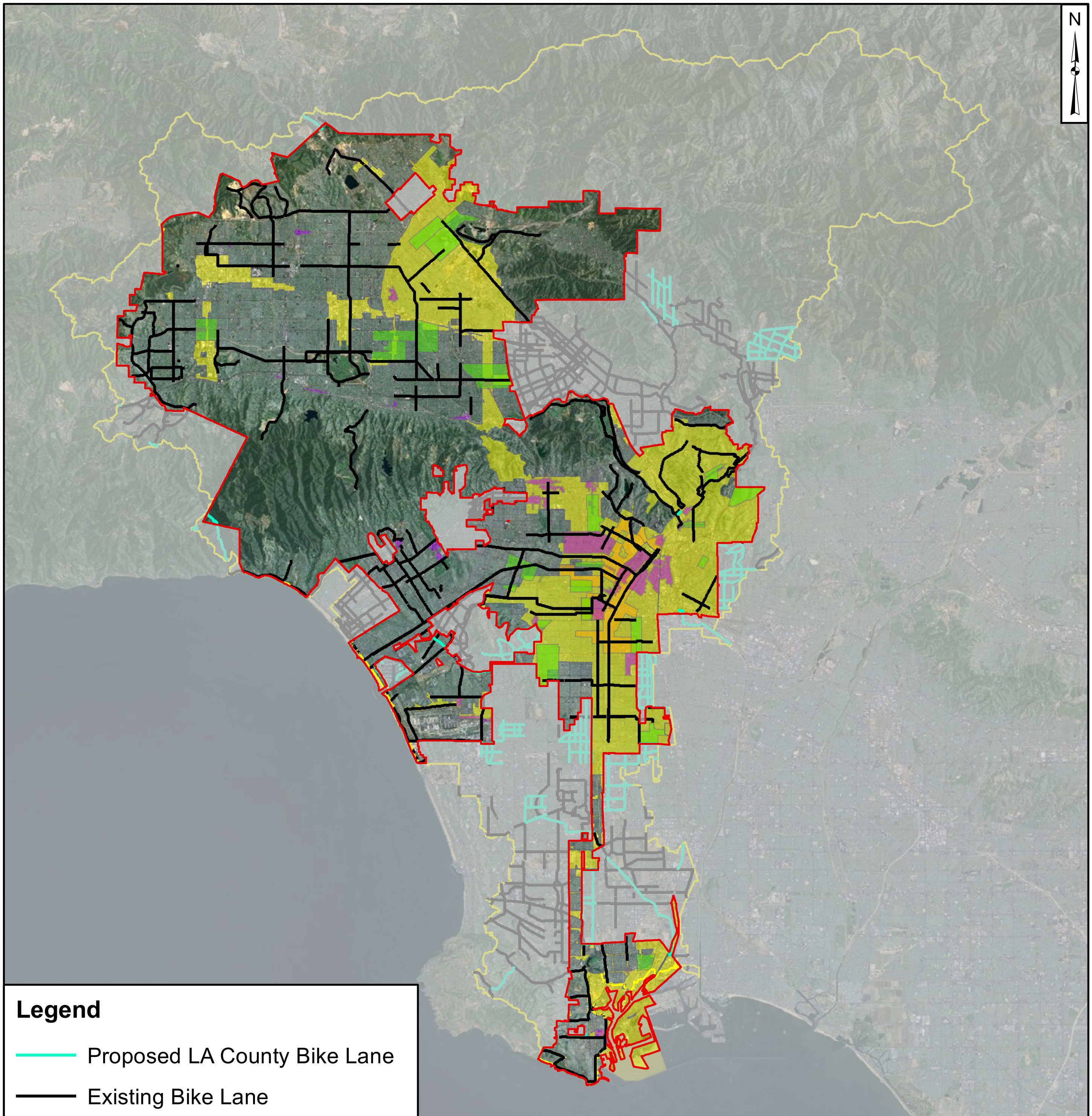
**Notes**

Other Citiy's General Plans not included in analysis

**Data Sources**

LA County General Plan, City of LA General Plan, LA County GIS Portal

Los Angeles P:\Users\Scott\LA_SCMP\LA_SCMP_Fig8-FutureLandUse.mxd SM 20131106




**Planning Designations and Bike Paths in Proximity to SCMP Study Area - DRAFT**

Los Angeles Stormwater Capture Master Plan

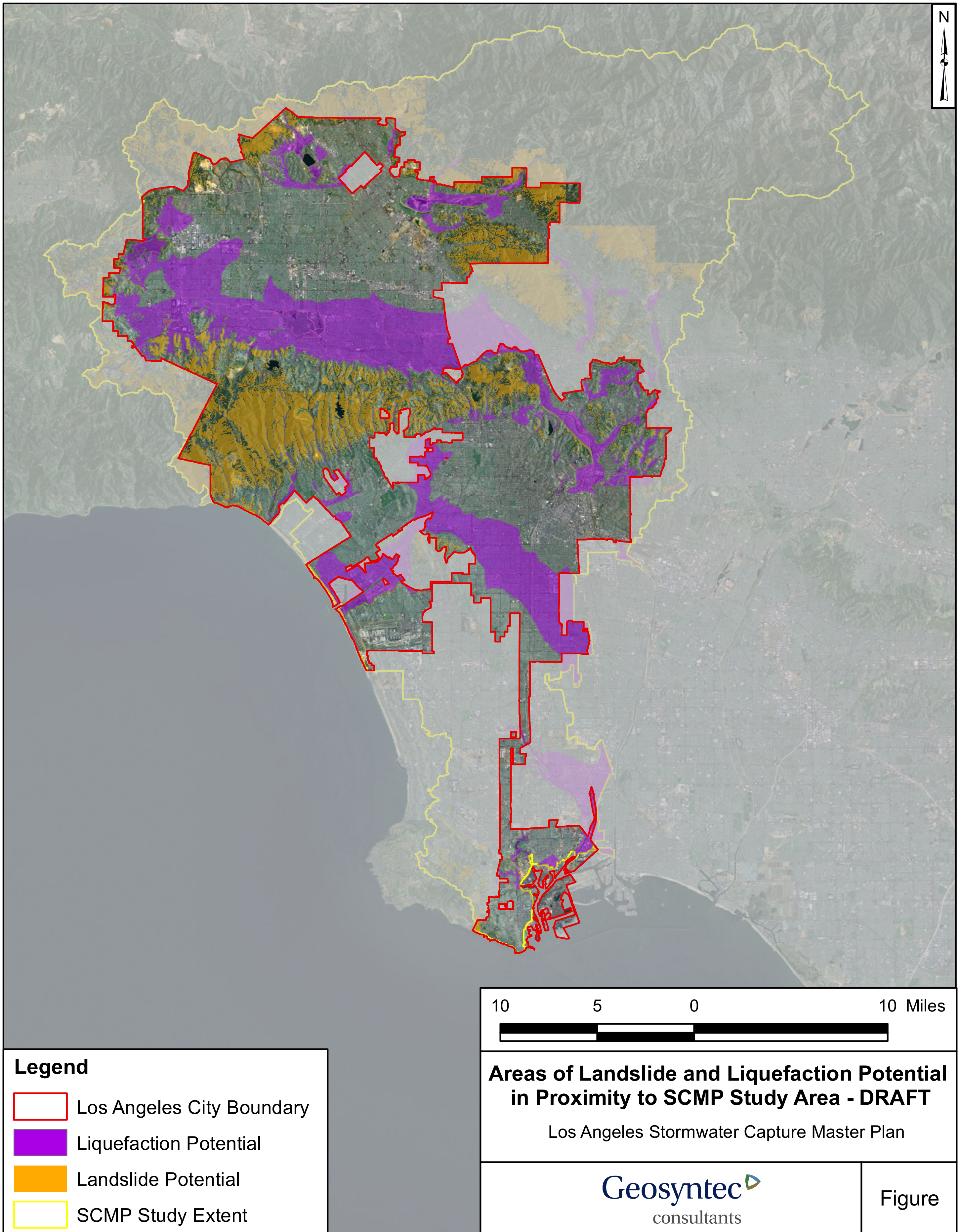
Geosyntec consultants

Figure 10

Los Angeles | November 2013

Data Sources
Los Angeles Department of City Planning, Los Angeles County GIS Data Portal

Los_Angeles P:\GIS\Projects\LA0282\Project_MXD\SCMP_Development_District.mxd SM 20131106




**Areas of Landslide and Liquefaction Potential in Proximity to SCMP Study Area - DRAFT**

Los Angeles Stormwater Capture Master Plan

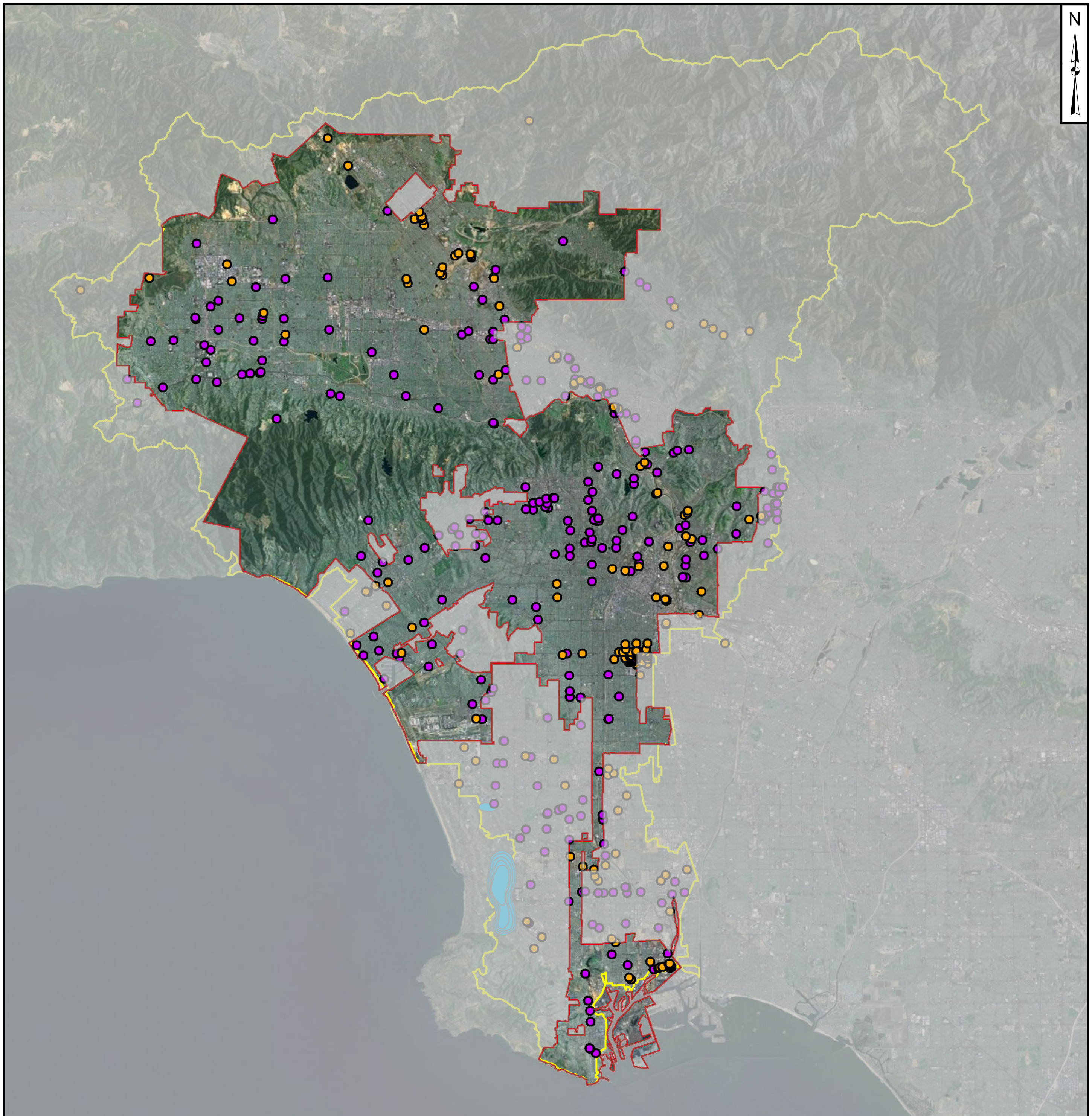
Geosyntec consultants

Figure 11

Los Angeles | November 2013

Data Sources
California Geological Survey

Los_Angeles P:\GIS\Projects\LA0282\Project_MXD\SCMP_Landslide_Liquefaction.mxd SM 20131106




Los_Angeles P:\GIS\Projects\LA0282\Project_MXD\SCMP_Haz_Waste.mxd SM 20131107

**Legend**

- Superfund Site
- Contaminated Drinking Water
- Saline Plume
- Los Angeles City Boundary
- SCMP Study Extent

10 5 0 10 Miles

**Hazardous Waste Sites in Proximity to SCMP Study Area - DRAFT**

Los Angeles Stormwater Capture Master Plan

Geosyntec consultants

Figure 12

Los Angeles | November 2013

Data Sources
U.S. EPA, L.A. Regional Water Quality Control Board, Department of Toxic Substances Control

# APPENDIX C. TM 1.3 EXISTING STORMWATER CAPTURE FACILITIES

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# Technical Memorandum 1.3 - FINAL

| | |
|---|---|
| Date: | February, 2014 |
| To: | Andy Niknafs, LADWP |
| Copies to: | Rafael Villegas, Virginia Wei, LADWP |
| From: | Mark Hanna, Geosyntec Los Angeles |
| Subject: | Stormwater Capture Master Plan: Task 1.3 -- Evaluate Existing Stormwater Capture Facilities |

## PURPOSE AND OBJECTIVE

The purpose of this subtask was to evaluate and provide an overview of existing centralized and distributed stormwater capture facilities/structures, projects, and programs within the City, as well as any surrounding watersheds that may affect City stormwater capture and groundwater recharge efforts. Centralized stormwater capture facilities generally include dams, spreading grounds, and spreading basins. Distributed facilities includes Low Impact Development (LID) Best Management Practices (BMPs) such as rain gardens, redirected downspouts, rain barrels, swales, and cisterns. While certain data regarding centralized facilities is readily available, the nature of distributed facilities, being smaller and widespread, it is more difficult to provide the same level of detail regarding existing conditions for the distributed BMPs.

## SYSTEM OVERVIEW AND HISTORY OF FLOOD CONTROL IN LOS ANGELES

The drainage system in Los Angeles is one of the most developed systems in the nation, including conveyances, impoundments, spreading grounds, flood control basins, and debris basins (see Attachment 1). The purpose of the flood control system is to protect urban infrastructure from flooding and to provide water conservation for replenishment of local groundwater basins. A brief discussion of the history of flood control in the Los Angeles County Drainage Area (LACDA) is important to understanding the context in which water conservation projections and improvement proposals are applied.

Prior to installation of flood control works, the Los Angeles County coastal plain was one of the greatest potential flood hazard areas in the United States for areas of comparable size, which is attributable to the unique topographic characteristics of the Los Angeles County watershed. The coastal plain rises uniformly from the ocean over a distance of 25 to 30 miles to an average elevation of about 2,000 feet at the base of the San Gabriel Mountains, or roughly 80 feet per mile.  The mountains rise abruptly out of the plain to over 7,000 feet in just one to three miles (approximately 3,500 feet per mile).  Furthermore, the San Gabriel Mountains are a complex mountain range that fracture and erode rapidly, causing flood waters laden with debris to cascade down steep river canyons out onto the coastal plain.

**Historical Background:  1700's to ~1915**

Floods ravaged the Los Angeles Basin throughout the eighteenth and nineteenth centuries.  The earliest recorded floods occurred in the winter of 1771 on the San Gabriel River and 1811 on the Los Angeles River.  In 1815, the Los Angeles River changed course and emptied into Ballona Creek.  The river changed back into its original course during the floods of 1825.  At least 12 major floods events were recorded from 1832 to 1890, with various ancillary effects such as large debris flows, new channel courses, and changing ocean outlets.

Prior to the late 1880's, limited development and low property values in the region neither created a general demand for flood control, nor warranted large-scale flood control projects. Although temporary damage was incurred, an occasional deluge was deemed beneficial to replenishing springs, mountain lakes, and supply water for irrigation.  This period of relative complacency came to an end when, from the 1880s through 1920, accelerated development and growth occurred throughout the basin.  Los Angeles County's population increased from 100,000 in 1890 to 500,000 in 1910, to 10.5 million today.  By the end of the first decade of the twentieth century, growth had reached a point where floods were considered a serious problem that threatened the future development of Los Angeles.

In 1913, Los Angeles City Engineer Frank Olmstead stated that the floods in the LACDA could be controlled using a three-fold approach:

1. Retention and storage of flood waters in reservoirs;
2. Creation of spreading grounds over gravel deposits to replenish groundwater aquifers; and
3. Straightening and reinforcement of river channels to facilitate discharge of flood waters to the ocean as quickly as possible with the least amount of destruction.

Olmstead's plan provided the basic foundation for all future flood control projects in Los Angeles County.  His vision that flood waters be discharged over spreading grounds has special significance because it incorporated water conservation into the flood control process.

**Development of the Los Angeles County Flood Control District**

On June 15, 1915, an act of the California State Legislature created the Los Angeles County Flood Control District (LACFCD) with an area of jurisdiction encompassing 2,760 square miles as shown on Attachment 1.  The charter stated the purpose of the LACFCD is to *"...provide for the control and conservation of flood, storm, and other waste waters and to conserve such waters for beneficial and useful purposes."*  (Van Wormer, 1991*)*

James W. Reagan was appointed Chief Engineer, and he submitted the first comprehensive plan for flood control that was adopted by the Board of Supervisors on January 2, 1917.  The plan included five basic elements:

1. Conservation of stormwaters through reforestation and retarding works in the mountains;
2. Containment of stormwaters with mountain dams;
3. The spreading of stormwaters on gravel deposits at the mouths of canyons in order to replenish the water table;
4. Diversion of the San Gabriel and Los Angeles Rivers to prevent siltation of Long Beach and San Pedro harbors; and
5. Acquisition of official channels of principal streams within the Los Angeles basin and permanent alignment and protection of those channels.

Table 1 provides a list Los Angeles County flood control dams that were constructed, the type of dam, and year completed.

**Construction of Flood Control Infrastructure (~1915 - 1939)**

Although there were many difficulties that slowed construction of the proposed dams and flood control facilities, the comprehensive plan was implemented.

Flood waters on January 1, 1934, carrying tens of thousands of tons of rock, mud, and other debris, ran off from recently-burned foothills and poured down onto the communities of Glendale, Montrose, and La Crescenta.  The disaster left 41 people dead and $6 million in property damages.

**Table 1. Flood Control Dams in the Los Angeles County Drainage Area**

| Dam Name | Construction Type | Year Completed |
|---|---|---|
| Big Dalton | Concrete Multiple Arch | 1929 |
| Big Tujunga | Concrete Arch | 1931 |
| Cogswell | Rock Fill | 1934 |
| Devil's Gate | Concrete Gravity | 1920 |
| Eaton Wash | Earth Fill | 1937 |
| Hansen | Earth Fill | 1940 |
| Live Oak Canyon | Concrete Gravity | 1922 |
| Lopez Dam | Earth Fill | 1954 |
| Morris | Concrete Gravity | 1934 |
| Pacoima | Concrete Arch | 1929 |
| Puddingstone | Earth Fill | 1928 |
| Puddingstone Diversion | Earth Fill | 1928 |
| San Dimas Canyon | Concrete Arch | 1922 |
| San Gabriel | Rock Fill | 1939 |
| Santa Anita | Concrete Arch | 1927 |
| Santa Fe | Earth Fill | 1949 |
| Saw Pit | Concrete Arch | 1928 |
| Sepulveda | Earth Fill | 1941 |
| Sierra Madre | Concrete Arch | 1928 |
| Thompson Creek | Earth Fill | 1928 |
| Whittier Narrows | Earth Fill | 1957 |

Chief Engineer Eaton noted that the defeat of flood control bond issues within the previous four years had brought about the New Year’s Day disaster.  The rejected bond issues had been specifically focused on channel improvements and debris basin construction in the devastated communities.  Eaton further stated that *"in no case where permanent types of protection works were installed was serious damage experienced."*  As an example, he noted that the Tujunga debris basin, completed in 1930, had saved the town of Tujunga from a similar fate.

**Emergency Relief Appropriation and Legislation (~1935 - 1940)**

The 1934 tragedy led to involvement of the U.S. Army Corps of Engineers (USACE) in the implementation of the comprehensive plan.  Major Wyman of the USACE developed a plan that outlined construction of debris basins at the base of the foothills, permanent channel improvements, construction of Eaton Dam (authorized under the Emergency Relief Appropriation Act of 1935), and the building of five additional flood control basins.  The latter were to be placed at strategic locations on the coastal plain where various streams merged to control and regulate flow.  Sepulveda, Hansen, and Lopez basins were planned for the San Fernando Valley, while Santa Fe and Whittier Narrows flood control basins were scheduled for the San Gabriel River.

More federal legislation followed the floods of March 1938 where 100 people were killed and $35 million in property damage was incurred.  The Flood Control Act of 1938 was submitted by the incoming Army Corps District Engineer Lieutenant Colonel Edward Kelton, with a revised comprehensive plan and budget of nearly $300 million.  This plan was formally approved as the Flood Control Act of August 8, 1941 and included Hansen, Sepulveda, and Lopez flood control basins; construction of debris basins at the mouth of 17 tributary canyons; improvement of approximately 49 miles of main channel and 53 miles of tributary channels; and reconstruction of 109 bridges.

**Final Phase of Flood Control Infrastructure (~1940 - 1980's)**

Construction of the Hansen Dam, which works in conjunction with Sepulveda Dam to control flood waters, began on September 2, 1938.  At the time of its completion in 1940, it was the largest structure of its kind in the world, with an impoundment capacity of 33,000 acre-ft

Sepulveda Flood Control Basin was finished in October 1941.  Capacity of the reservoir was 28,713 acre feet.

Lopez Dam, the third and final flood control basin planned for the Los Angeles River drainage, was completed in 1954.  Lopez Dam is located on Pacoima Wash and is considerably smaller than the other two structures.  The maximum impoundment recorded for Lopez Dam was 460 acre-feet at a water surface elevation of 1,280 feet.

After 60 years of infrastructure construction and millions of dollars spent, Los Angeles had finally accomplished flood control for the region.  However, over the past few decades, as imported water becomes more expensive and more susceptible to limitations, stormwater lost to the ocean has been recognized as an increasingly valuable resource for the region.  Existing flood control facilities and individual parcels are being retrofitted and new facilities are being developed to infiltrate stormwater for groundwater recharge.  Types of centralized and distributed stormwater capture are discussed in the following section.

## CENTRALIZED STORMWATER CAPTURE

Centralized stormwater capture facilities represent engineered features that convey, detain, or capture stormwater throughout the Los Angeles Region.  This section details only the facilities found within the City of Los Angeles and the watershed area tributary to the City.  Facilities are presented and discussed under the following subsections:

- Dams and reservoirs
- Debris basins
- Channel network
- Spreading grounds/water conservation facilities

### Dams and Reservoirs

Dams and reservoirs are located on major streams throughout the region, providing flood protection and water conservation.  Dam sites require stable geotechnical properties in narrow portions of the canyon, making them cost effective for storing water during rain events.  The flood control and water conservation system contains large dams and large debris basins that are both classified as "dams" by the Division of Safety of Dams (DSOD) in the State of California. The difference between the two is that dams are meant to store water, whereas debris basins are intended to capture sediment and bypass the water.  The dams that LACFCD owns and operates often have dual purposes, while the dams operated by the Corps are utilized only for flood control.  In addition to managing flood waters they also serve a water conservation purpose, where water stored behind the dams can be released at a later date and diverted into spreading grounds for groundwater recharge. Debris basins are discussed in the next subsection.  There are several major dams serving the City of Los Angeles described herein, a list of which is provided in Table 2.

**Table 2. Dams and Reservoirs in the Los Angeles County Drainage Area**

| Name | Location | Capacity (AF) | Trib. Area Area (sq. mi.) | Tributary To |
|---|---|---|---|---|
| Big Tujunga Dam and Reservoir (LACFCD) | NE of Sunland, Big Tujunga Canyon | 6240<br>(Current capacity 5025 due to sedimentation) | 82.3 | Big Tujunga Creek |
| Pacoima Dam (LACFCD) | San Gabriel Mountains, NE of San Fernado, CA in Pacoima Canyon | 6,060<br>(Current capacity 2834 due to sedimentation) | 28.2 | Pacoima Creek |
| Hansen Dam (USACE) | Lake View Terrace | 33,348-spillway crest,<br>59,299-top of dam,<br>10,500-allowance for sediment (50 yr),<br>21,000 allowance for sediment (100 yr).[1] | 150 | Tujunga Wash |
| Sepulveda Dam (USACE) | San Fernando Valley | 18,129 -top of spillway[2]<br>46,764-top of dam,<br>0-allowance for sediment. [3] | 152 | LA River |
| Lopez Dam (USACE) | Lake View Terrace | 165 -spillway crest,<br>1,606 -top of dam,<br>794 -sediment allowance (50-yr).[4] | 34 (including drainage area into Pacoima Dam) | Pacoima Wash |

[1] Based on survey Nov 2004.
[2] [crest gates raised-elevation 710 ft NGVD],
[3] Based on survey Nov 2004.
[4] Based on survey June 2010.

Big Tujunga Dam and Reservoir


**Big Tujunga Dam and Reservoir**

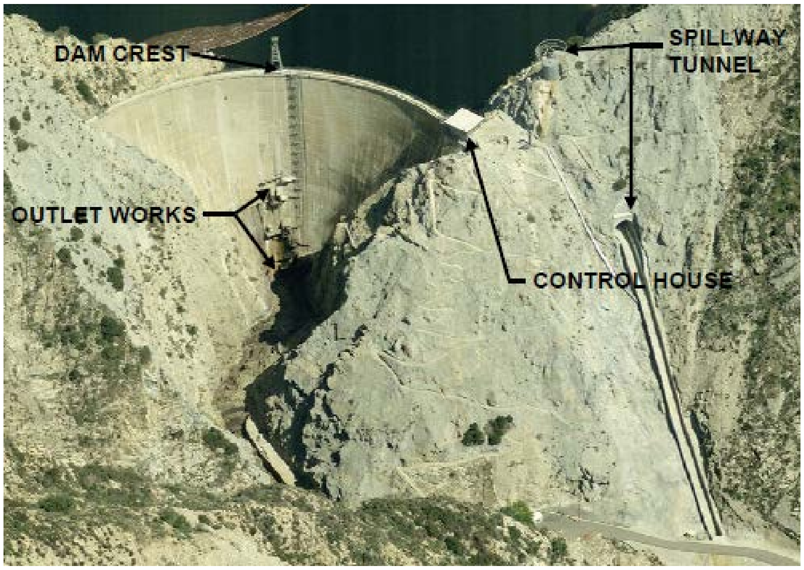
Big Tujunga Dam is a variable-radius thick-arch concrete dam with an earthfill wing wall northerly of the spillway.  It is located about 10 miles northeast of Sunland in Big Tujunga Canyon.  The dam was constructed between January 1930 to July 1931.  In 2012, a thickened buttress was added to the downstream face of the dam for seismic stability as part of a rehabilitation project.  The dam was originally designed for flood control and water conservation as part of a series of dams, but only Big Tujunga Dam No. 1 was constructed.

The reservoir has an original capacity of 6,240 AF, which is adequate for the Design Debris Event of 6,913,133 cubic yards.  The estimated storage capacity of the reservoir (per the August 2011 survey) was 5,025 AF at the spillway elevation of 2,290 feet.  The last sediment removal occurred between 1994 and 1995 when approximately 773,000 cubic yards of sediment were excavated and removed by trucks to the Maple Canyon Sediment Placement Site at the cost of $7.2 million.  The right abutment spillway capacity is 52,400 cubic feet per second (cfs).  The recent rehabilitation project provided an overtopping crest ogee spillway and modified existing abutment spillway for a combined capacity to pass DSOD's approved probable maximum precipitation (PMP) flow rate of 111,570 cfs.  The Capital Flood peak flow rate is 44,800 cfs. Water captured at Big Tujunga is recharged to the groundwater aquifer at Hansen and Tujunga Spreading Grounds.

The 2012 improvements removed a restriction on the stormwater storage capacity behind the dam.  LACFCD, in cooperation with LADWP, is currently working on a sediment removal project currently in the planning stages that can increase the water conservation capacity in this facility.

Pacoima Dam

Pacoima Dam is a constant-angle concrete-arch dam in Pacoima Canyon, located four miles northeast of San Fernando.  The original capacity at spillway is 6,060 AF and the crest height above the original streambed is 365 feet.  Dam construction began in 1925 and was completed in 1929.  The dam is founded on and abuts igneous and metamorphic rocks, which is extensively jointed and fractured, and deeply weathered on the upper walls of the canyon.



**Pacoima Dam and Reservoir**

The principal functions of Pacoima Dam are flood control, debris control, and water conservation.  Water impounded behind the dam during the storm season is gradually released and diverted into the Pacoima and Lopez Spreading Grounds to recharge groundwater. Construction activities inside the tunnel and on the spillway chute were completed in April 2004. The spillway modification consisted of enlarging the spillway tunnel to a 26-foot horseshoe tunnel.  This enlargement facilitated an increased spillway capacity of 24,700 cfs which is adequate for passing the Probable Maximum Flood (PMF) flow rate of 24,000 cfs.

The maximum debris capacity is 9.78 million cubic yards (6,060 AF), which is adequate for the Design Debris Event of 2.42 million cubic yards (1,503 AF).  The date of the last survey was September 2010, and it estimated that the remaining debris capacity was 4.72 million cubic yards (2,929 AF).  Sluicing is used for sediment removal at Pacoima Dam, of which the most recent sluicing occurred in 1983, sluicing a total of 1.07 million cubic yards of sediment.  LACFCD, in cooperation with LADWP, is currently working on a sediment removal project currently in the planning stages that can increase the water conservation capacity in this facility.

<u>Hansen Dam</u>

The Hansen Dam is located in the Lake View Terrace area of the City of Los Angeles northwest of Interstate-5 (I-5), east of State Route (SR) 118, and south of I-210.  The dam is a compacted earth-fill embankment, 10,475 feet long, with a maximum height above streambed of 97 feet.  The dam has a storage capacity of 33,348 AF at the spillway crest elevation of 1,060 feet (Nov 2004 survey) and extends in a general east-west direction at right angles to the Tujunga Wash.  The project began after the 1939 floods through a partnership with the LACFCD and the USACE under a Works Progress Administration contract to design a comprehensive flood risk management system for Los Angeles County.  The dam was completed in 1940.


**Hansen Dam**

Operation of the dam includes controlled releases up to 500 cfs until the water reaches the basin elevation of 1,010.5 feet.  Above this elevation, the dam releases are permitted up to 20,800 cfs, not to exceed the downstream capacity of Tujunga Wash or the Los Angeles River.  The water releases at or below the 1,010.5 feet elevation may be reduced to match the spreading grounds capacity of the Hansen Spreading Grounds and the Tujunga Spreading Grounds.  Little Tujunga Wash and Lopez Creek join the Big Tujunga Wash within the Hansen Dam Basin.

The USACE acquired 1,507.2 acres for construction, operations, and maintenance of the dam.  In June 1974, the USACE entered into an amended agreement that granted the City of Los Angeles 1,355.4 acres for recreational purposes.  In this area, there are a number of recreation facilities ranging from maintained open park space, a sports complex with soccer fields and baseball diamonds, two equestrian centers, parking lots, and a 10.5-acre swimming and fishing lake complex.  Most of the facilities are above the projected 100-year flood stage estimated at an elevation of 1,022.8 feet.  The lake has an unclassified infiltration rate of unknown value while the surrounding recreational areas have a moderate infiltration rate.

A concept report prepared by the City of Los Angeles, Department of Pubilc Works, Bureau of Sanitation, Watershed Protection Division published in December 2006 proposed treatment wetlands in the general vicinity of the former "Holiday Lake" located on the west side of the basin.  This concept added an estimated 10 AF per year of recharge capacity to the site.  The Hansen Dam Wetlands Restoration Project was completed and dedicated on March 2, 2012.

Discussions between the LACFCD and the USACE on operating Hansen Dam for water conservation purposes was initiated and a feasibility study was undertaken, but never finalized. This draft feasibility study identified that minor changes to the outlet facility, in conjunction with a reoperation strategy, could increase stormwater capture for recharge by up to 3,400 acre-feet per year. To date, the dam is only operated for flood control purposes.

Sepulveda Dam

**Sepulveda Dam and Basin**

Construction of the Sepulveda Dam was completed by the USACE between 1935 - December 1941 under congressional authorization as part of several Flood Control Acts.  It is an earth-filled embankment across the Los Angeles River with a reinforced concrete spillway and outlet works.  It has a crest length, including outlet works and spillway of 15,444 feet (2.93 miles), with a top-of-dam elevation of 725 feet, and a crest width of 30 feet.  The maximum height above the streambed is 57 feet.  The upstream slope is 1 vertical (V): 3 horizontal (H), and the downstream slope is 1V:4H.  The upstream slope is protected by grouted stone paving.  One flank of the dam's embankment extends southwest from the outlet works, then west alongside the Ventura Freeway (merging with the Freeway embankment for approximately 0.6 miles).  The other flank extends northeast, then north, along I-405 (San Diego Freeway) (merging with the Freeway embankment for approximately 1.1 miles).

The outlets of the dam are installed in a concrete section, 83 feet in width.  Outflow is discharged through four gated outlets, 6 feet wide by 9 feet high, and four un-gated outlets, 6 feet wide by 6.5 feet high.  All outlet entrance inverts (sometimes referred to as the gated sill) are at elevation 668 feet. Downstream of the conduit outlet portals, piers 13 feet in length provide a smooth transition to the flow from the eight conduits to the downstream channel.  Below the piers, the outflow discharges into a rectangular concrete channel, which is 83 feet wide for a distance of 294 feet, and then tapers over a 400-foot transition, to a width of 50 feet.  The channel invert, from the portal piers through the transition taper, is designed on a slope of 0.00924, which is sufficient to prevent backwater in the conduits and to ensure smooth flow through the transition for discharges up to at least 15,300 cfs.  The combined maximum capacity of the outlets is 16,500 cfs at a basin water surface elevation of 710 feet, which is the elevation of the top of the spillway gates in closed position.  The flow conveyance capacity of the Los Angeles River channel increases progressively as water flows downstream of the dam.

The spillway is a reinforced concrete ogee section of the overflow gravity type, having a gross length of 469 feet and a crest elevation of 700 feet (NGVD1929).  The spillway has seven submersible drum gates, each 57 feet long.   The water flows over the top of the drum onto the ogee section of the spillway.  The drum gates are separated by six 10-foot-wide piers, with a 5-foot-wide pier abutting each end of the spillway.  The total net spillway width over which water can pass is 399 feet.  The approach to the spillway is a gently sloping unpaved earthen ramp, rising from the approach channel to an elevation of 680 feet.

The project was designed with operable crest gates instead of a fixed spillway in order to minimize the water surface elevation of a spillway design flood, and hence minimize the height of the top of the dam, saving on both construction costs and the amount of land acquired for the basin.  The gates are set for fully automatic operations, but can also be operated in semi-automatic or emergency manual modes.  The crest gates are designed to operate automatically as the water surface elevation rises above 692.5 feet.  This operation is essential to prevent overtopping and failure of the embankment of the dam by a probable maximum flood.

The Sepulveda Dam provides flood risk management to the areas and communities adjacent to the Los Angeles River.  The control or regulation of flood runoff into the basin is governed by the 1989 Water Control Manual, which includes a description of the water control plan and provides extensive background information on the history of the project, watershed characteristics, hydrologic data collection systems, hydrologic forecasting, agency responsibilities, and coordination for water control management.

The lowest point in the Sepulveda Basin is 668 feet.  With the spillway gates in fully raised position, the water surface can rise to elevation 710 feet before spillway flow begins.  If the water surface elevation continues to rise above 712 feet, the spillway gates begin to gradually lower to pass larger flood flows.

Water control operations use the basin storage space (18,129 AF at elevation 710 feet NGVD as of 2004) in conjunction with the maximum scheduled release of 16,500 cfs to control flood inflow events to the authorized carrying capacity of the downstream Los Angeles River channel. The authorized carrying capacity of the downstream channel varies throughout flood events depending on rainfall and flood runoff downstream of the dam that use up a portion of the channel conveyance capacity.  Therefore, releases are reduced as necessary so as not to exceed the hydraulic capacity of the downstream channel.

Due to the urbanized nature of the watershed, the runoff response to rainfall is rapid with typically high peak discharges of relatively short duration.  With the intensive use of the basin for recreation and for transportation corridors (e.g., Burbank Boulevard and Woodley Avenue), inflows require that affected agencies and the public be given sufficient advance warning to minimize potential flood impacts and to ensure public safety.  The trash rack in front of the outlet facility occasionally becomes clogged from vegetative debris, and trash accumulation must be manually cleared.  The lower portion of the trash-rack has been permanently removed to prevent trash buildup that would affect the capability of the dam to make scheduled releases of flood waters.

The City of Los Angeles Bureau of Sanitation's Donald C. Water Reclamation Plant (TWRP) is located within the basin.  A floodwall surrounding the TWRP protects the plant from inundation up to the one-percent chance exceedance event which is estimated as elevation 712 feet NGVD. At higher water surface elevations, inundation of the treatment plant would result in contamination of surface waters from untreated or partially treated wastewater sewage. Continued increase of the water surface elevation will result in plant shut down and diversion of untreated sewage to the Los Angeles Hyperion Treatment Plant in Playa del Rey.

Lopez Dam

The Lopez Dam is located in the Lake View Terrace area of the City of Los Angeles northeast of I-210, in the Pacoima Wash downstream of the Pacoima Dam and Reservoir.  It is an earth-filled embankment 26

**Lopez Dam and Basin**

feet in height, built in 1954 by the USACE. The primary purpose of the facility is to attenuate large storm flows released from Pacoima Dam 2.5 miles upstream. The basin covers an area of about 47.5 acres in an alluvial plain with opportunity for groundwater recharge, with provision that the outlet is reconfigured from the present design of an uncontrolled 100-feet wide concrete spillway. The spillway marks the upstream terminus of the lined reach of Pacoima Wash.

**Debris Basins**

**Example of a Debris Basin**

Debris Basins are key components of the LACFCD's flood control system. Typically located at the mouths of canyons, debris basins not only capture sediment, gravel, boulders, and vegetative debris that are washed out of the canyons during storms, but also allow water to flow into the downstream storm drain system, thereby protecting drainage systems and communities in lower-lying watershed areas from possible flooding and property damage. The debris basin itself consists of an earth dam or other barrier constructed across a drainageway or other suitable location for collecting sediment. The dam is provided with properly designed spillways to discharge higher flows in a way that will not damage the dam or other improvements. Debris basins are of interest to the Stormwater Capture Master Plan because opportunities to retrofit these facilities may exist to augment retention for later release to downstream spreading areas.

All of the debris basins are owned and operated by the LACFCD (California Department of Fish and Game, 2010). The storage capacities provided are the maximum sediment and debris storage capacity at the time of construction (LACDPW, 2009). Storage capacities were available for all of the debris basins described herein, except for Bell Creek, Lopez Canyon, Skyridge, and Wilbur debris basins. A rough estimate of the storage capacity of Skyridge debris basin was made using Google Earth. For all others, storage capacity for these debris basins was obtained from the USACE (2009). The existing and potential storage capacity for stormwater runoff may differ from these values. The drainage area upstream of the facilities was obtained from the LACDPW website (LACDPW, 2009), except for Bell Creek, Lopez Canyon, Skyridge, and

Wilbur debris basins, which were estimated using topographic maps.  Attachment 1 shows the location of the debris basins that are discussed herein.  Table 3 is a summary of the debris basin locations, capacity, tributary area, and the tributary receiving waters.

**Table 3:  Debris Basins in the Los Angeles County Drainage Area**

| Name | **Location** | **Capacity** | **Trib. Area** | **Tributary To** |
|---|---|---|---|---|
| Aliso | Granada Hills | 26.0 AF | 2.77 sq. mi. | Aliso Creek |
| Bell Creek | West Hills | 10.5 AF | 5.58 sq. mi. | Bell Creek |
| Blanchard | La Crescenta | 46.5 AF | 0.47 sq. mi. | Arroyo Seco |
| Blue Gum | La Crescenta | 24.8 AF | 0.19 sq. mi. | Arroyo Seco |
| Cassara | Lakeview Terrace | 22.9 AF | 0.21 sq. mi. | Big Tujunga Wash |
| Cooks | Crescenta Highlands | 32.2 AF | 0.58 sq. mi. | Verdugo Wash |
| Cooks M1-A | Crescenta Highlands | 21.1 AF | 0.58 sq. mi. | Verdugo Wash |
| Denivelle | Sunland | 4.9 AF | 0.18 sq. mi. | Big Tujunga Wash |
| Dry Canyon | Calabasas | 4.9 AF | 0.49 sq. mi. | Cold Creek |
| Hog | Sylmar | 26.7 AF | 0.32 sq. mi. | Pacoima Wash |
| La Tuna Canyon | Sun Valley | 306 AF | 5.34 sq. mi. | Tujunga Wash |
| Limekiln | Northridge | 106.6 AF | 3.72 sq. mi. | Aliso Creek |
| Lopez | Pacoima | 8.1 AF | 1.50 sq. mi. | Tujunga Wash |
| May No. 1 | Sylmar | 39.7 AF | 0.70 sq. mi. | Pacoima Wash |
| May No. 2 | Sylmar | 8.1 AF | 0.09 sq. mi. | Pacoima Wash |
| Oliver | Pacoima | 19.8 AF | 0.18 sq. mi. | Big Tujunga Wash |
| Rowley | Sunland | 26.7 AF | 0.21 sq. mi. | Big Tujunga Wash |
| Rowley (upper) | Sunland | 18.0 AF | 0.31 sq. mi. | Big Tujunga Wash |
| Schoolhouse | Sylmar | 42.1 AF | 0.28 sq. mi. | Big Tujunga Wash |
| Schwartz | Pacoima | 27.9 AF | 0.25 sq. mi. | Big Tujunga Wash |
| Skyridge | Crescenta Highlands | 15-20 AF | 0.63 sq. mi. | Verdugo Wash |
| Sombrero | Sylmar | 54.5 AF | 1.06 sq. mi. | Pacoima Wash |
| Stetson | Sylmar | 25.4 AF | 0.29 sq. mi. | Pacoima Wash |
| Wilbur | Northridge | 3.1 AF | 7.76 sq. mi. | Aliso Creek |
| Wilson | Sylmar | 19.4 AF | 2.58 sq. mi. | Pacoima Wash |
| Zachau | Sunland | 29.8 AF | 0.35 sq. mi. | Big Tujunga Wash |

Aliso Debris Basin

Aliso Debris Basin is located on Aliso Creek and has a storage capacity of about 26.0 AF.  The drainage area upstream of the debris basin is about 2.77 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Bell Creek Debris Basin

Bell Creek Debris Basin is located on Bell Creek and has a storage capacity of about 10.5 AF. The drainage area upstream of the debris basin is about 5.58 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Blanchard Debris Basin

Blanchard Debris Basin is located in Blanchard Canyon and has a storage capacity of about 46.5 AF.  The drainage area upstream of the debris basin is about 0.47 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Blue Gum Debris Basin

Blue Gum Debris Basin is located in Blue Gum Canyon and has a storage capacity of about 24.8 AF.  The drainage area upstream of the debris basin is about 0.19 square miles.  Hansen and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Cassara Debris Basin

Cassara Debris Basin is located in Cassara Canyon and has a storage capacity of about 22.9 AF. The drainage area upstream of the debris basin is about 0.21 square miles.  Hansen and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Cooks Debris Basin

Cooks Debris Basin is located in Cooks Canyon and has a storage capacity of about 32.2 AF. The drainage area upstream of the debris basin is about 0.58 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Cooks M1-A Debris Basin

Cooks M1-A Debris Basin is located in Cooks Canyon and has a storage capacity of about 21.1 AF.  The drainage area upstream of the debris basin is about 0.58 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Denivelle Debris Basin

Denivelle Debris Basin is located on an unnamed stream and has a storage capacity of about 4.9 AF.  The drainage area upstream of the debris basin is about 0.18 square miles.  Hansen and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Dry Canyon-Southfork Debris Basin

Dry Canyon-Southfork Debris Basin is located on an unnamed stream and has a storage capacity of about 4.9 AF.  The drainage area upstream of the debris basin is about 0.49 square miles. There are no downstream spreading grounds that could be reached via gravity flow.

Hog Debris Basin

Hog Canyon Debris Basin is located in Hog Canyon and has a storage capacity of about 26.7 AF. The drainage area upstream of the debris basin is about 0.32 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

La Tuna Canyon Debris Basin

La Tuna Canyon Debris Basin is located in La Tuna Canyon and has a storage capacity of about 306 AF.  The drainage area upstream of the debris basin is about 5.34 square miles.  Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin. There are no existing conveyance facilities to convey water stored in the debris basin to the spreading facilities, so a gravity flow pipeline would need to be constructed.

Limekiln Debris Basin

The Limekiln Debris Basin is located in Northridge and has a storage capacity of about 106.6 AF.  The drainage area upstream of the debris basin is about 3.72 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Lopez Canyon Debris Basin

Lopez Canyon Debris Basin is located in Lopez Canyon and has a storage capacity of about 8.1 AF.  The drainage area upstream of the debris basin is about 1.50 square miles.  Lopez, Pacoima, and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

May No. 1 Debris Basin

May No. 1 Debris Basin is located in May Canyon and has a storage capacity of about 39.7 AF. The drainage area upstream of the debris basin is about 0.70 square miles.  Pacoima and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

May No. 2 Debris Basin

May No. 2 Debris Basin is located on an unnamed tributary to May Canyon and has a storage capacity of about 8.1 AF.  The drainage area upstream of the debris basin is about 0.09 square miles.  Pacoima and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Oliver Debris Basin

Oliver Debris Basin is located in Oliver Canyon and has a storage capacity of about 19.8 AF. The drainage area upstream of the debris basin is about 0.18 square miles.  Hansen and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Rowley Debris Basin

Rowley Debris Basin is located in Rowley Canyon and has a storage capacity of about 26.7 AF. The drainage area upstream of the debris basin is about 0.21 square miles.  Hansen and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Rowley (upper) Debris Basin

Rowley (upper) Debris Basin is located in Rowley Canyon and has a storage capacity of about 18.0 AF.  The drainage area upstream of the debris basin is about 0.31 square miles.  Hansen and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Schoolhouse Debris Basin

Schoolhouse Debris Basin is located in Schoolhouse Canyon and has a storage capacity of about 42.1 AF.  The drainage area upstream of the debris basin is about 0.28 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Schwartz Debris Basin

Schwartz Debris Basin is located in Schwartz Canyon and has a storage capacity of about 27.9 AF.  The drainage area upstream of the debris basin is about 0.25 square miles.  Hansen and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Skyridge Debris Basin

Skyridge Debris Basin is located on Bell Creek and its estimated storage capacity is between 15 AF and 20 AF.  The drainage area upstream of the debris basin is about 0.63 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Sombrero Debris Basin

Sombrero Debris Basin is located in Sombrero Canyon and has a storage capacity of about 54.5 AF.  The drainage area upstream of the debris basin is about 1.06 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Stetson Debris Basin

Stetson Debris Basin is located in Stetson Canyon and has a storage capacity of about 25.4 AF. The drainage area upstream of the debris basin is about 0.29 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Wilbur Debris Basin

Wilbur Debris Basin is located in Wilbur and Aliso Canyons and has a storage capacity of about 3.1 AF.  The drainage area upstream of the debris basin is about 7.76 square miles.  There are no downstream spreading grounds that could be reached via gravity flow.

Wilson Debris Basin

Wilson Debris Basin is located in Wilson Canyon and has a storage capacity of about 194 AF. The drainage area upstream of the debris basin is about 2.58 square miles. Pacoima and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

Zachau Debris Basin

Zachau Debris Basin is located in Zachau Canyon and has a storage capacity of about 29.8 AF. The drainage area upstream of the debris basin is about 0.35 square miles. Hansen and Tujunga Spreading Grounds and Branford Spreading Basin are located downstream of the debris basin.

**Channel Network**

The LACFCD and USACE storm channel system represents the major drainage infrastructure within the City and County of Los Angeles as shown in Attachment 1. More detailed maps of the storm drain networks that feed these channels are available. This storm drain and channel network conveys stormwater runoff in a manner consistent with the mission of the original charter. Many of the City's storm drains were built and are currently maintained by the LACFCD (under the umbrella of the LACDPW). Many of the major channels were built by the USACE under the Flood Control Act of 1941, and are still owned and operated by the USACE while others are operated by the LACFCD. Other drains within the system were built by the City of Los Angeles. As streams, creeks, and rivers leave the mountains and foothills, many are controlled by debris basins and dams. Others remain in their natural condition. In most cases, these natural systems are not owned or maintained by an agency until they enter a storm drain, whether it is an open channel or closed conduit. Several of the major streams/storm drains within the City of Los Angeles boundaries are discussed herein.

Aliso Creek

Aliso Creek is a major tributary of the Los Angeles River with a watershed of 21 square miles. It is the second major tributary to enter the Los Angeles River downstream of the Bell Creek/Calabasas Creek merge. The stream runs about 10 miles from Aliso Canyon below Oat Mountain to its confluence with the Los Angeles River. During its first mile, it is a free-flowing stream mostly contained within Aliso Canyon Park and Eddlestone Park. After it passes under SR 118, it empties into a retention basin and becomes a concrete flood control channel, flowing due south. Upstream of Plummer St., it merges with the Wilbur Canyon Wash, and shortly downstream merges with Limekiln Wash, both on the right bank. West of the West Valley Park, Aliso Creek makes a 90-degree bend to the east and merges with the Los Angeles River.

The maximum flow rate found for this creek is 10,000 cfs near its confluence with the Los Angeles River. The rectangular channel is 60-foot wide by 8-foot high at its wider location near the Los Angeles River confluence, with the earliest records of construction dating from 1952. At present, the channel is fully maintained by the LACFCD.

Arroyo Seco

The Arroyo Seco is a 24.9-mile-long seasonal river with a 46.7 square miles watershed. Upstream of Devil's Gate Dam, the Arroyo Seco helps to replenish the Raymond Basin aquifer, which provides about half of the local water supply to the City of Pasadena. The Arroyo Seco flows between the communities of La Cañada Flintridge on the west and Altadena on the east. Just below Devil's Gate Dam, the stream passes underneath the Foothill Freeway. At the north end of Brookside Golf Course in Pasadena, the stream becomes channelized into a flood control channel and proceeds southward through the golf course in the immediate vicinity of the Rose Bowl.

The Arroyo Seco passes under the Ventura Freeway and the Colorado Street Bridge, crossing the Raymond Fault at the southern boundary of Pasadena near the San Rafael Hills. The channel continues along the western boundary of South Pasadena, then into northeast Los Angeles, flowing southeast of the Verdugo Mountains and Mount Washington. The Arroyo Seco then proceeds through the Los Angeles neighborhoods of Highland Park, Hermon, Montecito Heights, and Cypress Park. It ends at the confluence with the Los Angeles River near Elysian Park, north of Dodger Stadium.

The creek becomes channelized at the north end of the Brookside Golf Course as a trapezoidal channel; however, it changes to a rectangular channel south of Seco Street near the 210 and 134 Freeways. The maximum flow rate found for this creek is 17,200 cfs near the confluence with Los Angeles River. The rectangular channel is 50-feet wide by 9-feet high at that location, with the earliest records of construction dating from 1934. The channel is maintained by the LACFCD.

The proposed Arroyo Seco Canyon Project, a partnership between the City of Pasadena Water and Power Department (PWP) and the Arroyo Seco Foundation, is a water resources enhancement, habitat restoration, and recreation improvement project funded by the state integrated regional water management program and PWP. The purpose of this project is to take a multi-benefit approach to increase the utilization of surface water rights held by PWP and the Lincoln Avenue Water Company (LAWC) by restoring and improving the intake facilities, modifying the existing sediment removal mechanism, naturalizing the Arroyo Seco streambed, and expanding recharge operations by creating additional spreading basins. In addition, the project includes recreational and educational amenities near the headworks structure, a new reduced size parking lot north of existing Jet Propulsion Laboratory (JPL) East Parking Lot and a public restroom south of Millard Creek along the Gabrielino Trail for those recreating in the Arroyo Seco Canyon.

The project is supplemented by a grant provided by the State of California Department of Water Resources from funds generated by Proposition 84. The funds were awarded through an Integrated Regional Water Management Program (IRWMP) Implementation Grant to the Greater Los Angeles County Region. The water supply benefits from this project are limited to the City of Pasadena and those with water rights to the Raymond Basin Aquifer.

Ballona Creek

Ballona Creek is an 8.8-mile-long waterway in southwestern Los Angeles County.  Its 130-square mile watershed drains the Los Angeles basin, from roughly the Santa Monica Mountains on the north, the Harbor Freeway (I-110) on the east, and the Baldwin Hills on the south. Ballona Creek heads into the historical Rancho Las Cienegas and flows through Culver City and the Del Rey district before emptying into Santa Monica Bay, between Marina del Rey and the Playa del Rey district.  Major tributaries to the Ballona Creek and Estuary include Centinela Creek, Sepulveda Canyon Channel, and Benedict Canyon Channel.

The creek begins near Venice Boulevard and Cochran Avenue in the City of Los Angeles and ends in Santa Monica Bay.  It is entirely channelized as rectangular box first, then transitions to a trapezoidal channel near Duquesne Avenue.  The maximum flow rate found is 28,300 cfs at the outlet where the channel is 165.5-foot wide by 21.5-foot high at that location, with the earliest records of construction dating from 1931.  The channel is maintained by the LACFCD, except for a 2-mile stretch between Washington Boulevard and La Salle Avenue in Culver City that is maintained by the USACE.

The lower reaches were historic freshwater marshlands that were dredged to create the Marina Del Rey yacht basin.  There are some remnants of the marshlands on the south side of the existing creek channel.  In addition, there are dedicated areas on the south side of the creek channel that provide for wetland areas.

Recharge opportunity is limited to several catchments in the far eastern portion of the watershed due to the confined nature of the aquifer, the highly urbanized watershed, high groundwater conditions, and seawater intrusion, however this watershed has already had several successful implementations of distributed rainwater harvesting programs.

Bell Creek

Bell Creek is a 10-mile long tributary of the Los Angeles River, located in the Simi Hills of Ventura County and the San Fernando Valley of Los Angeles County.  The stream begins in the Simi Hills in Ventura County, then flows as a creek southeast through Bell Canyon, Bell Canyon Park, and El Escorpión Park in a natural stream bed and later transitions to a concrete channel. Moore Creek joins in from the west, and then Bell Creek flows east, channelized through West Hills, where it is joined by the Bell Creek South Fork and South Branches and by Dayton Creek. The channel then passes through Canoga Park to join Calabasas Creek, and this confluence forms  the headwaters of the Los Angeles River.

The maximum flow rate found is 16,480 cfs at the confluence with Calabasas Creek.  The rectangular channel has a 60-foot wide by 17-foot height at the confluence, with the earliest records of construction dating from 1962.  The channel is fully maintained by the LACFCD.

The creek has a natural streambed of about 3,000 feet adjacent to Bell Canyon west of Valley Circle Boulevard in the County of Los Angeles, and about 1,000 feet adjacent to Highlander Road just east of the West Hills Recreation Center.

Browns Creek

Browns Creek is a 10.3-mile long tributary of the Los Angeles River in the western San Fernando Valley of Los Angeles County, California.  The stream begins as a free-flowing natural stream in the eastern Santa Susana Mountains running adjacent to Browns Canyon Road. Passing under the SR 118 Freeway, it is then encased in a concrete flood control channel and travels south through Chatsworth, Winnetka, and Canoga Park.  Browns Creek joins the Los Angeles River just west of Mason Avenue.  The channel receives flows from Santa Susana Creek just south of Parthenia Street in Canoga Park.

The maximum flow rate is 16,300 cfs near its confluence with the Los Angeles River.  The rectangular channel is 40-foot wide by 10-foot high at the confluence, with the earliest records of construction dating from 1971.  The channel walls near Winnetka were damaged in the 1994 Northridge earthquake.  The wash features a short bicycle path on its eastern bank in Chatsworth. The channel is fully maintained by the LACFCD.

The remaining free-flowing natural portion of the creek is located north of SR 118.

## Bull Creek

Bull Creek is a stream rising out of Bull Canyon in Oat Mountain. After leaving the canyon in Granada Hills, the channel transitions to an underground storm drain that parallels Balboa Boulevard. The channel turns east at Knollwood Country Club and runs along the south side of the golf course. From the country club it joins the east branch of the creek which begins above the Van Norman reservoir near the end of the Los Angeles Aqueduct. The creek runs from Granada Hills through North Hills, Van Nuys (including its airport), and Lake Balboa. South of Victory Boulevard, the river reverts to a natural stream and joins the Los Angeles River inside the Sepulveda Dam Recreation Area. This section has recently been restored under a federally-funded ecosystem restoration project, in part to protect the important riparian habitat. The channel is maintained by the LACFCD to the Victory Blvd. undercrossing where it enters the Sepulveda Flood Control Basin.

The Bull Creek channel joins the Los Angeles River in the Sepulveda Basin where the last 2,000 feet is an unlined natural channel alongside Lake Balboa and is maintained by the USACE.

## Burbank Western Channel

Burbank Western Channel (also known as Burbank Western Wash) is a 6.3-mile-long tributary of the Los Angeles River in the eastern San Fernando Valley. The stream begins at the confluence of Hansen Heights Channel and La Tuna Canyon Lateral in Sun Valley. It runs adjacent to I-5 for most of its length and is a concrete flood control channel. The stream travels southeast through the western part of Burbank, the Riverside Rancho area of Glendale, ultimately joining the Los Angeles River by the edge of the Los Angeles Equestrian Center.

The channel is completely lined and has a capacity of 28,500 cfs near the confluence with the Los Angeles River. The rectangular channel dimensions at that location are 60-feet wide by 13-feet high, with the earliest records of construction dating from 1943. The channel is maintained by the LACFCD, except for a 3,500-foot section upstream of the confluence with Los Angeles River in the City of Glendale, where this reach is maintained by the USACE.

## Caballero Creek

Caballero Creek is a tributary to the Los Angeles River. It runs from the southwest corner of El Caballero Country Club west of the Encino Reservoir in a rectangular open channel, and it crosses the country club 0.8 miles north in a concrete box. It then flows north and joins the Los Angeles River near the intersection of Victory Boulevard and Linley Avenue in the City of Los Angeles.

The channel is completely lined from end to end, except for a 700-foot reach at the southern end near the Caballero Country Club in Tarzana, California.  The maximum flow rate for this creek is 2,680 cfs near the confluence with the Los Angeles River.  The rectangular channel is 18.5-feet wide by 8-feet high at its widest location, with the earliest records of construction dating from 1960.  The channel is maintained by the LACFCD.

Calabasas Creek

Calabasas Creek is a 7.0 mile-long tributary of the Los Angeles River.  The stream begins at the confluence of Dry Canyon Creek from the Santa Monica Mountains and McCoy Canyon Creek from the Simi Hills near the Leonis Adobe in the town of Calabasas.  Calabasas Creek flows northeast through Woodland Hills and Canoga Park.  In Canoga Park, it joins Bell Creek, directly east of Canoga Park High School beside Vanowen Avenue.  The confluence marks the "headwaters" of the Los Angeles River.

Calabasas Creek is entirely encased in a concrete flood control channel.  The maximum flow rate found is 4,540 cfs near the confluence with the Los Angeles River.  The rectangular channel is 27-feet wide by 8-feet high at the confluence with Bell Creek, with the earliest records of construction dating from 1934.  The channel is maintained by the LACFCD.

Compton Creek

Compton Creek is a major tributary of the Los Angeles River in the Compton area.  The stream drains a highly-urbanized watershed of 42 square miles and is the last major tributary to enter the Los Angeles River before it reaches the Pacific Ocean.

The stream begins just east of South Main Street between 107th and 108th Streets in Los Angeles.  Compton Creek passes through Willowbrook, and has a length of 8.5 miles.  The northern, upstream portion of Compton Creek is a concrete-lined box channel, while the southern portion of the Creek is an earthen-bottom trapezoidal section with reinforced 'riprap' banks. Joined near its end by East Compton Creek, the creek ultimately empties into the Los Angeles River just south of Del Amo Boulevard.  The calculated channel capacity for this creek is 9,500 cfs near the confluence with the Los Angeles River.  The trapezoidal channel at this location is 120-feet wide at the bottom, 196-feet at top, and 13-feet high.  The earliest records of construction date from 1936.  The channel is maintained by the LACFCD, except for a 4-mile stretch from 122nd Street to just south of the 91 Freeway, which is maintained by the USACE.

The channel has an earthen-bottom from 1,200-feet north of the 91 Freeway to the Los Angeles River confluence (about 2.6 miles).  The earthen-bottom portion of Compton Creek contains remnant wetland habitat and adjoins some potential sites for constructed or treatment wetlands as well as wetland restoration and groundwater recharge.  An empty pervious 10-acre lot located adjacent to Compton Creek between Wadsworth Avenue and Central Avenue in the City of Los Angeles offers an opportunity for stormwater storage and possibly groundwater recharge.

Dayton Creek

Dayton Creek is a stream located just 4 miles from Calabasas, in Los Angeles County.  The creek starts at the foothills east of Valley Circle Boulevard along Dayton Canyon Road.  The creek is reportedly known to contain high levels of pollutants of concern.

The 2.5-mile concrete-lined channel starts near the intersection of Valley Circle Boulevard and Roscoe Boulevard.  The channel joins Chatsworth Creek from the North and Bell Creek near Sherman Way and Shoup Avenue in the City of Los Angeles.  The channel starts trapezoidal and transitions to a rectangular channel prior to the confluence with Chatsworth Creek.

The maximum flow rate found is 5,900 cfs near the confluence with Bell Creek.  The trapezoidal channel is 40-feet wide by 8-feet high at the confluence with Bell Creek, with the earliest records of construction dating from 1966.  The channel is maintained by the LACFCD.

Dominguez Channel

Dominguez Channel is a 15.7-mile stream that drains 110 square miles.  The watershed area is 96 percent developed, largely residential, and artificially bounded by a system of storm drains and flood control channels.  The channel begins just south of 116th Street in Hawthorne and travels through Gardena, Alondra Park, Torrance, Harbor Gateway, Carson, Wilmington, and empties into the East Basin of the Port of Los Angeles on the Pacific Ocean.  In addition, the Yukon Drain and Hollypark Drain join Dominguez Channel in Hawthorne and Gardena, respectively.

The maximum flow rate found for this creek is 12,825 cfs.  The trapezoidal channel is 150-feet wide by 10-feet high near the south channel end, with the earliest records of construction dating from 1930.  The channel is maintained by LACFCD.

The channel transitions to a trapezoidal section and earthen-bottom at Vermont Avenue in Gardena and remains an earthen-bottom channel for the remaining 8 miles.  A natural channel roughly 900-feet long connects from the north along Vermont Avenue.

East Canyon Channel

East Canyon Channel is a 3-mile-long tributary of Pacoima Wash that drains to Tujunga Wash in the San Fernando Valley. The channel starts at the confluence of Sylmar and Stetson Canyon just north of San Fernando Road in Sylmar and ends at its confluence with the Pacoima Wash just south of the 118 Freeway in the City of Los Angeles.

The stream alternates between open rectangular channel and reinforced concrete box at several locations. The maximum flow rate is 6,000 cfs at its confluence with the Pacoima Wash. The channel is 18-feet wide by 12-feet high at that location, with the earliest records of construction dating from 1968. The channel is maintained by LACFCD.

Los Angeles River

The Los Angeles River is considered to begin at the confluence of Bell Creek and Calabasas Creek in the Canoga Park section of the City of Los Angeles, just east of California SR 27. The river flows east to Browns Creek, then bends slightly south to its confluence with Aliso Creek. The river then flows through Winnetka and Reseda before entering the Sepulveda Basin formed by the Sepulveda Dam.

After exiting the normally dry reservoir, it crosses under Balboa Boulevard and through the outlet works of Sepulveda Dam. It then crosses under I-405 and passes through Van Nuys, Sherman Oaks, and Studio City. Then the river veers southeast and confluences with Tujunga Wash. The river then rounds a bend to the northeast and crosses under SR 170 and Highway 101 in a concrete box culvert before its confluence with Burbank Western Channel.

The river then parallels California SR 134 through North Hollywood and Burbank, crosses under I-5 and makes a sharp bend to the south-southeast as it curves around Griffith Park. It then confluences with Verdugo Wash and crosses under SR 134. The river transitions to an earthen-bottom channel near Griffith Park. Downstream of the park it enters another concrete section. It passes Silver Lake Reservoir to the west, and crosses under California SR 2, 32 miles from the mouth.

Making two meanders as it flows in a southeasterly direction, the river parallels the interstate and Riverside Drive then crosses under the interstate and California SR 110 as it flows east of Elysian Park. It then confluences with the Arroyo Seco, another major tributary, from the east. The river flows south past the Los Angeles State Historic Park to the west, and the Piggyback Yard (the Mission Yard), a large railroad yard, to the east. It enters a wider concrete channel and crosses under Cesar Chavez Avenue, Highway 101, and I-10 as it passes east of downtown Los

Angeles, flowing past the East Los Angeles Interchange for Highway 101, California SR 60, and Interstates 5 and 10 on the east.  It then makes a gradual turn east and then turns southeast, flowing a few miles before it begins to parallel I-710 near Maywood, Bell, Cudahy, and Commerce.

Paralleling I-710 south-southwest, the river then crosses under former California SR 42 and the interstate as it confluences with the Rio Hondo.  The Rio Hondo now serves as a distributary for the San Gabriel River from the east via the Whittier Narrows Reservoir.  The river then crosses under I-105 and shifts slightly southwest, then flows east of Compton and west of Bellflower. After crossing under California SR 91, it receives Compton Creek from the west, 2.7 miles from the mouth.  After crossing under I-405 for the second time, 2 miles from the mouth, it draws close to the Dominguez Channel to the west and flows south to its outlet in Long Beach, under I-710, past the RMS Queen Mary, and into the Port of Long Beach.

The maximum flow rate at the outlet is 183,000 cfs.  The trapezoidal channel is 370-feet wide at top by 15-feet high near the outlet at the Pacific Ocean.  The earliest records of formal construction date from 1930.  The channelization of the river was carried out by the USACE between 1938 and 1960.  The Los Angeles River is now maintained by the LACFCD, except between Southern Avenue in South Gate and Lankershim Boulevard in North Hollywood, and through the Sepulveda Flood Control Basin in the San Fernando Valley where it is maintained by the USACE.

Only three portions of the channel bottom remain unpaved:

- Through the Sepulveda Flood Control Basin in the San Fernando Valley (3 miles),
- Near Griffith Park through Elysian Valley where groundwater levels prevent it from being paved (2.5 miles), and
- At the River estuary in Long Beach where the River empties into the Pacific Ocean, south of Willow Street (3 miles).

Multiple opportunities may exist on the Los Angeles River for stormwater capture, and the major in-stream area that provides significant opportunity for is the area behind Sepulveda Dam. However, the dry reservoir bed provides a regional recreation area that may be difficult to replace.

Pacoima Wash

Pacoima Wash is a 33-mile long tributary of Tujunga Wash, in the San Fernando Valley of Los Angeles County. The wash begins at Pacoima Dam Reservoir proceeds south as a natural channel along Pacoima Trail Road. Pacoima Wash confluences with several other unnamed streams before entering the Lopez Dam reservoir area. South of Lopez Dam, Pacoima Wash is a concrete flood control channel that travels south from Kagel Canyon in Sylmar though San Fernando, Pacoima, Mission Hills, Panorama City, and Van Nuys.

Just after the junction of I-5 and the 118 Freeway, the stream flows to the Pacoima Spreading Grounds with a diversion towards the Tujunga Wash known as the Pacoima Diversion Channel. From the spreading grounds to Plummer Street, the channel is buried as an 81-inch reinforced concrete pipe (RCP) that transitions to 84-inch RCP. From Plummer to Parthenia Street, the channel is a trapezoidal concrete lined channel varying in width from 12-feet to 29-feet. From Parthenia Street to Raymer Street, the channel becomes an earthen-bottom trapezoidal channel varying in width from 48 feet to 60 feet with concrete lined banks. The design discharge in this reach varies from 835 to 4,460 cfs.

The design capacity for the Pacoima Wash is 9,999 cfs prior to the diversion. The channel dimensions at that location are: 91.5-feet wide at the top, 60-feet wide at the bottom, and 9-feet high. The wash is entirely contained in a trapezoidal channel. The earliest records of construction date back to the 1931. The channelization of the river was carried out by the USACE, but Pacoima Wash is now maintained by the LACFCD.

Pacoima Diversion Channel

The Pacoima Wash is diverted towards the Tujunga Wash via the Pacoima Diversion Channel. The diversion channel is a 3-mile long tributary of the Tujunga Wash. The trapezoidal diversion channel begins just after the junction of I-5 and the 118 Freeway and travels southeast through Pacoima and Arleta to join Tujunga Wash in Sun Valley. The trapezoidal channel transitions to a rectangular channel at Wentworth Street in Pacoima prior the confluence with Tujunga Wash.

The calculated capacity of the channel for this segment is 25,230 cfs near the confluence with Tujunga Wash. The channel dimensions at that location are: 55-feet wide by 13.5-feet high. The earliest records of construction date back to the 1953. The channelization of the wash was carried out by USACE, and the diversion is now maintained by the LACFCD.

Tujunga Wash

Tujunga Wash Channel is a 13.0-mile-long stream tributary to the Los Angeles River. It provides approximately one fifth of the Los Angeles River flow and drains 225 square miles. The channel is usually dry, especially the lower reaches, only carrying significant flows during and after storms.

Tujunga Wash consists of two forks, both beginning in the San Gabriel Mountains. The upper portion of Big Tujunga Wash is called Tujunga Creek, or Big Tujunga Creek. It travels roughly east to west, and several tributaries from the north and south join it as it flows to Big Tujunga Reservoir, formed by Big Tujunga Dam. Below the dam, the stream is called Big Tujunga Wash. It continues its westward flow, enters the San Fernando Valley and is met by Little Tujunga Wash a mile before reaching Hansen Dam and Reservoir. Little Tujunga Wash comes from the north, draining the portion of the San Gabriel Mountains immediately north of Hansen Reservoir. Downstream of the dam, Tujunga Wash flows south past the Hansen and Tujunga Spreading Grounds and is met halfway to its confluence with the Los Angeles River by the Pacoima Diversion Channel, and finally meets the Los Angeles River near Studio City.

The wash is a rectangular concrete channel from Hansen Dam in Sun Valley to its confluence with Los Angeles River in Studio City.

The calculated capacity of the channel, prior to the confluence with Los Angeles River, is 30,530 cfs. The channel dimensions at that location are: 70-feet wide by 14-feet high. The earliest records of construction date back to 1929. However, major improvements were made during the 1950's. The channelization of the wash was carried out by the USACE, and the wash is now maintained by LACFCD.

Verdugo Wash

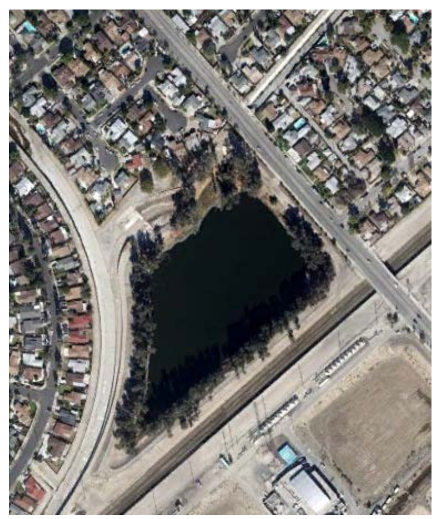
The Verdugo Wash is a 9.0-mile-long stream tributary to the Los Angeles River. The stream begins just south of I-210 in the La Crescenta Valley. It flows southeast along the eastern edge of the Verdugo Mountains, then south through a pass between the mountains and the San Rafael Hills, and then west joining the Los Angeles River just northeast of Griffith Park. Its entire path is located within the city of Glendale. With the exception of the free-flowing stream inside the Verdugo Wash Debris Basin Dam, Verdugo Wash is entirely encased in a concrete flood control channel.

The estimated capacity of the channel is 11,700 cfs prior to the confluence with the Los Angeles River. The typical channel dimensions are 43-feet wide by 13-feet high. At the confluence with the Los Angeles River, there is an earthen-bottom transition section about 850 feet long by 225 feet wide.  The earliest records of construction date back to the 1935 with updates in 1968.  The USACE channelized the wash, which is now maintained by LACFCD.

**Spreading Grounds/Water Conservation Facilities**

Water conservation facilities are typically adjacent to river channels and in earthen-bottom channels that permit water to percolate into groundwater for future groundwater pumping and augmentation of domestic water supplies.  These facilities are located in areas where the underlying soils are composed of permeable sediments that are hydraulically connected to the underlying aquifers.  The various types of water conserved include: local, imported, and reclaimed water.  Local water is primarily runoff due to rainfall on the mountain and valley watersheds, dam releases, and rising water within the watershed.  Imported water is water originating outside the watershed from Northern California or the Colorado River.  Reclaimed water is the effluent produced by waste water reclamation plants.  While space constaints limit the possibility of new centralized water conservation facilities, there are opportunities to retrofit existing facilities to increase their capacity to recharge groundwater basins.

<u>Branford Spreading Basin</u>



**Branford Spreading Basin**

The Branford Spreading Basin is an in-stream spreading facility located southwesterly of Arleta Avenue in the Sun Valley area of the City of Los Angeles.  Constructed in 1956 upstream of the confluence of the Tujunga Wash and Pacoima Diversion Channel, it receives uncontrolled flows from the Branford Street Drain, Bond Issue Project 107.  It is a single deep basin about 20-feet deep with a wetted surface of 7 acres and storage capacity of 137 AF.  The Branford Street Drain is a lined trapezoidal channel about 7,500-feet long up to San Fernando Road, where it becomes an underground storm drain receiving tributary runoff from the area south and west of the Hansen Dam and Tujunga Wash and east of SR 118.  The channel design capacity and the basin intake capacity is 1,540 cfs.  The percolation rate is estimated at 1 cfs, which results in approximately 1,000 AF of recharge per year.  The Branford Spreading Basin is located west of the Tujunga Spreading Grounds, which are located on the east side of the Tujunga Wash.

The Branford Spreading Basin is owned and operated by the LACFCD. A proposed upgrade to the Basin may install new pumps to drain the basin and transfer water to the Tujunga Spreading Grounds. This will also provide access to the basin invert to remove fine silts and maintain or improve operational capacity. Expected additional recharge potential is approximately 500 AF per year.

Lopez Spreading Grounds


**Lopez Spreading Grounds**

The Lopez Spreading Grounds are located in the Lake View Terrace area of the City of Los Angeles northeast of I-210 and west of Lopez Canyon Road. Constructed in 1956 by the LACFCD, it consists of 6 shallow basins with a wetted area of 12 acres. It receives controlled flows from Pacoima Dam and the Lopez Flood Control Basin immediately upstream of the spreading ground. The storage capacity is 24 AF with an intake capacity of 25 cfs. The percolation rate is estimated at 15 cfs. This historic annual conservation at Lopez has been approximately 600 acre-feet per year.

Proposed improvements, with the LACFCD as the lead agency, will be to improve the intake and distribution system and deepen the existing basins to create an additional 750 AF per year of recharge capacity.

Hansen Spreading Grounds


**Hansen Spreading Grounds**

Hansen Spreading Grounds were developed by the LACFCD. The grounds consisted of 20 basins covering 105 acres with an intake capacity of 400 cfs and a storage capacity of 279 AF. Flows are diverted from Tujunga Wash below Hansen Dam into the spreading grounds.

Hansen Spreading Grounds were recently improved under a joint agreement between LACFCD and LADWP. The 20 basins were deepened and combined to form 6 large basins. The project increased the storage to a total storage of 1,406 AF with an intake capacity of 600 cfs.

The latest configuration has been in operation since 2010.

Pacoima Spreading Grounds

The Pacoima Spreading Grounds comprise 169 acres and consist of a 12-basin shallow facility that can store 530 AF.  The facility is one of the major water conservation facilities that recharge the San Fernando Basin. The grounds receive controlled flows from Pacoima Dam, partially controlled flow from Lopez Flood Control Basin, and uncontrolled flow from East Canyon and Pacoima Wash. Water is diverted from Pacoima Wash into the spreading grounds through a radial gate, and the water is distributed through an intake channel to the spreading basins. This facility is operated by the LACFCD.  The average annual recharge capacity is 6,453 AF.

**Pacoima Spreading Grounds**

The facility's percolation is limited due to clay-rich lenses with low permeability that underlie the recharge area.  The intake to the spreading grounds is limited to 600 cfs.  Flows exceeding this limit cause flooding on Arleta Street.  Channel flows frequently exceed the 1,700 cfs radial gate operating capacity. When this occurs, diversion to the spreading grounds is suspended and flows are channeled to Tujunga Wash.  Additional maintenance and operational difficulties exist at the facility.  The LACFCD is considering improvement alternatives.

Tujunga Spreading Grounds

The Tujunga Spreading Grounds is a 150-acre spread facility owned by the LADWP and operated by the LACFCD.  The grounds are located at the confluence of the Tujunga and Pacoima Wash Channels.  The unique location allows the Tujunga Spreading Grounds to be managed in conjunction with LACFCD's other facilities along both waterways.  The site is utilized for recharging the San Fernando Basin.  The spreading grounds currently consist of 20 shallow basins with a rubber dam used to divert water into the facility.

**Tujunga Spreading Grounds**

LADWP and the LACFCD are cooperatively working to enhance the Tujunga Spreading Grounds. Enhancements include deepening and consolidating the existing basins into 9 large spreading basins, installing two high flow intakes with 60-foot inflatable rubber dams, and modifying the existing intake to improve water quality and remove sediments. Other equipment to be installed includes control houses, slide gates and spillways, and a remote control telemetry system. The project plan incorporates community access and open space for passive recreation, limited to operational constraints. The City of Los Angeles will maintain the open space attributes of the project, and the LACFCD will continue to operate the recharge facilities.

The project will increase storage capacity to 790 AF from its current level of 100 AF and increase the intake capacity from 250 cfs to 450 cfs. The recharge volume will double from 8,000 to an estimated 16,000 AF per year.

## DISTRIBUTED STORMWATER CAPTURE

While centralized stormwater capture plays a key role in groundwater recharge in the City of Los Angeles, space constraints limit opportunities for new facilities and have changed the focus towards distributed stormwater capture. Distributed stormwater capture includes stormwater management Best Management Practices (BMPs) that utilize vegetation, soils, and natural processes to manage stormwater runoff close to the source. Distributed facilities can be placed throughout the City on any landscape, including parks, public and private development, public infrastructure and rights of way, and entire residential blocks, and can therefore be installed within the highly developed landscape of Los Angeles. Table 4 provides a summary of distributed stormwater capture practices that are applicable to a variety of land use types. These facilities can also be scaled to maximize stormwater capture given the available space.

In addition to being more versatile in their applicability, distributed facilities are garnering support from a wide range of organizations because of the multitude of benefits they can provide. In addition to augmenting groundwater supplies, distributed facilities can provide wildlife habitat, flood protection, cleaner air, cleaner water, and recreation opportunities. They can also provide water conservation by providing a source of irrigation water and reduced irrigation demand through native plantings. The multi-benefit nature of these projects facilitates funding by incentivizing multiple agencies to share construction and maintenance costs and increasing grant opportunities.

The political landscape is also encouraging the development of distributed stormwater capture. The City of Los Angeles and Los Angeles County both have Low Impact Development (LID) Ordinances which mandate the inclusion of distributed projects in new development and significant redevelopment projects. The new Los Angeles County MS4 Permit also calls for increased local stormwater capture through LID and regional infiltration projects. The City of Los Angeles further encourages distributed stormwater capture projects through existing incentive programs.

**Table 4. Distributed Stormwater Capture Practices Applicable to Los Angeles (EPA, 2013)**

| | |
|---|---|
| ***Vegetated Distributed Stormwater Capture Practices*** | |
| Bioretention cells/rain gardens | Shallow, vegetated, depressed landscape areas that collect, treat, and absorb stormwater runoff from rooftop, sidewalk, and street surfaces. Also known as rain gardens, bioretention cells mimic natural hydrology by infiltrating and evaporating stormwater runoff close to the source. |
| Bioretention swales | Similar to bioretention cells, but generally configured as long, linear swales, as opposed to closed cells (or potholes). |
| Infiltration basins, swales, and trenches | Generally larger at their widest surface point than they are deep, and they do not contain any perforated pipes or drain tiles to distribute and/or facilitate infiltration. |
| Downspout disconnection to pervious areas | Re-routing of rooftop drain pipes (or gutter downspouts) to permeable areas, allowing stormwater runoff to infiltrate into on-site soils and promote groundwater recharge. |
| Planter boxes (with infiltration) | Urban bioretention cells, or rain gardens, with vertical walls and open bottoms that collect and absorb stormwater runoff from sidewalks, parking lots, and streets. Typically used in dense urban areas and as a “streetscaping” element. |
| ***Non-vegetated Distributed Stormwater Capture Practices*** | |
| Rainwater capture | Re-routing of rooftop drainage pipes to rain barrels, cisterns, and underground vaults for storage and reuse. |
| Permeable pavement | Paved surfaces that infiltrate, treat, and/or store rainwater where it falls. May be constructed from pervious concrete, porous asphalt, permeable interlocking pavers, and other materials. |
| Dry wells, including underground infiltration facilities/galleries and injection wells | A well or injection well is a bored, drilled or driven shaft, or a dug hole, whose depth is greater than its largest surface dimension; an improved sinkhole; or a subsurface fluid distribution system used to discharge fluids underground.<br><br>A dry well is a well, other than an improved sinkhole or subsurface fluid distribution system, completely above the water table so that its bottom and sides are typically dry except when receiving fluids. |

The City of Los Angeles possesses a mix of both existing and proposed distributed facilities for stormwater capture and treatment. Because these projects are by definition small and distributed throughout the City, it would be impractical to discuss each existing and proposed distributed facility in this document, but some key examples are discussed below. Additionally, while any given project may be limited in scope or impact, the intention for many of these projects was to serve as pilot project which could later be implemented throughout the City and thus have a significant collective impact.

Many of these examples are part of the Sun Valley Watershed Plan which exemplifies the potential of distributed stormwater capture by applying it at a range of scales throughout the watershed to provide an integrated network of stormwater capture. Incentive programs to promote the implementation of these projects (both local and non-local) are also discussed in this section.

**Existing**

The existing distributed facilities that warrant specific discussion for their relevance to the wider context of stormwater capture in the City of Los Angeles are:

1. The Riverdale Avenue Green Street Demonstration Project
2. The Elmer Avenue Neighborhood Retrofit Project
3. The Woodman Avenue Green Infrastructure Project
4. The BMPs installed at 1100 S. Hope St
5. The Garvanza Park Stormwater BMP Project
6. The Sun Valley Park Drain and Infiltration System Project
7. The Tuxford Green Project
8. The North Hollywood Alleys

These facilities inform the larger context of stormwater capture in Los Angeles by:

- Providing standard plans for design and construction,
- Demonstrating flood control potential and evaluating the performance of distributed facilities,
- Showcasing the adoption of BMPs by private developers, and
- Demonstrating the successful repurposing of public space to include stormwater capture.

## Standard Plan for Stormwater Capture

**Riverdale Avenue Green Street Project**

Riverdale Avenue Green Street Project (Riverdale) is a green street located adjacent to the Los Angeles River at Riverdale Avenue and Crystal Street, in Elysian Valley, Los Angeles.  The street was completed in September, 2010, at cost of $620,000.  Riverdale's primary function is to capture, divert, and infiltrate stormwater and dry weather runoff from a 14-acre drainage area that previously flowed into the Los Angeles River.  Riverdale achieves this purpose through the use of curb cuts, vegetated stormwater curb extensions, bioswales, native vegetation, filtration sumps, and an infiltration gallery.  In addition, the project provides benefits to water quality, open space, habitat, attenuation of peak flow, improved pedestrian access, educational opportunities, reduction of urban heat-island effect, and improved neighborhood aesthetics.

Although similar green street projects exist within the City of Los Angeles, such as the nearby Oros Green Street Project, Riverdale is unique as it showcases the City of Los Angeles' adopted standard plan for green street construction, engineering, and design.  These plans are available for use by Los Angeles city staff, private developers, and other municipalities, and it is the City's stated intention that the plan *"is intended for repetitive use on all projects."*  Use of the standard plan within the City of Los Angeles will expedite plan checks and reduce permit fees.

As such, Riverdale provides an example for residential stormwater capture projects in the City, and through reduced permit fees, preapproval, and expedited review, provides incentives for their adoption on a larger scale.

## Flood Control and Evaluating the Performance of Distributed Facilities

The Elmer Avenue Neighborhood Retrofit Project (Elmer) is a neighborhood green street/alley project located in the Sun Valley neighborhood of the City of Los Angeles.  The project was constructed in three phases, the first of which saw the retrofit and installation of BMPs under the street, in the public right of way, and on participating private homes along a single residential block.  This phase was completed in May 2010 at a cost of $1,300,000.  The second phase saw the completion of a green alleyway, which

**Elmer Avenue Neighborhood Retrofit Project**

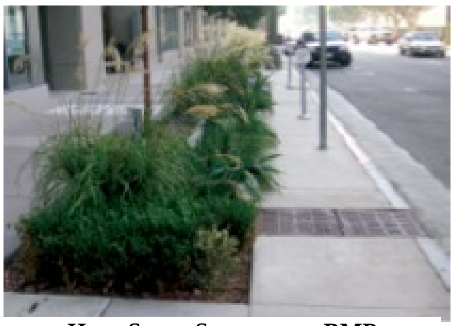
was completed in July of 2013 for $625,000.  The third phase was completed in summer of 2013, and includes enhancements to manage suspended solids, and an increased stormwater capture capacity.  The project provides groundwater recharge to the San Fernando Basin, draining a 60-acre urban catchment within the Los Angeles River watershed, and infiltrating approximately 40 AF of stormwater per year. The individual BMP components of this distributed facility include an infiltration basin, filtration sumps, bioswales, native vegetation, permeable pavements, rain barrels, and native landscaping enhancements on participating resident property.

Through the integrated implementation of BMPs, Elmer has provided substantial flood control benefits for the surrounding streets.  Prior to construction the street had no storm drains and suffered considerable flooding during rain events.  Since completion of phase 1 of the project in 2010, there have been no flooding incidents, providing preliminary evidence that flood issues have successfully been mitigated without the use of traditional single purpose storm drain construction.  Furthermore, Elmer has been the site of performance monitoring and evaluation since the completion of phase 1 of the project.  Data collected has informed the feasibility and appropriateness of distributed systems, with preliminary results showing that bioswales do not uptake dangerous levels of contaminants, that significant amounts of stormwater are being infiltrated into the ground, that adjustments to norms of street maintenance are needed, and that residential receptiveness to the project is overwhelmingly positive.

Taken together, the Elmer projects demonstrate that important benefits, such as flood control, can be achieved through the integrated use of BMPs at a distributed facility, providing multiple benefits as opposed to traditional single purpose systems.  In addition, monitoring and evaluation at Elmer shows that the conceptualized benefits of distributed stormwater capture have values that are observable and quantifiable, without significant evidence of unintended consequences, such as contaminant accumulation or resident apathy.  For long-term project success, however, new stewardship practices will have to be developed, and adopted by both residents and those providing general city services.

The Woodman Avenue Green Infrastructure Project is a partnership between the LADWP and the LAC-BOS & Street Services using approximately $1.6 million from State Proposition 50 funds, $1 million from the LADWP, and another $750,000 from the LAC-BOS for a project to replace street hardscape with natural landscape and improving on ecosystem function.  This project replaced a 3/4-mile long concrete median along Woodman Avenue in Panorama City with a naturalized swale that potentially captures 1.5 million gallons of runoff (in an average storm event) from the surrounding 135 acre tributary area and infiltrates it into the groundwater rather than direct it into the nearby Tujunga Wash.  It creates a enjoyable streetscape with pedestrian walkways, will plant 175 new trees and 27,000 square feet of native and drought tolerant plants and shrubs.  Scheduled completion is December 2013.

Adoption of Best Management Practices by Private Developers



**Hope Street Stormwater BMP**

The BMPs installed at 1100 South Hope Street (Hope St.) represent a distributed system of stormwater management strategies implemented by private development.  Hope St. is a site of luxury condos three blocks east of the Staples Center, in downtown Los Angeles.  The BMPs at the site are in the public right of way between the side walk and the curb, and consist of curb cuts, bioswales, tree wells, and native vegetation.  The project provides benefits to water savings, water quality, and improved pedestrian amenities.

The developers of Hope St. successfully sought approval, and subsequently incorporated wider sidewalks and street trees into the condo project where widening of the street was originally required.  In this way, upon incentivization from the City of Los Angeles, private developers successfully incorporated a distributed stormwater management system into their overall project.  This demonstrates that with the appropriate enticement, private development can be an important participant in the expansion of distributed facilities for stormwater management.

Repurposing of Public Space

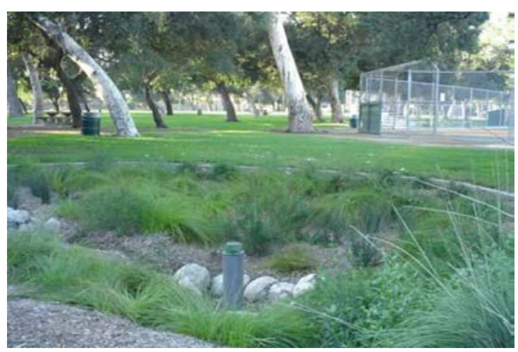
Garvanza Park Stormwater BMP

The Garvanza Park Stormwater BMP Project (Garvanza Park) is located in the Highland Park neighborhood of Los Angeles. Garvanza Park sits at the base of an 85-acre subwatershed to the Arroyo Seco, where water from the surrounding storm drains is diverted to an underground retention facility, installed beneath the park. The underground system includes a continuous deflective separation unit for pretreatment, a settling basin, a direct use retention chamber, and an infiltration basin. Above groundwater efficient landscaping and irrigation have been installed. The project was completed in March of 2012 for a price of $3.8 to $5 million dollars.

Garvanza Park treats an estimated 50 AF/year, of which one half is retained onsite to irrigate the five acres of park landscape. In addition to the water treatment and filtration benefits, Garvanza Park also provides flood control, water quality benefits, community open space, aesthetics, habitat benefits, educational opportunities, reducing heat island effect, and park fitness amenities.

Garvanza Park's BMPs demonstrate the successful repurposing of a public space to incorporate distributed stormwater management. In the appropriate location and context, further parks and open space facilities can be contribute to increased stormwater management without loss of public space or a reduction of park amenities.

The Sun Valley Park Drain and Infiltration System Project is identified as a major component of the Sun Valley Watershed Management Plan, a plan developed by the Los Angeles County Flood Control District to solve the major flooding problem, while retaining all stormwater runoff from the watershed, increasing water conservation, recreational opportunities, and wildlife habitat, and reducing stormwater pollution.



**Sun Valley Park Project**

The Project converted an existing municipal park into a flood mitigation, water quality treatment, and water conservation multi-use site.  Runoff from the 21-acre tributary drainage area is conveyed to the Sun Valley Park and routed through a water quality treatment system to remove suspended solids and heavy metals.  The treated runoff is directed into two underground infiltration basins for recharge into the groundwater aquifer.  The water conservation benefit is estimated to be 30 acre-feet annually.  The infiltration basins are buried beneath athletic fields maintaining the park's functionality.  Native California, drought tolerant plants are placed throughout the park to treat runoff from surrounding areas.  Construction was completed in 2006 at a total project cost of about $7 million.  Funding was provided by the Local Groundwater Assistance grant, Proposition 12 grant from the TreePeople, and the LACFCD.

The Tuxford-Green project would decrease flooding at the Tuxford Street and San Fernando Road intersection. This project is particularly significant in that flooding at this intersection has been a chronic problem in the community for many years. The Phase 1 project would mitigate this flooding problem. The Phase 1 site would improve stormwater quality through the use of large-scale stormwater separation devices that remove trash, debris, oil and grease, and suspended pollutants. The project would also provide irrigation supply to proposed landscaping improvements at the intersection. The project was proposed in two phases. Phase 1 focused on the flooding problem at the intersection itself. Phase 2 worked to eliminate flooding upstream in San Fernando Road and Tuxford Street by installing collector drains in each street upstream of the intersection and included improved conveyance under the intersection as well as an underground cistern.

**Incentive Programs**

The City has a history of successfully implementing municipal programs to incentivize distributed stormwater capture.  Four such local programs were reviewed. Addistionally, three non-local programs were reviewed. Although the locale and climate associated with these programs is unique, a review of these programs provides useful information that is applicable to the City.  The following is a list of programs reviewed herein:

- Los Angeles Rainwater Harvesting Program
- City of Los Angeles, Proposition O
- Los Angeles Rain Gardens Program
- LADWP Residential Water Conservation Rebate Program
- Seattle Public Utilities (SPU) RainWise Residential Program

- Portland Bureau of Environmental Services Grey to Green Initiative
- Philadelphia Water Department Stormwater Management Incentive Program

In addition to the above stormwater programs, California's solar power programs may provide insights on incentive program frameworks that have been successfully applied throughout the State.

City of Los Angeles Rainwater Harvesting Program

The City's Rainwater Harvesting Program (LA, 2009) defines rainwater harvest, a term synonymous with stormwater capture, as:

> *"…the process of intercepting rainwater from a roof (or other surface) and putting it to beneficial use... homeowners gain an extra water supply while simultaneously reducing the pressure on our limited water supplies."*

This program provides guidance and technical information on disconnecting downspouts and installing rain barrels and rain gardens on private residential properties.  The multiple benefits of this program (LA, 2013a) are compatible with the goals of the SCMP:

- Protect bays and oceans – By capturing rainwater that falls on roofs, landowners help reduce the amount of runoff flowing into local rivers and creeks and ultimately into the Pacific Ocean, thereby improving the quality of local waterways.
- Reduce energy demands - Water-related energy consumption in California accounts for nearly 20% of the state's electricity.  One inch of rain falling on 1,000 square feet of rooftop produces more than 600 gallons of water.  If every homeowner replaced this amount of potable water with captured rain water, energy consumption in California would be reduced.
- Practice water conservation - California is a state with ongoing water supply challenges. Using rainwater helps conserve drinking water supplies.
- Recharge underground aquifers - Forty percent of Southern California's drinking water comes from groundwater supplies on average.  Harvesting rain water and allowing it to infiltrate into the ground within forebay zones and where the unconfined aquifers are used for water supply replenishes water supply aquifers.

Given that landscape irrigation demand is lowest in the winter months when storms occur and highest in the summer months after storms have not occurred for several weeks or months, the amount of potable water demand reduction that rain barrels provide may be limited when compared to the amount of imported water demand that can be reduced by recharging aquifers with locally captured stormwater.

Proposition O

Proposition O was passed in Los Angeles in 2004. This program made available $500 million for projects that would help meet Federal Clean Water Act requirements or protect water quality, provide flood protection, and increase water conservation, habitat protection, and open space. Eligible projects include those that fall into the following categories:

- River, Lakes, Beaches, Bays, and Ocean Water Quality Protection Projects;
- Water Conservation, Drinking Water, and Source Protection Projects;
- Flood Water Reduction, River and Neighborhood Parks that Prevent Polluted Runoff and Improve Water Quality Projects;
- Stormwater Capture, Clean-up, and Re-Use Projects

Some of the projects funded by Proposition O include Echo Park Lake, Westchester Stormwater BMPs, Machado Lake Ecosystem Rehabilitation Project and Wilmington Drain Multi-Use Project, Penmar Water Quality Improvement Project, and the South Los Angeles Wetland Park.

Los Angeles Rain Gardens Program

The Los Angeles Rain Gardens program was launched in the summer of 2011, developed as a pilot program by the LADWP, TreePeople, and Generation Water to develop the service model for installations of rain gardens across the City.  The program boundaries were originally in the northeast San Fernando Valley, based predominantly on infiltration feasibility.  However, the program has since expanded to include many communities in the San Fernando Valley foothills south of the 101 and the Western San Fernando Valley, where broad interest for rain gardens was already in place.

The program offers rebates up to $500 per rain garden, with a maximum of $1,000 per home for up to two rain gardens.  To be eligible for a rebate, the rain garden must manage stormwater runoff from at least a 500-square feet of catchment area (with some exceptions allowed), the roof must have existing gutters, and siting feasibility requirements must be met (Yoshida, 2013).

Program interest has been distributed broadly around the region.  The top neighborhoods for applicants have been Van Nuys, North Hollywood, Sylmar, and Granada Hills.  To date, the program has been able to convert approximately 27% of interested leads into completed rain gardens, with a total of 164 installs completed to date (LA, 2013b).

LADWP Residential Water Rebate Program for Homes and Businesses

LADWP re-launched its water conservation rebate program for homes and businesses in July, 2012, offering rebates on numerous water-saving incentives to encourage conservation of municipal water.  Under this program, residents who replace water-thirsty lawns with California Friendly Landscape are eligible for rebates up to $2.00 per square foot, for a maximum of up to $4,000 per project.  This rebate amount increased from $1.50/ per square foot in April, and is offered for a limited time (LADWP, 2013).

Customers' plans must be pre-approved by the LADWP prior to installation, and evidence of installation must be provided after the landscaping is replaced to receive the rebate.  LADWP's Water Conservation Division staff conduct pre-and post-audits of all applicant's landscapes.  The LADWP (2009) estimates that:

> *"…with 30-40% of water use occurring outdoors, replacing traditional lawns with drought tolerant varieties presents a viable option for significant water savings throughout the city. One square foot of traditional lawn needs approximately 50 inches of water per year.  In comparison, most drought tolerant plants need approximately 15 inches of water or less per square foot per year. In an average year, Los Angeles receives about 15 inches of rain per year..."*

Similar to the Rainwater Harvesting program described previously, this program is compatible with the SCMP goal of reducing potable water demand.

Seattle Public Utilities RainWise Residential Program

Seattle Public Utilities' (SPU's) RainWise Residential program is a stormwater incentive program for single family residential customers.  The program began in 2010 and currently offers rebates for residents in the Ballard neighborhood in northwest Seattle to install and maintain rain gardens or cisterns on their private properties.  Qualifying properties may be eligible to receive rebates up to $3.50 per square foot of stormwater runoff managed on-site using a rain garden or cistern (SPU, 2012).  SPU is currently exploring opportunities to expand RainWise to other neighborhoods as part of its Long-Term Combined Sewer Overflow Control Plan.  King County is also exploring opportunities to collaborate with SPU to extend RainWise to other priority basins in the county and include additional types of incentives, such as incentives for commercial property owners to construct vegetated roofs, cisterns, and permeable pavement (King County, 2011).

While SPU's current program offers rebates for both rain gardens and cisterns, approximately 80 percent of participants choose rain gardens.  The average rain garden is designed to control stormwater runoff from approximately 1,100 square feet of impervious area.  With a rebate of $3.50 per square foot multiplied by an average of approximately 1,100 square feet, the average rain garden incentive cost equates to approximately $3,850.

Based on discussions with Bob Spencer, SPU's RainWise Program Manager (SPU, 2012), a major key to program success has been contractor training.  SPU has offered several rounds of contractor training and provides customers with a list of pre-qualified contractors.  Residents can obtain bids and hire from that list to install approved facilities on their properties.  The program website (https://rainwise.seattle.gov/city/seattle/overview) allows residents to verify eligibility, hire approved contractors, schedule inspections, and obtain rebates on-line, helping to bolster participation in priority areas.  In 2012, SPU estimated that 5 to 15 projects were being installed per month, with an annual capture volume estimated as approximately 1 million gallons of stormwater runoff per year.

<u>Portland Bureau of Environmental Services Grey to Green Initiative</u>

The City of Portland Bureau of Environmental Services (BES) Grey to Green Initiative includes distributed stormwater capture projects and programs that help manage stormwater runoff naturally, control invasive plants, restore native vegetation, protect sensitive natural areas, and restore Portland's streams.  The investments provide multiple benefits of improving water and air quality, wildlife habitat, neighborhood livability, and adaptability for climate change.

The program began in 2008.  Since that time, public and private partners have helped accomplish the program goals by:

- Planting more than 30,000 yard and street trees to capture more than an estimated 18 million gallons of stormwater per year upon maturity;
- Constructing approximately 850 green streets;
- Acquiring and protecting more than 400 acres of open spaces for stormwater management; and
- Restoring native vegetation on more than 4,100 acres (Portland BES, 2013), helping to lessen potable water demand for irrigation.

These portions of the Grey to Green Initiative are directly applicable to the SCMP.

Philadelphia Water Department Stormwater Management Incentive Program

The City of Philadelphia, through the Philadelphia Water Department (PWD) and the Philadelphia Industrial Development Corporation (PIDC), launched the Stormwater Management Incentives Program (SMIP) in 2012 to offer incentives and assistance to non-residential customers to reduce runoff and pollutant loading to receiving water bodies (PWD, 2013a). Program funds are used to design and construct detention and retention basins, tree trenches, green roofs, permeable pavement, and rain gardens, among other facility types, on eligible non-residential properties.

The SMIP is part of PWD's *Green City Clean Waters Plan* that includes a goal to convert 9,500 impervious acres to *"green acres."* Green acres capture and manage the first one inch of stormwater runoff to achieve fishable, clean and healthy rivers and streams. The grant also allows businesses, institutions, and other non-residential customers to reduce their stormwater rates by providing funding for the design and implementation of these green infrastructure projects and to join the City of Philadelphia in its quest to be the greenest city in the nation. Project funding is limited to $100,000 per impervious acre or less. All funded projects are required to file a deed restriction in the form of an Access, Operations, and Maintenance Agreement with the property. Applicants must complete an Economic Opportunity Plan (EOP) with the City of Philadelphia's Office of Economic Opportunity to document good faith efforts to provide opportunities for Minority, Woman and Disabled-owned businesses. Grantees are eligible to receive credits on their stormwater charges upon successful construction of the green stormwater infrastructure.

As of July 2013, PWD and PIDC have awarded $4.7 million in grants to promote green distributed stormwater capture. Applications for 31 projects were received in 2013, of which 17 were funded to create an estimated 77 green acres (PWD, 2013b).

California Solar Incentives

When considering incentives that can motivate private property owners to invest in retrofits to their properties, it is useful to look at similar programs. In this case, incentive programs in place for solar system installations on private properties were evaluated, such as the California Solar Initiative. This program has been sufficient in economic incentive to attract "aggregators" to the California markets. Aggregators are businesses who will own, operate, and manage systems at multiple facilities, for a fee from each facility owner. Verengo and Solar City are two examples of solar system aggregators operating in California.

Numerous studies have been conducted on the effects of aggregators on solar installations (Gaula & Carley, 2012), which generally conclude that if incentives are sufficient for aggregators to operate profitably within a market, then they can increase the number of installations substantially.  Forbes (Pentland, 2013) reports that *"More than two-thirds of the residential solar power systems installed in California over the past two years were owned by third-party investors, according to the U.S. Energy Information Administration,"* suggesting that aggregators have a significant role in private property retrofits.  Aggregators can only operate when financial incentives are sufficient to cover the costs of financing, installing, depreciating, operating, and maintaining the systems they own and operate.

## CONCLUSIONS

Centralized and distributed facilities can continue to contribute to the City's water supply portfolio.  Centralized facilities, located in specific locations, perform very well at capturing large flows when they are available. Distributed facilities, if implemented in a programmatic fashion, have the potential to add to the water supply and conservation portfolio.  Most stormwater capture facilities also have the added benefits or providing open space opportunities, water quality improvements, and can function as educational platforms to increase conservation and awareness.

### Centralized

The flood control facilities within the Los Angeles region have been developed to address key issues including intense rainfall, high topographic relief, debris flows, protection of life and property, and the need for water conservation.  The highly-urbanized nature of the region leave limited opportunities for large-scale conservation projects within the Los Angeles River watershed.  Optimization of the existing infrastructure, along with focused efforts to maximize open space and water conservation facilities in multi-use opportunities provide the best opportunities for increased stormwater capture and conservation.

The key features of the flood control system include dams, debris basins, channels, and spreading grounds.  These facilities have protected the highly-urbanized regions within the City and have provided significant groundwater replenishment.  However, as the region has grown, the need for further water conservation has led planners to look for further opportunities to capture and store stormwater, a significant natural resource.

There are limited areas where large-scale capture and recharge opportunities exist.  Use of open space such as parks, power line easements, gravel pits, and unlined portions of existing channels represent the best opportunities for large projects.

**Distributed**

Distributed stormwater facilities in the City of Los Angeles are important for future stormwater capture efforts. Existing facilities are examples of potentiality and often adopted standards, where they demonstrate a feasibility and capacity to achieve promised goals, show the successful adoption of BMPs in contexts other than public projects, and demonstrate that public and private spaces can be repurposed without loss of amenities or access. Proposed facilities show that these concepts are being expanded to increase the scope and scale of distributed facilities to manage stormwater, with projects that seek to increase private/public partnerships, educate the populace, promote water conservation, transfer the ownership of property to install BMPs, and repurpose commercial land to better manage stormwater.

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# APPENDIX D. TM 1.4 EXISTING PLANS AND STUDIES

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# Technical Memorandum 1.4

Date: March, 2014

To: Andy Niknafs, LADWP

Copies to: Rafael Villegas, Virginia Wei, LADWP

From: Mark Hanna, Geosyntec Los Angeles

Subject: Stormwater Capture Master Plan: Task 1.4 -- Review Existing Plans and Studies

## PURPOSE AND OBJECTIVE

There are numerous plans and studies in the Los Angeles basin relating to stormwater capture. The purpose of this subtask was to review the volume of existing information to assist with the determination of the feasibility and compatibility of recommended stormwater capture projects as well as implementation strategies with existing local and regional efforts. To achieve this objective, an extensive list of plans and studies were reviewed and key findings were summarized. Subsequently, general conclusions were drawn on this body of work as relevant to the Stormwater Capture Master Plan (SCMP).

## APPROACH

The approach consisted of data compilation and review of existing plans and studies from various agencies as well as outside studies. Plans and publications were reviewed and summarized, with an emphasis on information about:

- context of stormwater capture in the City of Los Angeles and its tributary watersheds.
- feasibility of stormwater capture (with regards to effectiveness, safety, and setting and scale)
- potential opportunities of stormwater capture (with regards to increasing stormwater capture, improving water quality, and decreasing dependence on imported water)

In general, operations and maintenance (O&M) of stormwater capture projects was rarely mentioned and when it was it was usually in the form of recommendations (e.g. "clean out basins before and after each storm event"), so broad conclusions on O&M were not included.

## SUMMARY OF EXISTING PLANS AND STUDIES

This section discusses existing plans and studies related to stormwater capture in the Los Angeles basin. Attachment 2 is a summary table of existing plans and studies evaluated in this Technical Memo (TM). Plans and studies are listed in the order that they are presented in the TM. Presentation and review of information from existing plans and studies is grouped into the following categories:

- Urban Water Management Plans and Related Documents
- Integrated Resource Plans and Integrated Regional Water Management Plans
- Watershed Management Plans Informing the Context of Stormwater Capture in the City of Los Angeles
- Other Studies Informing the Context of Stormwater Capture in the City of Los Angeles

### Urban Water Management Plans and Related Documents

There are numerous plans and studies for the Los Angeles basin relating to stormwater capture. The State of California requires that Urban Water Management Plans (UWMP) be adopted and updated every five years for urban water suppliers in order to better manage their water supplies. The main goal of UWMPs is to support long-term water resource planning and to ensure that adequate water supplies are available to meet existing and future demands.

This requirement was first established in 1984 when the California Urban Water Management Planning Act was passed. Every urban water supplier that provides over 3,000 acre-feet (AF) of water annually is required to adopt an UWMP every five years to assess the reliability of its water sources over a 20-year planning period that considers normal, dry, and multiple dry years. The LADWP adopted its first UWMP in 2000, whereas some of the surrounding and smaller water suppliers (i.e., Burbank and Glendale) adopted their plans at least ten years later. Since its initial adoption, the UWMP Act has had a number of new requirements added, such as the new requirement to address California’s more recent mandate of reducing per capita water use by 20 percent by the year 2020.

This section summarizes the LADWP's 2010 UWMP. In addition, this section also reviews related plans, studies, and documents that were a result of the LADWP UWMP or provided supporting guidance to it. Finally, as a point of comparison, this section reviews several UWMPs developed by neighboring water suppliers.

City of Los Angeles Urban Water Management Plans (2010)

Since its first UWMP in 1985, LADWP has updated its UWMP every five years, with the most recent update adopted in 2010. The 2010 UWMP puts a greater emphasis than ever before on increasing local recycled water and stormwater capture efforts. It notes that both the SCMP and the Recycled Water Master Plan (RWMP) will serve as complementary plans to meeting the goals of the 2010 UWMP.

Among its many goals, the 2010 UWMP projects that by 2035 there will be 10,000 AF per year of additional water conservation through rain barrels and cisterns. Furthermore, it projects that there will be a minimum of 15,000 AF per year of increased groundwater pumping in the San Fernando Basin due to water supply augmentation via increased stormwater infiltration.

While the 2010 UWMP does mention that further study is needed in order to determine how much more groundwater can be pumped while sustaining the basin's safe yield, it does recognize that the SCMP will identify the potential AF per year quantities available for stormwater recharge, and develop an implementation plan to augment the basin. Determining safe yield will be addressed by later efforts by LADWP.

The 2010 UWMP also includes a review of existing and planned stormwater capture projects and programs that will increase centralized stormwater recharge capacity by approximately 26,000 AF per year in the San Fernando Basin, thereby increasing the total average basin recharge to approximately 51,700 AF per year. The plan also estimates that distributed strategies (i.e., rain barrels, rain gardens, cisterns, and neighborhood recharge projects) will yield a groundwater recharge increase of approximately 33,000 AF per year (see Table 1).

**Table 1:  Stormwater Capture Trend of 2010 City of LA UWMP (2010)**

| | **(AF per year)** |
|---|---|
| Centralized Stormwater Capture Projects | |
| Spreading Ground Facilities (including East Valley groundwater replenishment or "Regional Recharge") | 40,950 |
| Distributed Stormwater Capture/Direct Use Projects | |
| Urban Runoff Treatment Facilities (e.g. Santa Monica Urban Runoff Recycling Facility) | 5,000 |
| Rain Barrels | 2,400 |
| Cisterns | 8,000 |
| Rain Gardens | 5,960 |
| Neighborhood Recharge (e.g. street ends, subregional basins, pocket parks. Non-parcel based) | 12,000 |
| TOTAL Distributed | 33,360 |

City of Los Angeles Recycled Water Master Planning Documents (Prepared: October 2012)

As a result of the UWMP goal to increase recycled water use citywide to 59,000 AF/yr by 2035, the City of Los Angeles Recycled Water Master Planning Documents (RWMP) were developed as a guide for both near-term recycled water planning (through 2035), as well as long-term recycled water planning for up to 50 years beyond 2035.  The review was mainly a collaborative effort between the LADWP, the Los Angeles Department of Public Works (LADPW), Bureau of Engineering (BOE), and Bureau of Sanitation (LASAN).  The RWMP documents include an evaluation of recycling alternatives that integrate two strategies to increase recycling: groundwater replenishment (GWR) and non-potable reuse (NPR). Because of blending requirements instituted by the California Department of Public Health (CDPH) for GWR projects, stormwater is critically linked to the City's recycled water plans.

The following five documents were created as part of the RWMP:

- Groundwater Replenishment Master Planning Report
- Groundwater Replenishment Treatment Pilot Study
- Non-Potable Reuse Master Planning Report
- Terminal Island Water Reclamation Plant Barrier Supplement and Non-Potable Reuse Concepts Report
- Long-Term Concepts Report

In close alignment with stormwater capture goals, the RWMP foresees that recycled and purified water will be the source of groundwater replenishment via existing spreading grounds (30,000 AF per year by 2035) and new non-potable reuse projects (9,650 AF per year).  The RWMP also anticipates groundwater replenishment through stormwater capture, but acknowledges its seasonal and annual fluctuations.  However, the RWMP does recognize that spreading stormwater in recharge basins may take precedence over spreading recycled water during extreme wet weather conditions.

The RWMP recognizes that the CDPH regulations require the City to utilize advanced treatment in order to recharge recycled water.  According to CDPH's 2008 Draft Regulation for Groundwater Recharge Reuse, the initial maximum recycled water contribution (RWC) for surface application groundwater recharge reuse projects (GRRPs) would be 20% unless reverse osmosis and subsequent advanced oxidation treatment are used (the City will use reverse osmosis at Donald C Tillman plant), in which case there are no predefined blending requirements, but each Groundwater Replenishment Reuse Project must be approved by the CDPH.  Under the CDPH guidance, it is anticipated that some of the water that replenishes the groundwater basin will need to come from non-recycled water sources (i.e., imported water or stormwater).

<u>City of Los Angeles Recycled Water Master Plan (Prepared: December 2006)</u>

The City of Los Angeles Recycled Water Master Plan is one of five documents that were produced as part of the City's Integrated Resources Plan in 2006.  The plan identified future recycled water projects/facilities that could be implemented in a phased approach, based on factors such as water demand, economics, water quality regulations, and public acceptance. While the plan did recommend the study of recharging groundwater basins with recycled water, it primarily focused on the analysis of recycled water for non-potable use.  It did not analyze how stormwater can impact recycled water use.

City of Los Angeles Water Supply Action Plan - Securing L.A.'s Water Supply (Prepared: 2008)

The Water Supply Action Plan (WSAP) is a predecessor to the RWMP documents that set an overall blueprint for creating sustainable sources of water for Los Angeles.  It established a goal of using 50,000 AF per year of recycled water by 2035 to offset demands on potable supplies. This goal was later increased to 59,000 AF per year when the 2010 UWMP was adopted.

The WSAP proposed four short-term and five long-term strategies.  The "Short-Term Conservation Strategies" included:

1. Enforcing prohibited uses of water;
2. Expanding the prohibited uses of water;
3. Extending outreach efforts; and
4. Encouraging regional conservation measures.

The "Long-Term Conservation and Recycling Measures" included:

1. Increasing water conservation through reduction of outdoor water use and technology;
2. Maximizing water recycling;
3. Enhancing stormwater capture;
4. Accelerating clean-up of the groundwater basin; and
5. Expanding groundwater storage.

The plan established the goal of enhancing stormwater capture as a long-term strategy, mainly by retrofitting Big Tujunga Dam and other large-scale projects, but also by cleaning contaminated San Fernando Basin groundwater to expand groundwater storage.  In addition, the WSAP planned for the pursuit of stormwater capture and direct use through 2030 using distributed stormwater captures programs, such as rain barrels or cisterns, residential and city park smart irrigation systems, conservation rebates, and incentives.

Urban Water Management Plans and Related Documents of Neighboring Cities

This section discusses UWMP's and related documents prepared by neighboring cities.

*City of Santa Monica Urban Water Management Plan (Prepared: 2010)*

The Santa Monica UWMP discusses its water sources and supplies, water quality, water demand, and reliability of supply, and it proposes Best Management Practices (BMPs) and 14 conservation measures. In addition, the Santa Monica UWMP includes the city's Water Shortage Contingency Plan, approved two years before the adoption of the UWMP.

The City of Santa Monica is aggressively pursuing stormwater capture projects and incentive program with the goal of becoming water independent by 2020 through the installation of additional wells. Santa Monica's UWMP foresees rainwater harvesting as an alternative water source, but it does not have a discussion related to stormwater infiltration. Current efforts to support rainwater harvesting include promotion of free landscaping workshops and rebates for rain barrels and/or cisterns. A recent grant award from the California Department of Water Resources has enable Santa Monica to double the rebate amounts for these products.

At present, the City of Santa Monica is preparing a Sustainable Water Master Plan that merges all water-issue related elements. In this plan, increased use of groundwater and recycled water will be analyzed and promoted.

*City of Beverly Hills Urban Water Management Plan (2010)*

The City of Beverly Hills UWMP describes the city's existing water supply resources (including imported water and local groundwater), water quality, water demand, reliability planning, and conservation measures. In addition, the plan includes an "Urban Water Shortage Contingency Plan" describing current conservation activities, similar to the one developed for Santa Monica.

Even though the UWMP recognizes that percolation has decreased over the years due to increased urbanization, it does not propose any related stormwater capture or groundwater replenishment strategies. Instead, the only groundwater-related strategy to increase water supplies is through groundwater pumping. Proposed alternative water sources are recycled water, gray water, and desalination projects; however, the plan does not describe any current or expected plans for implementation.

*City of Burbank Urban Water Management Plan (2010)*

The Burbank UWMP studies water demand, water supply, water recycling, contingency planning, and demand management measures. Burbank began to evaluate stormwater mitigation methods with the concept of stormwater infiltration and recharge to promote low-impact development (LID). There is a pilot percolation (Green Street) project on the Lake Street frontage, which was completed in 2011. Additionally, Burbank adopted a policy in 2009 that annually commits two percent of water sales to fund water conservation. The five Stormwater Mitigation Methods being implemented with Green Street technology are:

- Permeable Pavers & Gravel Reservoir;
- Infiltration Planter Bump-Outs;
- Filtration Planters at Open Space;
- Silva Cell System; and
- Kristar Tree Pod System.

Burbank also developed a Recycled Water Master Plan (RWMP, 2007) to increase the use of recycled water delivered; the Green Building and Sustainable Architecture program for new constructions; as well as the Smart Grid tool, advanced meters, and systems for enhanced customer and utility water efficiency.

*City of Glendale Urban Water Management Plan (2010)*

The Glendale UWMP reviews water demand, water supply, and water quality of the current system.  The plan proposes a series of recycled water activities, including recycled water for power plant and cemetery expansions, as well as increased regulation and encouragement of recycled water for non-potable use.  It also offers water conservation BMPs and develops the Water Conservation Campaign and Ordinance carried out in recent years.  The plan does not formulate any strategy related to stormwater capture.

<u>Summary</u>

Review of the LADWP UWMP and neighboring water supplier UWMPs indicates that the LADWP clearly has the most robust strategies for stormwater capture in the region.  In recent years, the LADWP has placed a much greater emphasis on implementing stormwater capture strategies, with an increasing trend from 2000 to 2010, which shows a growth in the use and prioritization of such strategies.

Also apparent is that the City WSAP represented a significant blueprint for future plans.  The UWMP and other related plans that followed all reference the WSAP as the overarching vision for their planning goals.  Some of the goals that the WSAP set were later updated in the 2010 UWMP to support increased local water supply efforts.  For example, the 50,000 AF per year goal for recycled water use by 2035 set by WSAP was later updated to 59,000 AF per year in the 2010 UWMP.

The City's RWMP foresees that recycled and purified water will be a source of groundwater replenishment via existing spreading grounds (30,000 AF per year by 2035) and new non-potable reuse projects (9,650 AF per year).  Spreading recycled water will be subject to CDPH blending requirements.  While the RWMP anticipates replenishing groundwater through stormwater capture, it does acknowledge limits due to seasonal and annual fluctuations.

The three planning efforts by the City (WSAP, 2010 UWMP, and RWMP) all identify the SCMP as a complementary effort to their plans for recycled water, stormwater capture, and groundwater recharge.  Collectively, these publications foresee that the SCMP will identify the potential quantities of stormwater available for recharge and develop an implementation plan to augment the groundwater basin, as well as recommend specific stormwater capture projects.

**Integrated Resource Plans and Integrated Regional Water Management Plans**

There are numerous integrated resource plans (IRP) and integrated regional water management plans in the Los Angeles basin relating to stormwater capture.  The concept behind integrating all water-related elements of the region dates back twenty years.  In 1996, the Metropolitan Water District of Southern California (MWD) Integrated Water Resource Plan (IWRP) (and its subsequent updates in 2004 and 2010) started an evolution in the way that plans have been developed for the past two decades.  Originally, IWRPs were focused on management of imported water sources and existing groundwater sources.  Since 1996, the plans evolved to include a greater emphasis on wastewater and stormwater as feasible alternatives for augmenting water supplies.

The Integrated Resource Plan produced by the City of Los Angeles in 2006 was groundbreaking in the sense that it recognized the interrelationships between different City departments on water-related issues.  Since then, these departments have been collaborating to achieve water recycling and stormwater capture related goals.  Nevertheless, there are still areas that could benefit from greater cooperation.  This section reviews IRP's in the region.

<u>City of Los Angeles Integrated Resources Plan (Adopted: September 2006 )</u>

The City prepared its IRP in 2006 as a way to develop a more holistic vision for water planning in Los Angeles that linked wastewater planning with urban runoff management and recycled water.  LADWP collaborated with the LASAN to develop this plan.  In addition to creating a more comprehensive plan for water resources than had traditionally been done independently, this plan represented a milestone for the City as it explicitly recognized the interrelationships among all water resource activities and functions.

A significant result of the IRP was the creation of a plan that maximizes benefits while reducing costs and impacts on a watershed-wide basis rather than being limited to municipal boundaries.

In addition, the plan provides planning strategies to integrate the three interdependent water systems: wastewater, recycled water, and stormwater.  The plan offers four alternatives, all of them aiming to meet a *"20% projected increase in wastewater flow over the next 20 years while maximizing the beneficial reuse of recycled water and urban runoff; optimizing the use of the existing facilities and water resources; reducing pollution; and reducing dependency on imported water."*

As part of its *"Go-Policy Directions"* the IRP seeks to increase the amount of dry and wet weather urban runoff that is diverted, treated or captured, and beneficially used.  The recommended alternative to meet the goal for dry weather includes smart irrigation and direct use, and for wet weather includes on-site percolation and storage/use.  This strategy will be able to manage 42% of total dry runoff for an estimated cost of $591 million.  As for the wet weather runoff treatment, costs are much higher (at $1.597 billion), but it is estimated that 47% of total wet runoff will be managed.

Furthermore, the "Go-Policy Directions" also propose:

- The Department of Building and Safety to evaluate and modify applicable codes to encourage all feasible BMPs for maximizing on-site capture and retention and/or infiltration of stormwater instead of discharge to the street and storm drain, including porous pavement;
- Department of Recreation and Parks to coordinate with LADPW on including stormwater management BMPs in all new parks.

A five-year review of the IRP conducted in 2012 found that recommended projects cost $545 million less because of a reduction in construction costs, saving LADWP customers an average of $164/year.  The review also found that the LADPW and the Department of Recreation and Parks had successfully incorporated stormwater management BMPs at many new parks.  Efforts are still on-going to evaluate the feasibility of using certain City properties for stormwater retention and/or treatment projects.

Furthermore, City departments have fostered better coordination on projects; however, moving forward the City could realize more benefits from even greater cooperation.  An example of this coordination is the guidelines for residential rainwater harvesting and green street design standards that were developed by the City of LA through a joint effort of many departments and bureaus.

Greater Los Angeles County Integrated Regional Water Management Plan (Adopted: December 2006)

The Greater Los Angeles County Integrated Regional Water Management Plan (IRWMP) encompasses 92 cities in the Greater Los Angeles County Region (GLAC), including the LADWP as a participant. The primary goal of the IRWMP is to address water quality, resource, and supply issues for the region by fostering collaboration and integration of single purpose efforts between participating agencies. The main highlights of the IRWMP that pertain to stormwater capture include:

- Short- and long-term objectives to comply with water quality regulations (including Total Maximum Daily Loads [TMDLs]) by improving the quality of urban runoff, stormwater, and wastewater;
- Optimization of local water resources to reduce the region's reliance on imported water;
- Long-term priority to protect groundwater supplies through stormwater recharge;
- Target goal to reduce and use 150,000 AF per year (40%) of dry weather urban runoff and to capture and treat an additional 170,000 AF per year (50%) for a total target of 90%; and
- Target goal to reduce and use 220,000 AF per year (40%) of stormwater runoff from developed areas and to capture and treat an additional 270,000 AF per year (50%) for a total of 90%.

Creating a regional plan for water resource management supports the optimization of local water resources, including stormwater runoff, recycled water, and groundwater, which in turn reduces dependence on imported water and enhances water supply reliability. In this sense, the IRWMP has a dual goal of aiming to improve water supply and quality, as well as to enhance open space, recreation and habitat, and improve flood management in the GLAC Region. In order to better address the needs, objectives, and targets of this vast region, five sub-regional plans were developed.

Even though the GLAC IRWMP recognizes stormwater runoff as a potential water supply source that is underutilized, it does not provide an adequate strategy for stormwater capture, only offering management strategies for *"Stormwater Quality and Flood Management."* Strategies related to stormwater include:

- Increase recharge of treated stormwater;

- Reduce impervious surfaces;
- Increase recharge of stormwater;
- Use stormwater for landscape irrigation; and
- Reduce peak stormwater runoff flows.

The proposed targets related to improving water supply and stormwater capture are:

- Increase capture and use of stormwater runoff by 27,000 AF per year that is currently lost to the ocean;
- Increase both centralized and distributed stormwater infiltration by 75,000 AF per year; and
- Develop 58,000 AF of new stormwater capture capacity spatially dispersed to improve surface water quality.

An updated version of this plan is forthcoming, but as of the publication date of this TM, it has not been adopted.

<u>Metropolitan Water District Integrated Water Resources Plan (Adopted: 1996, last update October 2010)</u>

In 1993, the MWD initiated the development of its IWRP that was approved three years later. In this early stage of integrated water management, the plan primarily focused on how to effectively bring imported water to MWD customers, as well as the development of sufficient storage capacity as a hedge against potential future water supply shortages. The 2004 IWRP update changed this perspective towards a greater recognition of conservation and local water supply alternatives. And finally, the 2010 IWRP sought to develop even greater local water supply options and stormwater capture solutions.

The MWD IWRP offers an informative appendix (A.12) entitled "*Stormwater/Urban Runoff Issue Paper"* that identifies related issues and recommendations to improve quality and use of stormwater as a local supply resource.

The paper states the following *opportunities* related to stormwater / urban runoff within the MWD service area:

- There is an annual average of more than 1 million AF of stormwater runoff currently generated from urban areas;

- There is more than 3.2 million AF of available groundwater storage space within the MWD service area;
- Stormwater and dry-weather runoff can be captured and recharged into the groundwater basin, stored on site and used to supplement irrigation, and stored in surface water reservoirs and used to meet municipal demands;
- 34 stormwater projects and programs have been identified that could collectively increase regional stormwater capture by 45,000-56,000 AF per year;
- Stormwater projects often provide multiple benefits, which attracts multiple funding partners;
- Synergy exists between groundwater, stormwater, and recycled water resources; and
- There is increasing statewide interest and support for integrated projects and programs.

And finally, the paper provides the following stormwater related *recommendations*:

- Identify and study various pilot projects to develop a model to quantify the relationship between capture and production, to quantify water supply component costs and benefits, to optimize partnerships, and to better understand regional challenges;
- Model, per basin, the effect of increased active stormwater recharge on production yield;
- Determine a business case and an accurate cost/benefit analysis for providing regional incentives/rebates based on the study of various pilot projects;
- Coordinate a proactive, unified approach to legislation and regulation for the region, including ordinances and building standards;
- Encourage enhanced stormwater recharge/use partnerships to educate the public on the benefits and uses of stormwater, including the relationship between stormwater quality and drinking water supply, and facilitate coordination of information to increase message consistency;
- Promote open regional discussion on enhanced stormwater capture and use as a water supply resource, as well as between stormwater, water supply, and groundwater managers;
- Develop a set of monitoring guidelines to increase technical knowledge; and
- Encourage information sharing of challenges and lessons learned to improve future water supply augmentation efforts.

City of Pasadena Water Integrated Resources Plan (Adopted: January 2011)

The City of Pasadena developed an IRP to better manage their various water policies using a long-term strategy.  Pasadena's IRP focuses on future planning for their water supply and greater conservation, with the following key elements:

- Aggressive water conservation through new ordinances and rebates;
- Dam storage for groundwater recharge;
- Recycled water for non-potable reuse; and
- Groundwater storage of imported water.

Their IRP also discussed on-site stormwater capture projects for direct landscaping use and groundwater recharge, to be developed by:

- Evaluating and implementing LID ordinances;
- Developing a comprehensive stormwater strategy along with other cities; and
- Pursuing funding through grants and partnerships.

Considered programs to treat or reduce stormwater discharges include:

- Residential rain barrels;
- Residential rain gardens;
- Residential infiltration strip/bioswales;
- Commercial parking lot swales; and
- Permeable pavement in parking lots.

Pasadena's IRP mentions the Raymond Basin Judgment in 1944, which modified groundwater extraction rights for the Monk Hill, Pasadena, and Santa Anita subareas.  As a result, the supply yield from these programs would be very small due to the calculation of groundwater credits per the Judgment. The IRP describes how this judgment in turn affects their incentive to replenish groundwater through stormwater capture.

Summary

While most of the IRP/IRWMP's analyzed do not have strong strategies for stormwater capture, it is apparent that stormwater as a water supply source has become a greater focus in recent years.  However, the most recent City of Los Angeles IRP was conducted in 2006, which is outdated considering how far the City has come in terms of planning for stormwater capture solutions.  The City of Los Angeles 2006 IRP only proposed to increase the amount of dry/wet weather urban runoff diverted, treated or captured, and beneficially used, whereas the City of Pasadena's 2011 IRP aims to implement LID ordinances and develop a comprehensive stormwater strategy along with other cities.  However, the City of LA has been implementing similar strategies, even though it is not spelled out in its 2006 IRP, which means that the City's IRP is due for an update to reflect the evolution of stormwater practices.

The majority of IRP/IRWMP's acknowledge that coordination with other regional agencies/plans is needed.  In fact, the entire purpose of having an IRP is to address coordination of water-related issues by agencies that have traditionally been independent of each other.  The City's IRP notes that greater coordination between the LADWP, City of Los Angeles Department of Recreation and Parks (DRP), and the LADPW should occur on future projects.  Even though a 5-year review conducted in 2012 observes that better coordination is happening, it could still be improved.  The Rainwater Harvesting Program developed by the LADPW in 2009 is an example of a program that could have been coordinated with the LADWP and DRP, and since this is an on-going program, such coordination efforts could still transpire.

**Watershed Management Plans Informing the Context of Stormwater Capture in the City of Los Angeles**

Watershed Management Plans (WMPs) constitute another category of planning efforts that address the region's diverse landscape and the large number of vested stakeholders in water quality.  A total of eight WMPs exist in the region that inform the context of stormwater capture for the City of Los Angeles.  The plans can be categorized as regulatory plans, comprehensive plans, or visionary plans.

**Regulatory** plans contain mandates, required actions, and benchmarks that affected agencies and local governments have to meet.  Of the eight WMPs, two of them fall into the regulatory category:

- The Water Quality Control Plan, Los Angeles Region: Basin Plan for the Coastal Watersheds of LA & Ventura Counties (WQCP) and
- Standard Urban Storm Water Mitigation Plan (SUSMP).

**Comprehensive** plans are traditional master plan documents that have been adopted by local governments to set long-term development and restoration goals.  Four plans fall into this category:

- Los Angeles River Master Plan (LARMP);
- The Los Angeles River Revitalization Master Plan (LARRMP);
- The Tujunga Wash Watershed Groundwater Recharge Master Plan (TWWGRMP); and
- The Water Quality Compliance Master Plan for Urban Runoff (WQCMPUR).

**Visionary** plans, similar to comprehensive plans, identify opportunities and develop long-term strategies that incorporate stormwater capture.  Unlike the comprehensive plans, however, they do not guide the strategic planning of local governments in an official capacity.  There are five visionary plans:

- Common Ground: From the Mountains to the Sea (CGFMS)
- Compton Creek Watershed Management Plan (CCWP)
- The Tujunga/Pacoima Management Plan (T/PMP)
- Arroyo Seco Watershed Management and Restoration Plan (ASWMRP)
- Sun Valley Watershed Management Plan (SVWMP)

<u>Regulatory Plans</u>

This section discusses the two regulatory plans.

*The Water Quality Control Plan, Los Angeles Region: Basin Plan for the Coastal Watersheds of LA & Ventura Counties (1994)*

The WQMP is a plan enacted by the Los Angeles Regional Water Quality Control Board (RWQCB) to preserve and enhance water quality and protect beneficial uses of all regional waters.  The plan, approved by the State Water Resources Control Board (SWRCB) in 1994, specifically designates beneficial uses for surface water and groundwater, sets objectives to protect the designated beneficial uses and comply with the state's anti-degradation policy, and describes implementation programs to protect all waters in the region.

The WQCP affects the context of stormwater capture in the City by setting a legal standard for water quality conditions, but how these conditions must be met is not stipulated.  In many instances, however, the adoption of stormwater capture strategies is essential to comply with the WQCP's benchmarks.  The adoption of stricter WQCP standards would create the need for implementation of more widespread stormwater capture strategies.

*Standard Urban Stormwater Mitigation Plan (2000)*

The SUSMP was approved by the SWRCB on March 8, 2000.  Objectives of the SUSMP are to reduce pollutants from stormwater to the maximum extent practicable.  Unlike the WQCP, the SUSMP dictates the adoption of certain stormwater capture strategies to reduce pollution in order to comply with clean water regulations.  Specifically, SUSMP mandates that new development of a certain size must use or adopt minimum sets of BMPs.

The SUSMP is applicable to all of Los Angeles County and incorporated cities, with the exception of Long Beach, which has a separate SUSMP.  By requiring BMPs, the SUSMP provides a clear regulatory push for certain new development to implement stormwater capture.

<u>Comprehensive Plans</u>

This section discusses the four comprehensive plans.

*Los Angeles River Master Plan* (1996)

The LARMP was approved by Los Angeles County Board of Supervisors on June 13, 1996, with the stated intent *"to create a document that identifies ways to revitalize the publicly-owned rights-of-way along the Los Angeles River and Tujunga Wash into an urban treasure."*  The LARMP includes eight key goals, two of which relate directly to stormwater capture:

- Ensure flood control and public safety needs are met, and
- Consider stormwater management alternatives.

The benefits of stormwater capture, however, are also applicable to the remaining goals of the plan.  Specifically, in order to achieve flood management and water conservation goals, the LARMP recommends the development of cost effective, multi-use flood control facilities, allowing for increased stormwater retention, while providing additional recreational facilities and creating wildlife habitat.

*The Los Angeles River Revitalization Master Plan (2007)*

The LARRMP was adopted by the Los Angeles City Council in 2007 and includes four key goals, with the first two goals containing sub-goals that directly support stormwater capture strategies:

1. Revitalize the River
    - Enhance flood storage
    - Enhance water quality
    - Restore a functioning ecosystem
2. Green the Neighborhoods
    - Extend open space, recreation, and water quality features
3. Capture Community Opportunities
4. Create Value

While stormwater capture is included in the goals of the LARRP, projects that increase stormwater capture do not constitute a large part of the plan.  The plan states that only infiltration opportunities arise from removing concrete from the river and allowing natural percolation along the river's length.  Two specific projects include *"water quality treatment wetlands,"* but the LARRP does not provide additional details.  However, it does make the general recommendation of implementation of BMPs where soils are suitable.  Overall, the focus of the plan is more on habitat restoration and community connections along the river.  In addition, there is discussion of political structures to assist with implementation.

*The Tujunga Wash Watershed Groundwater Recharge Master Plan (2011)*

The TWWGRMP, prepared jointly by the LACDPW and LADWP, came as a result of multiple cooperative agreements between these two entities surrounding the concept of enhanced stormwater capture for groundwater recharge.

The Tujunga Wash is a significant contributor to the Los Angeles River, with an average annual runoff volume of 35,000 acre-feet (not counting the Pacoima Wash subwatershed). The Tujunga Wash subwatershed contains Hansen Dam, Big Tujunga Dam Tujunga Wash, Hansen Spreading Grounds, Sheldon Pit, and Boulevard Pit. The Pacoima Wash subwatershed of the Tujunga Wash produces an average annual runoff volume of 13,700 acre-feet, of which 8,000 is produced above Pacoima Spreading Grounds. Pacoima Wash subwatershed contains Pacoima Dam, Lopez Dam, Pacoima Spreading Grounds, Lopez Spreading Grounds, and Branford Spreading Basin.

LACDPW recently completed three projects within the Tujunga Wash subwatershed: Big Tujunga Dam Rehabilitation, Hansen Spreading Grounds Intake Modification, and Hansen Spreading Grounds Basin Modifications. For the purposes of the TWWGRMP, these three projects were identified as the baseline scenario against which each project and master plan scenario were evaluated. The six projects evaluated as part of plan included Hansen Dam Water Conservation, Boulevard Pit, Tujunga Spreading Grounds Modification, Pacoima Dam Sediment Removal, Lopez Spreading Grounds Improvements, and the Canterbury Avenue Power Line Right-of-Way. Project schedules were developed to assess the readiness and a cost-benefit analysis was evaluated for each project. The environmental evaluation conceptually identifies potential environmental constraints associated with each potential project.

All projects within the plan were anticipated to be completed by the year 2020 with a 50 year economic life for each project and an inflation rate of 5%. The benefit analysis involved the determination of the annual benefit of recharged stormwater runoff measured in average annual runoff recharged in acre-feet. The plan recommends a scenario (Master Plan Scenario B) which includes Boulevard Pit, Tujunga Spreading Grounds Modifications, Pacoima Dam Sediment Removal, Lopez Spreading Grounds Improvements, and Canterbury Avenue Power Line Right-of-Way. Per the plan, this scenario would increase groundwater recharge within Tujunga Wash Watershed by 15,134 acre-feet on an average annual basis.

*The Water Quality Compliance Master Plan for Urban Runoff (2009)*

The WQCMPUR was adopted by the Los Angeles City Council in 2009 seeking a broad watershed-based perspective that uses green and natural solutions to improve water quality and to comply with current and emerging water quality regulations.

The plan supports stormwater capture through the identification of goals and objectives in the areas of water quality compliance, citywide collaboration, and community engagement. Also, WQCMPUR identifies clear benefits regarding the use of stormwater capture strategies. In addition, the plan:

- Identifies key issues for the future of urban runoff management;
- Provides strategic guidelines for improving the quality of Los Angeles' rivers, creeks, lakes, and ocean;
- Identifies opportunities for collaboration among City departments and with non-governmental organizations; and
- Describes how rainwater can be used beneficially to augment our water supply.

Visionary Plans

This section discusses the four visionary plans.

*Common Ground: From the Mountains to the Sea (2001)*

The CGFMS report was released in 2001 by the Council for Watershed Health. Primarily focused on parks and open space, the plan encourages stormwater capture and infiltration in these areas. Specifically, the plan:

- Promotes the use of non-structural BMPs for stormwater capture and infiltration;
- Encourages infiltration of urban runoff into groundwater basins; and
- Encourages the use of residential stormwater capture.

*Compton Creek Watershed Management Plan (2005)*

The CCWP was released in 2005 by the Council for Watershed Health to apply sound science to management of the watershed in order to integrate surface and groundwater regulatory programs, promote collaborative efforts, and prioritize issues.

In support of stormwater capture, the CCWP encourages development of comprehensive, collaborative, and integrated strategies through stakeholder engagement, with a goal of introducing *"the watershed concept to the people who reside, do business, and provide services"* within the watershed. Many of the goals are explicitly or implicitly related to stormwater capture as a means for achieving multiple benefits.

*The Tujunga Pacoima Watershed Plan (ongoing)*

With funding from the California Bay-Delta Watershed Program, The River Project developed a visionary plan for the Tujunga and Pacoima Washes, the largest tributary area to the Los Angeles River. The plan identifies multiple benefits, ranging from enhancing the regional water supply and water quality, returning Tujunga and Pacoima Wash to a more natural condition, to ecosystem enhancements and community recreation opportunities including the creation of neighborhood pocket parks in several underserved communities in the area.

This project was developed with community members and government agencies and identified specific projects that improve healthy watershed functions. The project included Watershed-U – a six-week workshop to educate community members about specific issues, and development of a kindergarden-12$^{th}$ grade curriculum specific to the Tujunga Wash.

The Plan lays out coordination throughout with local, state and federal agencies, providing a blueprint for recovery of functionality throughout the Los Angeles River Watershed. To date, many of the projects identified as part of the plan have been undertaken and completed, including the Woodman Avenue Median Retrofit.

*Arroyo Seco Watershed Management and Restoration Plan (2006)*

The ASWMRP was released in 2006 by North East Trees, the purpose of which is the re-establishment of the Arroyo Seco as a natural river along with a set of tributaries that run unobstructed from the San Gabriel Mountains down to the confluence with the LA River.  A major constraint is that implementation requires significant funding.

In support of stormwater capture, ASWMRP identifies several projects that would achieve water quality and habitat improvement.  The plan proposes that watershed-wide projects could be distributed throughout the Arroyo Seco, providing an important role for stormwater capture strategies.

*Sun Valley Watershed Management Plan (2004)*

The Sun Valley Watershed Management Plan was initiated to solve local flooding issues with a multipurpose solution that was crafted based on the understanding that stormwater is a valuable resource for enhancing water supply in the region. As a part of this plan, twenty two projects were identified and twelve of these were selected for further evaluation. These twelve included infiltration, stormwater reuse, onsite non-regional BMPs, and subsurface conveyance systems. These projects were used to develop six alternatives each with a different design obejctive:

1. Maximize infiltration
2. Maximize Reuse
3. Maximize Water transfer
4. Maximize onsite non-regional BMPs
5. Tunnel/force main
6. Combination approach

Alternative two was found to be the most cost effective. Short and long term funding opportunities were also identified as part of this plan.

<u>Summary</u>

As a whole, the Watershed Management Plans provide a clear picture of the context of stormwater capture in the City of Los Angeles.  These plans support stormwater capture strategies and implementation by creating a regulatory framework and strategic vision for moving forward.

**Regulatory** plans contain mandates, required actions, and benchmarks that affected agencies and local governments have to meet.  Of the eight WMPs, two of them fall into the regulatory category.  (1) The WQCP affects the context of stormwater capture in the City by setting a legal standard for water quality conditions, but how these conditions must be met is not stipulated. The adoption of stricter WQCP standards would create the need for implementation of more widespread stormwater capture strategies.  (2) The objectives of the SUSMP are to reduce pollutants from stormwater to the maximum extent practicable by dictating the adoption of certain stormwater capture strategies to reduce pollution in order to comply with clean water regulations.  The SUSMP is applicable to all of Los Angeles County and incorporated cities (except Long Beach).  By requiring BMPs, the SUSMP provides a clear regulatory push for certain new development to implement stormwater capture.

**Comprehensive** plans are traditional master plan documents that have been adopted by local governments to set long-term development and restoration goals.  Three plans fall into this category.  (1) The LARMP identifies ways to revitalize the publicly-owned rights-of-way along the Los Angeles River and Tujunga Wash and two goals that relate directly to stormwater capture: ensure that flood control and public safety needs are met and consider stormwater management alternatives.  The LARMP recommends the development of cost effective, multi-use flood control facilities, allowing for increased stormwater retention, while providing additional recreational facilities and creating wildlife habitat.  (2) The LARRMP includes goals that directly support stormwater capture strategies, including enhancing flood storage and water quality as well as restoring a functioning ecosystem.  (3) The TWWGRMP investigated several large centralized projects within the Tujunga and Pacoima Washes that could increase groundwater recharge by more than 15,000 acre feet per year. (4) The WQCMPUR seeks a broad watershed-based perspective that uses green and natural solutions to improve water quality and to comply with current and emerging water quality regulations.  The plan supports stormwater capture through the identification of goals and objectives in the areas of water quality compliance, citywide collaboration, and community engagement.

Finally, **Visionary** plans identify opportunities and develop long-term strategies that incorporate stormwater capture, and there were four applicable visionary plans reviewed.  These plans were focused in different watersheds within and surrounding the City of Los Angeles, including (1) the overall region, (2) Compton Creek, (3) Tujunga and Pacoima Washes, and (4) the Arroyo Seco.

**Studies Informing the Context of Stormwater Capture in the City of Los Angeles**

The context of stormwater capture in the City of Los Angeles is informed by a robust body of scientific research and study, conducted by government experts, professional scientists, and academics, with results published in peer-reviewed journals. Overall, the studies inform the feasibility of stormwater capture in Los Angeles and illuminate opportunities available for expanded stormwater capture in the region. Together, this research concludes that stormwater capture in the City is effective, safe, and provides multiple benefits in the correct settings and scale. Furthermore, this body of research identifies a mix of strategies available to increase stormwater capture, improve water quality, and decrease dependence on imported water sources. The conclusions drawn enjoy a broad consensus across the body of research examined. These studies are discussed herein and grouped by 1) studies addressing feasibility and 2) studies addressing opportunities.

<u>Studies Addressing Feasibility</u>

Relevant studies informing the feasibility of stormwater capture in Los Angeles have examined and evaluated:

- Effectiveness of using stormwater to recharge groundwater;
- Effectiveness of BMPs and LID to reduce peak flows and treat stormwater;
- Safety of using stormwater to recharge groundwater; and
- Appropriateness of projects depending on setting and scale.

Taken together, this body of work concludes that stormwater capture is a feasible strategy for achieving key stormwater goals, including groundwater recharge, removal of selected contaminants from urban runoff, reduction of peak flows, mitigation of flood risk, and providing multiple benefits to stakeholders.

*Effectiveness*

The effectiveness of stormwater capture is addressed by research examining the capacity of groundwater basins to receive and infiltrate stormwater. Published in 2002, "*Infiltration of Urban Stormwater Runoff to Recharge Groundwater: A Study of the San Fernando Valley*" analyzed the feasibility of infiltration basins to recharge groundwater in the San Fernando Valley. The results of the study found that infiltration basins with a surface area of 0.1 - 0.5 acre located in a five-acre drainage area, could capture 0.90 - 1.87 AF per year of stormwater runoff.

Also, the study concluded that among the pollutants tested, none were found to contaminate groundwater via stormwater infiltration.

Further assessment of the overall effectiveness of stormwater capture examines the performance of strategies in achieving capture, diversion, water quality, and infiltration goals. The publication "*End of Separate Storm and Sewer Systems: Integrated Solutions to Runoff Management in Los Angeles*", published in 2003, examined the City's strategies to control and manage wet and dry weather runoff. The study concluded that infiltration, where feasible, was the most effective strategy for managing wet weather runoff. Diversion of runoff to wastewater collection and treatment facilities was found to be an option best suited for dry weather run off. Coastal diversions proved effective in improving water quality adjacent to Santa Monica Bay beaches.

Two recent studies developed in 2011 for publication and presentation for the research/industry trade groups StormCon and the Water Education Federation (WEF), "*Stormwater as a Resource: Rainwater Harvesting in the City of Los Angeles*" and "*Increasing the Cost Effectiveness of Stormwater and Rainwater Harvesting for Water Supply and Water Quality in Los Angeles*" describe the multi-beneficial aspects of stormwater capture and rainwater harvesting in Los Angeles. An important finding from both of these studies is how improvements in the operations of the region's centralized facilities, along with an overall improved awareness of the value of local resources, groundwater recharge per inch of rain has increased significantly in the past 35 years, from just under 1,100 acre-feet of recharge per inch of rain per year to more than 1,400 acre feet of recharge per inch of rain per year. And as current spreading grounds are enhanced, or new spreading areas are developed in the Eastern, or the largely untapped Western San Fernando Valley (with large storm flows and multiple opportunities for additional capture and storage) (Swift et. al, 2007), this trend line should continue to increase.

Additional important research tests the ability of stormwater capture strategies to reduce peak flows and mitigate flooding. The publication, *"Can stormwater harvesting restore pre-development flows in urban catchments in South East Queensland?"* asked if stormwater capture strategies in Australia could reverse the trend of increased runoff caused by urbanization. Published in 2013, the study found that while runoff cannot be reduced to pre-urbanization levels, catchment and harvesting systems can mitigate stormwater runoff to a degree that reduces adverse impacts on the physical and ecological condition of streams.

Whereas many studies focus on the effectiveness of structural BMPs to capture stormwater, the publication, "*Portland's Green Infrastructure: Quantifying the Health, Energy, and Community*

*Livability Benefits Development,"* examined the effectiveness of stormwater capture strategies to produce benefits beyond water quality and infiltration. The study, published in 2010, found that habitat enhancement, ecosystem services, energy savings, air quality, mental and physical health, greenhouse gas reductions, and community livability are all benefits that select stormwater BMPs could achieve.

*Safety*

In a region with a history of groundwater basin contamination, the feasibility of infiltrating stormwater to recharge groundwater basins for later use depends upon the existing condition and safety of the receiving basins. A study by the United States Geological Survey, titled *"Ground-Water Quality Data in the San Fernando–San Gabriel Study Unit, 2005—Results from the California GAMA Program"* provides data highlighting which groundwater basins and/or locations within basins are acceptable for stormwater recharge and use.

The *"Los Angeles Basin Water Augmentation Study"* is an ongoing study, evaluating if infiltration of stormwater has had any noticeable effect on groundwater basin health. To date, the study has found that for common constituents in urban runoff, there is no correlation between the infiltration of urban runoff and its impact on groundwater quality. The model developed in this study is being used to verify modeling results for the SCMP.

*Setting and Scale*

When otherwise safe and effective, studies find the feasibility of stormwater capture to achieve stated goals will shift depending upon the setting and context of the strategies implemented. The 2007 publication, *"Rainwater as a Resource: A Report on Three Sites Demonstrating Sustainable Stormwater Management"* summarized the successes and challenges derived from the evaluation of three rainfall retention projects, whereby BMPs were installed at a single-family home in South Los Angeles, Broadous School in Pacoima, and Open Charter School in Westchester. The report found that changes in property ownership, institutional changes, and timing at each site influenced the effectiveness of BMPs to capture and treat stormwater, highlighting the need for stormwater capture strategies to be flexible and adaptive to achieve maximum effectiveness.

The ASCE publication, *"Standard Urban Storm Water Mitigation Plan Compliance at the Port of Los Angeles"* from 2004 evaluated the effectiveness of stormwater capture strategies in a heavily-industrialized setting, with unique tidal, flooding, and truck traffic conditions. The study found that the Port of Los Angeles' adoption of innovative, in-line stormwater treatment was effective in removing contaminant from the storm drain system without exposing key facilities to flooding or disrupting Port operations.  This finding illustrates that industrial and commercial settings can be strategic sites for the adoption of stormwater capture practices.

Studies Addressing Opportunities

Relevant studies addressing the opportunities for stormwater capture in the City of Los Angeles have examined the potential to increase stormwater capture, achieve substantial improvements in water quality, and decrease the dependence of the City on imported water.  Generally, these studies conclude that there are a variety of strategies to accomplish stormwater goals that are cost effective, provide multiple stakeholder benefits, and increase the resiliency of the region to water supply fluctuations, particularly in the face of climate change.

*Increase Stormwater Capture*

Several studies have evaluated where opportunities are most appropriate for increased stormwater capture strategies in the Los Angeles Region.  The publication, *"The Green Visions Plan,"* published in 2004, was a study to develop a visionary plan with practical planning tools to promote habitat conservation, watershed health, and recreational open space.  In terms of opportunities for stormwater capture, the plan highlights the potential for BMP and LID installations on industrial land.  Building on the conclusions of "*Standard Urban Storm Water Mitigation Plan Compliance at the Port of Los Angeles,"* the study concludes that the use of stormwater capture BMPs on select industrial sites could remediate as much as 20% of stormwater pollution in the region.  The study suggests that partnerships or outright purchase of land would be needed to achieve the 20% goal.

Conversely, *"The Green Solution Project,"* investigates the potential for increased stormwater capture on public lands.  Published in 2008, the study found that in all Los Angeles County watersheds, there are between 9,500 and 20,200 acres on 10,000 parcels of public lands suitable for stormwater capture projects.  Conversion or retrofit of these publicly-owned lands would mitigate nearly 40% of the polluted runoff in the region.

The 2002 publication, *"Rainfall Interception by Santa Monica's Municipal Urban Forest"* evaluates opportunities that trees and tree cover provide in capturing stormwater.  The study explains that the main stormwater management benefit provided is flood control because trees intercept rainfall.  In the City of Santa Monica, for example, the flood control benefit can be quantified in monetary terms, with an individual tree averaging $3.60 in diverted flood costs annually.  As a whole, the urban canopy of Santa Monica intercepts 1.6% of total annual rainfall; therefore, the study concludes that a well-maintained urban canopy has the opportunity to play an important role in stormwater infiltration and flood control.

The publication, *"Capturing Urban Stormwater Runoff: A Decentralized Market-Based Alternative"* from 2008 suggests that incentive-based strategies using well-distributed small-scale BMPs are more cost effective than a centralized approach for reducing runoff. Construction and maintenance costs are lower for a centralized solution due to economies of scale, but land costs associated with centralized facilities outweighs these savings.

*Improve Water Quality*

The ability of stormwater capture to improve water quality is another focus of research in the City of Los Angeles. The 2013 publication, *"Green Infrastructure Opportunities and Barriers in the Greater Los Angeles Region"* ascertains how the City would benefit from the adoption of LID ordinances or green infrastructure programs. The study concludes that some of the greatest cost savings benefits would be related to water quality improvements.

The 2009 report, *"Green Streets & Green Alleys Design Guidelines Standards: Rainwater Harvesting Program,"* looks directly at how improved stormwater capture standards would benefit the City of Los Angeles. The study concludes that a mix of streets, alleys, public right-of-ways/parkways, sidewalks, medians, and parking lots accommodating stormwater capture will filter and infiltrate stormwater, thereby improving water quality, water supply, and the overall health of the region's watershed.

*Decreased Dependence on Imported Water Sources*

Decreasing the region's dependence on imported water is needed as the availability and reliability of water from the Bay Delta and Colorado River is forecasted to decrease. The 2012 publication, *"Stormwater Capture: Opportunities to Increase Water Supplies in Southern California"* asks what strategies will be needed to increase the reliability of local regional water supplies. The study recommends that in cases where on-site LID and BMPs are the most cost-effective control method, they should be incorporated into development plans. Furthermore, the study recommends a process by which municipalities can conduct an audit of local government codes and policies to identify and resolve barriers to implementing green infrastructure. The study identifies the inability to receive credit for groundwater recharge benefits from green infrastructure as an example of a barrier to stormwater capture.

Another recent study covering stormwater capture within southern Los Angeles County was developed and funded by the Water Replenishment District of Southern California (WRD). In an effort to increase its sustainable water supply portfolio and to decrease its reliance on imported water, WRD has implemented a number of projects to capture more stormwater for groundwater recharge, and continues to look for more project opportunities. This study was conducted to evaluate the feasibility of implementing distributed stormwater recharge projects throughout the WRD region.

WRD's 420 square mile service area is located within Los Angeles' most urbanized watersheds including those of the Los Angeles and San Gabriel Rivers. Segments of these rivers and their receiving waters are impaired and subject to existing and proposed enforceable surface water quality regulations, including multiple total maximum daily loads (TMDLs). Because distributed stormwater recharge projects have the potential to improve water quality, they can be considered multi-benefit projects that can contribute to achieving TMDL compliance.

To identify catchments with greatest potential to provide distributed and subregional groundwater recharge and to help reduce pollutant loading of surface water bodies, the assessment considered a suite of factors important to siting groundwater recharge projects (e.g. geologic conditions, pre-existing contamination, dewatering) and local water quality objectives.

Analyses identified approximately 10% of the 270,000 acres within the WRD service area as opportunities for local and regional stormwater recharge where nearly 17,000 AF per year of potential water supply benefits can be expected. Of those, nearly 8,000 acres were identified as high priority areas that could contribute more than 4,000 AF per year to the local potable aquifers. In addition, the study identified that each acre of land in south Los Angeles County that receives well-sited retrofits could annually yield approximately 0.54 AF of groundwater recharge and more than 200 pounds of pollutant reduction.

Distributed stormwater capture projects identified by this report may be too costly for WRD, or a similar water supply agency, to construct on their own. The cost per acre-foot remains well in excess of the cost of imported water. However, because distributed stormwater capture is a multi-benefit effort, funding partners could be available for these projects. Other project partners who would realize benefits, as well as state and federal grants, can be used to fulfill the remaining needs of the project.

The pilot catchment identified during this project revealed the possibility for multi-agency collaboration. The City of Los Angeles Department of Public Works Bureau of Sanitation became an engaged and interested partner during the project because that organization had also designated the pilot catchment as a priority location for stormwater quality mitigation. The collaboration between WRD, LASAN and this project team resulted in an implementation grant from the State Water Resources Control Board Proposition 84 funding which is now being developed for construction in 2014.

Finally, MWD's "*Blue Ribbon Report,*" from 2011 is a clear recognition that local supplies and water use efficiency will play an increasing role in the region's water supply portfolio. The study presents a scenario analysis identifying potential supplies that could be added to the region's supply portfolio by 2060, including stormwater capture estimated at 250,000 to 500,000 AF per year. Interestingly, only centralized stormwater capture strategies are factored into this analysis, yet the conclusions demonstrate that the opportunity for stormwater capture to increase local supplies is large.

<u>Summary</u>

There is a significant body of research on stormwater capture that is relevant to the City of Los Angeles. Relevant studies informing the feasibility of stormwater capture in Los Angeles concludes that stormwater capture is a feasible strategy for achieving key stormwater goals, including groundwater recharge, removal of selected contaminants from urban runoff, reduction of peak flows, mitigation of flood risk, and providing multiple benefits to stakeholders.

Relevant studies addressing the opportunities for stormwater capture in the City have examined the potential to increase stormwater capture, achieve substantial improvements in water quality, and decrease the dependence of the City on imported water. Generally, these studies conclude that there are a variety of strategies to accomplish stormwater goals that are cost effective, provide multiple stakeholder benefits, and increase the resiliency of the region to water supply fluctuations, particularly in the face of climate change.

Overall, this research has positive implications informing the feasibility of stormwater capture to achieve important goals. In addition, the research has identified no shortage of opportunities and settings in which the City can implement stormwater capture strategies to achieve the multi-beneficial goals of improved water quality, groundwater recharge, flood control, habitat restoration, and adaptation to climate change.

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# APPENDIX E. TM 1.5 REGULATORY FRAMEWORK OF STORMWATER CAPTURE

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# Technical Memorandum 1.5

Date: April 2014

To: Andy Niknafs, LADWP

Copies to: Rafael Villegas, Virginia Wei, LADWP

From: Mark Hanna, Geosyntec Los Angeles

Subject: Stormwater Capture Master Plan: Task 1.5 -- The Regulatory Framework of Stormwater Capture
Geosyntec Project: LA0828

## PURPOSE AND OBJECTIVE

The purpose of this subtask was to review and investigate the regulatory drivers (including policies, ordinances, and incentive programs) pertinent to Citywide stormwater capture at the local, regional, state, and federal levels to inform the development of the Stormwater Capture Master Plan (SCMP). This review included those that both encourage stormwater capture, as well as those that pose a conflict. This effort not only focused on existing and forthcoming policies, ordinances, incentives, and regulations but also considered future growth and development in the City and the associated impact on stormwater capture and groundwater recharge efforts.

## APPROACH

The approach consisted of review and analysis of water rights, groundwater basins and storage incentive programs, and regulatory drivers of those not only directly addressing stormwater capture and groundwater recharge.

## REVIEW OF WATER RIGHTS, GROUNDWATER BASINS, AND STORAGE

The relationship between stormwater capture and infiltration to replenish groundwater basins warrants a review of water rights as well as groundwater basins and storage.

### Water Rights Review

This section provides a brief review of both surface and groundwater rights in the City.

Surface Water Rights

Three types of water rights govern surface water in California:

- Pueblo Water Rights - recognizes settlements under the Spanish and Mexican governments, and grants these pueblo rights to all streams and rivers flowing through the City and all groundwater beneath the City. This water may be used to satisfy water requirements of the original settlements and of land subsequently annexed to the city. These rights pertain to the City of Los Angeles' surface water rights, and the native groundwater contained within the San Fernando Basin, for the Upper Los Angeles River above the confluence with the Arroyo Seco.
- Riparian Water Rights - grants the owners of land adjacent to surface waters the right to divert enough water for use on the adjacent property. These pertain to water rights associated with property adjacent to a flowing stream. If not specifically disassociated through a sales or other agreement or decree, properties adjacent to a stream have the potential to divert water for beneficial use on that property. These rights are subject to availability after the pueblo diversions.
- Appropriative Water Rights - subordinate to pueblo and riparian water rights, are given for diversion and beneficial use of water to users away from the water body; between appropriators, the rule of priority is *"first in time, first in right."* These rights are applied for, and granted by, the State Water Resources Control Board.

Groundwater Rights

Adjudication refers to the distribution of groundwater rights to users. Under common law, landowners can extract as much groundwater from beneath their property as they can put to beneficial use. Adjudications serve to establish how much water is appropriate based on the hydrogeology and area of each owner's land and the attainment of beneficial uses. While adjudications can be time-, money-, and litigation-intensive, completed adjudications have contributed to successful use of groundwater throughout the state, particularly in the Los Angeles Region.

**Groundwater Basins and Storage**

Because of the relationship between stormwater capture and infiltration, and groundwater recharge, it is useful to review and understand local groundwater basins and their storage potential. While several technologies and best management practices (BMPs) are used to capture and treat stormwater, few reservoirs (both surface and groundwater) have been identified for the potential storage of this treated stormwater. In Southern California, groundwater basins have about 3.1 million acre feet (MAF) of **available** storage, or storage that can be pumped and used (Atwater, 2011). Significant capture and storage of stormwater is dependent upon greater and more efficient use of groundwater basins for storage.

The San Fernando Basin and the Central Basin are key to LADWP's efforts to capture and store stormwater for later use. Other relevant groundwater basins include the West Coast, Main San Gabriel, Hollywood, and Santa Monica groundwater basins. Attachment 1 shows a map of these basins and LADWP's water rights for each basin. Descriptions of these basins, and the associated challenges to greater use of these basins, are presented herein as these basins will likely play a significant role in projects to capture and use stormwater within the City of Los Angeles.

Groundwater Contamination

Although groundwater basins currently offer the most storage space available, many cannot be used because of contamination. Therefore, any water infiltrated or injected into these basins would become contaminated as well. This contamination can last decades and the stored water must be remediated before it can be placed to beneficial use.

Remediation is a time-intensive process that involves determining responsibility before groundwater remediation can begin. There are also technical obstacles to groundwater remediation efforts, including multiple pollutants and contamination across more than one aquifer zone.

Cleanup goals may evolve over time as new pollutants are identified, and target concentrations change based on new information about the risk and effects of pollutants. Although local examples exist, it can be extraordinarily difficult to find end uses for the treated water. Even though pumped and treated water is a valuable resource, agencies often lack the coordination or legal means to successfully bring this water to beneficial use. These problems are further complicated by the fact that several regulatory agencies have jurisdiction, and their regulatory requirements are often inconsistent.

San Fernando Basin

The San Fernando Basin is the largest of the Upper Los Angeles River Area (ULARA) basins. Following the 2005 water year, the basin had 504 thousand acre-feet (TAF) of available storage (volume that can be pumped) out of 3.1 MAF total capacity (Metropolitan Water District, 2007). The basin was adjudicated in 1979 (the San Fernando Basin "Judgment"), and the safe yield (amount of water that can be pumped without depleting the aquifer beyond its ability to be replenished naturally) was defined as 90,680 acre feet (AF) per year. The Judgment upheld the pueblo water rights of the City to all water derived from precipitation. The total extraction rights are 96,838 AF per year, with the difference allotted to the cities of Glendale, Burbank, and Los Angeles for water imported to the basin from these cities for storage. LADWP currently has 511,501 AF in storage credits in the San Fernando Basin, though only 184,666 AF is currently available.

The ULARA Watermaster assists the Court in its administration and enforcement of the provisions of the adjudication Judgment and any subsequent orders of the Court entered pursuant to the Court's continuing jurisdiction. It is composed of representatives from the cities of Burbank, Glendale, Los Angeles, and San Fernando, along with the Crescenta Valley Water District. The principle challenge to greater use of this basin is contamination by volatile organic compounds (VOCs), including trichloroethylene (TCE) and perchloroethylene (PCE), hexavalent chromium, 1,4-dioxane, 1,2,3-trichloroproprane (TCP), n-nitrosodimethylamine (NDMA), perchlorate, and other pollutants. Currently, LADWP is taking active steps to bring the basin back into production. Remediation efforts have been hindered due to many issues. There are multiple primary responsible parties present and allocating responsibility has proved difficult. In addition, contaminants have migrated beyond the boundaries of the Superfund Operable Units (OUs), and groundwater contamination patterns have been influenced by pumping.

To date, remediation efforts have focused on the North Hollywood OU, where TCE, PCE, chromium, 1,4-dioxane, and nitrate have severely impacted LADWP's water supply. While the U.S. Environmental Protection Agency (EPA) remedies are limited in scope, LADWP is planning a large, centralized treatment system for the basin. LADWP is currently conducting the Groundwater System Improvement Study (GSIS) for the basin to optimize its groundwater resources. This study is contributing to the necessary California Department of Public Health (CDPH) Policy Memo 97-005 (CDPH, 1997) permitting for *"extremely impaired sources,"* and ultimately the design and construction of the centralized treatment facility to treat and distribute potable groundwater. Effective use of this groundwater basin, which has a significant volume available for storage, is dependent upon groundwater cleanup and management strategies.

Central Basin

The Central Basin underlies the cities of Artesia, Bellflower, Cerritos, Compton, Downey, Huntington Park, Lakewood, Los Angeles, Long Beach, Montebello, Paramount, Pico Rivera, Norwalk, Santa Fe Springs, Signal Hill, South Gate, Vernon and Whittier. The basin has a total storage capacity of 13.8 MAF, with 1.1 MAF unused; 330 TAF are available for storage, although no formal storage plan has been established (and hence the storage capacity is underutilized) [Metropolitan Water District (MWD), 2007]. The basin was adjudicated by the California Department of Water Resources (CDWR), also the Watermaster for the basin, in 1965. Adjudicated rights are set at 267.9 MAF, although only 80% of this can be pumped each year. A 1991 revision allowed users to carry over 20% of their pumping allocations from one year to the next.

Safe yield in the basin is 125,805 AF per year. However, allowable annual pumping is 217,000 AF per year, with the Water Replenishment District of Southern California (WRD) being the agency that ensures enough replenishment water is delivered to make up any difference between safe yield and extractions. WRD has authority to replenish the basin, using imported and recycled water provided by the County Sanitation Districts of Los Angeles County. WRD determines the amount of supplemental recharge required, while the Los Angeles County Department of Public Works (LACDPW) is responsible for groundwater recharge at the Montebello Forebay Spreading Grounds under a permit issued by the Los Angeles Regional Water Quality Control Board (RWQCB). While all of this infrastructure to advance storage is already in place, there has until recently been lack of a storage plan for the available storage space to store volumes of water above the adjudicated amounts.

After multiple failed attempts, in 2012, several cities overlying the Central Basin met to determine if a compromise judgment could be reached. In December of 2013, Los Angeles Superior Court granted the motion by the Water Replenishment District, Long Beach, Los Angeles, Lakewood and other parties to amend the Central Basin Judgment to establish a legal framework for the storage and extraction of stored water in the Central Basin. The legal framework permits a groundwater pumper with adjudicated rights to store water (e.g. through stormwater infiltration) and subsequently extract that stored water without the extraction counting against its water rights and without having to pay the Replenishment Assessment.

Of yet unknown potential import for the Stormwater Capture Master Plan, a party (or parties) may be credited through the capture, treatment and recharge of stormwater into the Central Basin. If Los Angeles, or other parties to the Central Basin Judgment, implement a project that provides additional long-term reliable supply to the Central Basin, their annual extraction rights may be increased a commensurate amount, provided regular monitoring is performed to determine the actual amount of recharged water, among other provisions.

Another potential opportunity includes cooperative projects between two or more parties to the Central Basin Judgment may participate in a groundwater recharge project by sharing common costs and benefits, and hence can share, on a proportional basis, the additional extraction rights produced. Water rights gained from a project of this type likely would not be subject to the replenishment assessment upon extraction.

Other Groundwater Basins

There are several other groundwater basins where LADWP has interest, or may have interest in the future, and these basins have varying levels of opportunities and constraints related to stormwater capture.

*West Coast Basin*

The West Coast Basin overlies the cities of El Segundo, Manhattan Beach, Hermosa Beach, Torrance, Inglewood, Hawthorne, Gardena, Lomita, Carson, and Long Beach. The basin has a total storage capacity of 6.5 MAF, of which 1.1 MAF are unused; 120 TAF are available for storage (MWD, 2007). Most of this basin is confined; therefore, there have not been any locations identified for water spreading and groundwater recharge. Thus, recharge is only feasible through injection, which is limited by the Los Angeles RWQCB. In addition, brackish water located inland of the West Coast Basin barrier may limit the ability to store and extract water in some parts of the basin. In recent years, the Brewer and Goldsworthy Desalters have increased the ability to use this part of the basin. Overall, this basin has little opportunity for storage.

*Main San Gabriel Basin*

The Main San Gabriel Basin underlies the communities of Arcadia, Azusa, Baldwin Park, Bradbury, Covina, Duarte, El Monte, Glendora, Industry, Irwindale, La Puente, Monrovia, Rosemead, San Gabriel, San Marino, South El Monte, South Pasadena, Temple City, Walnut, and West Covina. The total storage capacity of the basin is 8.6 MAF, of which 800 TAF of this space is usable. However, supplemental imported water cannot be stored when the groundwater elevation at the key well exceeds 250 feet above mean sea level, which is currently exceeded (MWD, 2007). Thus, usable space is currently unavailable.

The basin was adjudicated in 1973, and the Watermaster changes the maximum pumping limit from year to year. It was 240 TAF and 210 TAF in fiscal year 2005/06 and 2006/07, respectively. In addition, the Watermaster has used cyclic storage accounts to store imported water against future replenishment requirement for three accounts (MWD, 2007). These accounts allow delivery of imported water when it is available, and the water is stored in the basin. This basin can be used efficiently when the groundwater table is sufficiently low to allow for storage.

*Hollywood Basin*

The Hollywood Basin is bounded on the north by the Santa Monica Mountains and the Hollywood fault, on the east by Elysian Hills, on the west by the Newport-Inglewood uplift, and on the south by the La Brea High. The total storage volume is 400 TAF, and it is unknown how much of this is unused or available. This basin is located beneath a highly urbanized setting, which has decreased the surface area open to direct percolation and thus limits natural recharge. Recharge is also limited by shallow groundwater (less than 20 feet deep in the central and eastern portions of the basin). Due to limited recharge, the safe yield is only 3,000 AF/year. Finally, contamination and high levels of total dissolved solids (TDS) make treatment necessary to meet drinking water standards. Together, these factors may make stormwater capture and groundwater recharge in the Hollywood Basin extremely limited.

*Santa Monica Basin*

The Santa Monica Basin underlies the cities of Santa Monica, Culver City, and Beverly Hills, as well as the communities of Pacific Palisades, Brentwood, Venice, Marina del Rey, West Los Angeles, Century City, and Mar Vista. The total storage volume is 1.1 MAF, and it is unknown how much of this is unused or available. The basin is unadjudicated, although there is production by the City of Santa Monica from 12 groundwater wells. Similar to the Hollywood Basin, this basin is highly urbanized with no spreading basins, and the Santa Monica Mountains represent the main source of recharge. In addition, several production wells have been impacted by Methyl Tertiary Butyl Ether (MTBE) and TCE contamination, which further limits the ability to store and extract water in this basin. Overall, these factors combine to limit the potential for stormwater capture and groundwater recharge in this basin.

*Sylmar Basin*

The Sylmar Basin is adjacent to the San Fernando Basin on the north.

The Cities of Los Angeles and San Fernando share rights to this basin equally, per the Sylmar Basin Stipulation of March 22, 1984. Several safe yield studies have been conducted on this basin, the most recent of which was conducted in 2012 and served as the basis for the Watermaster conditionally increasing the safe yield of this basin to 7,140 AF/Y (3,570 AF/Y for both San Fernando and Los Angeles. Los Angeles and San Fernando can store in the basin for later use. In 2012 the Watermaster also determined that credits could not be accrued for more than five years and devised a sustainable strategy for preserving most accrued credits.

*Verdugo Basin*

The Verdugo Basin lies northeast of the San Fernando Basin. Glendale has rights to extract 3,856 AF/Y and the Crescenta Valley Water District (CVWD) has rights to extract 3,294 AF/Y. Historically, Glendale has not has used its water rights completely, but it has recently expanded its pumping capacity.

There are no provisions in the Judgment for the use of stored water credits in this basin.

*Eagle Rock Basin*

The Eagle Rock Basin is located in the southeast corner of Upper Los Angeles River Area. It consists of only 800 acres and comprises 0.6 percent of the total valley fill in ULARA. It has a very small native safe yield. However there is a higher safe yield due to the fact that Los Angeles uses this Basin to store imported water. While Los Angeles has the right to extract, or allow to be extracted, the entire safe yield of Eagle Rock Basin, this city does not currently extract groundwater from this basin.

**REVIEW OF CITY AND COUNTY REGULATORY DRIVERS**

The City and the County of Los Angeles (County) have adopted stormwater capture related ordinances and policies at an increasing rate over the past two decades. In this section, the policies and ordinances reviewed and analyzed are those that both directly and indirectly influence stormwater capture. The process for adopting ordinances and policies varies between the City and County.

At the City level, ordinances and policies are adopted by the Los Angeles City Council. A motion by a council member, board member, and/or commissioner of a City department can direct staff to draft an ordinance and report back specific findings. The motion usually outlines general guiding principles that the final ordinance should include. A draft of the ordinance is then reviewed by the respective council committee(s) that relate to the specific subject area before it is brought back to City Council for a vote. Sometimes, the process may take a few years from start to finish. It is common for task forces to be developed in order to provide adequate representation between departments and community stakeholders, as well as technical guidance. Extensive community outreach is usually completed to ensure adequate public feedback before a final draft is produced. If a vote on a pending ordinance is not taken within two years or more since the initial motion was passed, then that item may expire (as exemplified by the expiration of the draft Stream Protection Ordinance (City of Los Angeles, 2007) on June 30, 2010).

At the County level, ordinances and policies are adopted by the LA County Board of Supervisors. Similar to the Los Angeles City Council, a board supervisor can make a motion directing staff to draft a specific ordinance. The respective County department is assigned to review and draft language for adoption. Extensive outreach is also conducted before a final draft is produced. Adopted Los Angeles County ordinances and policies usually only affect unincorporated areas. However, such ordinances can be used as a model for municipalities within the County to use for their own purpose. Examples include the Low Impact Development (LID) Ordinance (Los Angeles County, 2009) and the Plastic Bag Ban Ordinance (Los Angeles County, 2011), both of which were adopted by the County before the City of Los Angeles and other County municipalities adopted similar ordinances.

Provided herein is a summary of existing ordinances and policies, presented in chronological order from past to present. If prior ordinances have been replaced, generally only the current iteration is discussed

**The Greater Los Angeles County Vector Control District (GLAVCD)**

The Greater Los Angeles County Vector Control District (GLAVCD), formed in 1952 as the Southeast Mosquito Abatement District to control mosquitos emanating from the Los Angeles River, was renamed the GLACVCD in 1994. A vector is any arthropod, insect, rodent or other animal of public health significance capable of harboring or transmitting the causative agents of human disease (e.g. malaria, plague) to humans (GLACVCD, 2014). The GLACVCD provides scientific research, inspection, and control of multiple vectors such as mosquitos, black flies, and midges. In 2002, the GLACVCD began its Underground Storm Drain Program to eliminate this significant source of mosquitos, and their operations include inspecting neglected swimming pools and ponds, freeway drains, spreading basins, lakes, wetlands, street gutters, and many other mosquito breeding sources. The GLACVCD has several guidelines and policies applicable to stormwater capture which include screening cisterns and rain barrels with screens, and to eliminate water from standing for longer than 48 to 72 hours.

**Los Angeles Stormwater Ordinances 173494 and 172673 (Passed September 2000)**

Ordinances 173494 and 172673 modified Section 64.72 of the Los Angeles Municipal Code (LAMC). These ordinances outline the requirements necessary to control storm water pollution from sediments, erosion, and construction materials. These requirements were developed to be consistent with the requirements of the 2000 Los Angeles County Storm Water NPDES Municipal Permit.

**City of Los Angeles Landscape Ordinance (Adopted: May 1996, amended April 2005)**

The Landscape Ordinance, adopted in 1996 (City of Los Angeles, 1996), established consistent landscape standards for projects to enhance landscape quality, conserve water use, increase air quality, and reduce urban heat and glare effects. It established a "Landscape Point System," which is a way of evaluating projects based on the amount of points they earn from satisfying a suite of landscape requirements. The Planning Department reviews and either approves or disapproves the proposed landscape, although exceptions may be granted. The ordinance was later amended in 2005 to simplify and clarify existing provisions of the code by reducing redundancies and eliminating conflicts with the Zoning Code.

The ordinance itself does not refer directly to stormwater capture, but the majority of the proposed requirements/guidelines contribute indirectly to enhance stormwater capture. For instance, a low-water-consumption irrigation system could be required along with specific small scale BMPs, such as the use of permeable pavement in yard and/or garden areas of a building, rain barrels and/or small cisterns, planter boxes, rain gardens, and/or dry wells, among other BMPs.

*Recommendation:* The ordinance could enhance stormwater capture efforts by including more comprehensive policies that encourage or require the use of rain barrels, rain gardens, improved site planning (i.e., to increase the likelihood of stormwater capture), and changing the current 100 square feet minimum permeable paving area requirement to instead be a minimum percentage of the total area of new developments. In addition, the ordinance could benefit from a handbook, similar to that developed for the County's Drought Tolerant Landscaping Ordinance, which details how a project can incorporate the most effective water conservation elements.

**Los Angeles County Hydrology Manual (Prepared: January 2006)**

While not a regulatory driver per se, The Los Angeles County Hydrology Manual (LACDPW, 2006) provides guidance on how to implement stormwater capture BMPs mandated by other policies or ordinances. The Hydrology Manual outlines the LACDPW's hydrologic design procedures and serves as a reference and training guide. This manual contains charts, graphs, and tables necessary to conduct a hydrologic study within the County, along with examples that offer guidance on hydrologic methods.

The primary purpose of the manual is to explain the steps for converting rainfall to runoff flows and volumes using designated standards. Specifically, it establishes procedures to design storm drains using calculated rainfall that is converted to runoff. The manual's focus is on how runoff is collected and moves through storm drains, including a description of the factors affecting hydrology, flood protection policies implemented, as well as major watersheds and tributaries in the County. However, the manual neither mentions stormwater capture, nor does it mention that stormwater could become a supply source.

*Recommendation:* A future revision to the manual would benefit from including a reference to stormwater capture efforts throughout the County, as well as any guidance on how to design hydrologic systems that support stormwater capture facilities.

**City of Los Angeles Stream Protection Ordinance DRAFT (Prepared: 2007, never adopted and ultimately expired in 2010)**

The Stream Protection Ordinance (City of Los Angeles, 2007) was developed as a response to the loss of natural streams throughout the City's urban landscape. The intent was to restore and protect streams that have long been neglected throughout the urban infrastructure or that have been used primarily as storm drains. Goals were to stabilize stream banks, provide infiltration of stormwater runoff, remove stormwater runoff pollutants, maintain appropriate base flow of streams, provide flood protection, and provide wildlife migration corridors. While the ordinance was drafted in 2007, it was never adopted by City Council, remains in draft form, and the motion expired in 2010.

The ordinance proposed to establish minimum acceptable requirements for buffers to protect the streams, wetlands, and floodplains within the City through four different phases:

1. Stream Mapping for its inspections;
2. Stream Protection;
3. Flood Control to discourage armoring of streams/drainage courses; and
4. Stream Retrofit.

The ordinance aimed to improve urban stormwater runoff quality and infiltration. Simultaneously, it discouraged hillside storm drain pipes/structures or flood control pipes/structures that impact natural streams. If it returns for final approval, the ordinance could prioritize protecting streams in areas that have high stormwater capture possibilities.

The ordinance also outlined penalties for violations that may include civil penalties not to exceed $10,000; and/or criminal penalties in the form of a fine not more than $10,000 per violation, or imprisonment for not more than 90 days, or both.

*Recommendation:* While the intent of the ordinance was extremely complementary to stormwater capture efforts, it may prove to be infeasible for adoption because of its strict penalties and lack of incentives. If the ordinance is ever brought back for consideration, it could benefit from including incentives for developers and property owners, such as fast tracking of permits or a tiered system of implementation, similar to CALGreen, where some basic policies are required for every project, but stricter policies are offered as a voluntary option with an added incentive for implementation. The ordinance could also benefit from prioritization of certain streams over others for protection, thereby creating a phased approach for implementation based on areas of most importance.

**Green Streets Committee (Formed 2007)**

The City of Los Angeles Board of Public Works initiated the Green Streets Committee in 2007 requesting all City Council controlled Departments and Bureaus, and all proprietary Departments, to participate. The Green Streets Committee fosters communication and collaboration between city departments. The Committee works to identify and evaluate the effectiveness of existing green street features and to continue to identify funding and location options in which to upgrade with green street features. The Committee also facilitates the evaluation and implementation of green street features such as swales, vegetated curb extensions, and permeable pavers (to filter stormwater and runoff). The Committee has the following four subcommittees: Policy, Resource Development, Strategic Planning/Project Development, and Problem Solving/Technical. Successful green street projects that have come out of this initiative to date include a commercial street in downtown Los Angeles at Hope Street near 11th Street; Oros Street, a residential neighborhood in Elysian Park; and the Riverdale Green Street Project.

**Los Angeles County Low Impact Development Ordinance (Adopted: January 2009)**

The Los Angeles County LID Ordinance (Los Angeles County, 2009a) was one of three ordinances adopted by the County as part of their Green Building Program; the other two ordinances include the Drought Tolerant Landscaping Ordinance and the Green Building

Ordinance. While the LID ordinance only applies to unincorporated areas of the County, it does serve as a model for County municipalities to follow. The LID ordinance was designed to protect surface and groundwater quality, maintain the integrity of ecosystems, and control stormwater runoff at or close to the source. The main features of the proposed ordinance are that it:

- Prepares the development site for a likely "50-year capital design storm event";
- Prevents pollutants from leaving the development site in stormwater as the result of storms;
- Sets up the development of a LID Standards Manual; and
- Requires developments to install and maintain minimum site design features.

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.

*Recommendation:* The LID ordinance is designed to protect surface and groundwater quality, but does not include strategies on how to use recharged groundwater, or captured stormwater, as a supply source. Therefore, a potential revision could include strategies focused on how to use captured water as a supply source (i.e., creating individual cisterns where water can be accumulated for non-potable use).

**Los Angeles County Drought Tolerant Landscaping Ordinance (Adopted: January 2009)**

The Los Angeles County Drought Tolerant Landscaping Ordinance (Los Angeles County, 2009b) is one of the three ordinances adopted as part of the County's Green Building Program. This ordinance applies to all new projects within unincorporated areas of the County and seeks to conserve water resources by requiring landscaping that is appropriate to the region's climate.

The ordinance applies minimum standards, including the use of drought-tolerant plants for a minimum of 75 percent of the total landscaped area, while turf can only be used for a maximum of 25 percent of landscaped areas. The ordinance impacts stormwater capture because it creates guidelines for gardens that use rainwater as a resource. In order to support implementation of this ordinance, the County developed the Drought Tolerant Landscaping Handbook, which details how to implement such landscapes and incorporate designs that allow rainwater to be captured. The handbook also explains how to install a rain garden and provides a way to calculate the amount of possible water (in gallons) to be captured. It would be helpful if the City had a similar handbook to complement their Landscape Ordinance.

*Recommendations:* The ordinance could benefit stormwater capture efforts by requiring or incentivizing on-site stormwater capture and direct use.

**Los Angeles County Green Building Ordinance (Adopted: January 2009)**

The Los Angeles County Green Building Ordinance (GBO) (Los Angeles County, 2009c) is the last of three ordinances adopted by the County as part of their Green Building Program. In addition to conserving water, the GBO seeks to not only conserve energy, natural resources, and keep waste from landfills, but also to minimize impacts to existing infrastructure. The GBO's standards are applied to all new residential and non-residential projects in unincorporated areas of the County.

*Recommendations:* While the GBO sets powerful guidelines for water conservation, it does not include a strong stormwater capture element. The only element in the ordinance that could potentially support stormwater capture is the tree-planting requirement. Various projects have distinct requirements for the amount of trees required, and these trees must be approved from the drought-tolerant plant list produced by the County. Depending on where the trees are placed, it could potentially support stormwater capture. However, the ordinance could benefit from including ways that new projects incorporate stormwater capture features (i.e., building systems within existing buildings to capture stormwater and use for non-potable uses).

**City of Los Angeles Emergency Water Conservation Plan (Adopted: July 1990, Amended: August 2010)**

The City first adopted an Emergency Water Conservation Plan Ordinance in response to the drought conditions in the early 1990's which was last amended in August 2010. Five phases of water conservation are incorporated into the plan with prohibitions and water conservation measures steadily increasing by phase. As of February 2014, the City is implementing Phase II of the Emergency Water Conservation Plan which restricts outdoor watering to three days a week.

The circumstances that caused this Ordinance to be adopted highlight the importance of the SCMP as a means of securing local water supply resources. The ordinance itself neither impacts stormwater capture, nor does it conflict with any stormwater capture goals.

*Recommendations:* none.

**City of Los Angeles Green Building Code (Adopted: January 2011)**

This ordinance, adopted in on January 2011 (City of Los Angeles Department of Building and Safety, 2011), is based on the 2010 California Green Building Standards Code, commonly known as "CALGreen" that was developed and mandated by the State of California to attain consistency among the State's various jurisdictions. The objectives of the ordinance include reducing energy, water use, waste, and the carbon footprint of buildings. It creates standards that all new buildings, additions, and alterations valued at over $200,000 within the City must meet.

The ordinance has an impact on stormwater capture goals because it sets minimum standards for projects to manage stormwater drainage and retention during construction. In addition, post-construction stormwater management is incentivized. Faster permitting is considered for projects that incorporate permeable surfaces that are not less than 20% of the total parking, walking, or patio surface area. The same incentive is also offered for projects that include rainwater capture, storage, and re-use systems.

*Recommendations:* A potential revision to this ordinance could include either increasing the incentives for stormwater capture and/or requiring it for retrofits and additional new projects categories.

**City of Los Angeles Hillside Ordinance (Adopted: May 2011)**

The City of Los Angeles Hillside Ordinance (City of Los Angeles, 2011a) established a series of standards for residential development along hillsides in order to protect hillsides and prevent out-of-scale development in the City. The proposed regulations address setback requirements, maximum residential floor area, height and story limits, lot coverage, grading limits, off-street parking requirements, fire protection, street access, and sewer connections.

The ordinance has little reference to its impact on stormwater capture. However, it does provide an exception to maximum grading requirements if grading is done for the purposes of water storage tanks and required stormwater retention improvements. Also, infiltration is discouraged on hillside residences for slope stability issues.

*Recommendations:* The ordinance could benefit stormwater capture efforts by requiring or incentivizing on-site stormwater capture and direct use.

**City of Los Angeles Interim Irrigation Guidelines (Adopted: April 2011)**

The Interim Irrigation Guidelines, adopted by the City in 2011 (City of Los Angeles, 2011b), are landscape design and installation requirements for certain landscape projects aimed at conserving outdoor water use. These guidelines are a requirement of State Assembly Bill 1881, which requires all local agencies to update local landscape ordinances so that they are at least as effective as the Model Water Efficient Landscape Ordinance (MWELO) developed by the CDWR. The guidelines apply to new landscape installations or landscape rehabilitation projects in the City. Requirements include:

- Developing a water budget that landscape irrigation cannot exceed;
- Completing a soil management report;
- Grouping most plants by hydrozones;
- Utilizing automatic irrigation controllers and sensors; and
- Developing and implementing a post-installation irrigation and maintenance schedule.

*Recommendations:* The guidelines relate to stormwater capture by requiring that landscape plans incorporate on-site *"stormwater BMPs,"* and identify any applicable rain harvesting or catchment technologies. A potential revision to the guidelines could require the incorporation of rainwater harvesting.

**City of Los Angeles Low Impact Development Ordinance (Adopted: May 2012)**

Similar to the LID ordinance produced for the County, the City's LID ordinance (City of Los Angeles, 2012) is a set of site design approaches and BMPs that are designed to address runoff and pollution at the source. The City's LID ordinance has significant benefits to stormwater capture because it requires that every development or redevelopment over 500 square feet manage stormwater runoff to the maximum extent possible, including (in order of priority): infiltration, evapotranspiration, and capture and use, with all site stormwater runoff being treated through a high removal efficiency biofiltration/biotreatment system. Each site must capture the ¾-inch storm, or the 85$^{th}$ percentile storm, whichever is smaller.

A BMP Handbook (City of Los Angeles, 2011c) was developed in order to support implementation of the LID ordinance and present stormwater management programs designed to reduce pollutants in stormwater and urban runoff. The handbook provides guidance for developers and individuals involved in new development and redevelopment projects. In addition, the City's project review and permitting process is reviewed, along with identification of stormwater mitigation measures, and references to source and treatment control BMP information.

*Recommendations:* Since the LID ordinance represents a distributed stormwater capture solution, it relies on individuals to implement and achieve its goals. As a result, the ordinance would benefit from greater education on the importance of stormwater capture and how to successfully implement such strategies using the most cost-effective methods. Even though the handbook is extremely helpful, a smaller and a more targeted handbook could be beneficial for providing specific recommendations. For example, a recommendation could identify the type of rain barrels to purchase and how to incorporate them properly into existing development or redevelopment plans.

**City of Los Angeles Re-Code LA (in process, January 2014)**

The City is undertaking a five-year project that constitutes the first comprehensive update of the City's Zoning Code since 1946. The update is a vital component of the City's Development Reform Initiative to create a more efficient, predictable, and transparent process for development. The goal of the project is to create livable communities, encourage sustainable development, and foster economic vitality – aided through creating a revised, user-friendly zoning code for the City of Los Angeles.

*Recommendations:* There is potential to incorporate stormwater capture into this process, while also reviewing the draft for conflicts. Specifically, building and plumbing codes could be updated to enable/encourage capture and on-site use (with appropriate treatment) of rainwater. Additionally, it would be beneficial to develop and obtain approvals from the LA Department of Building and Safety for standard plans and specifications for stormwater capture practices.

**Summary and Recommendations**

An increasing number of policies and ordinances related to stormwater capture have been produced in the past two decades. While the City adopted a Landscape Ordinance in 1996 (City of Los Angeles, 1996) and attempted to adopt a Stream Protection Ordinance in 2007 (City of Los Angeles, 2007), it was actually the County that adopted the first major stormwater capture ordinances, the most significant of which was the 2009 Green Building Program that included the LID, Drought-Tolerant Landscaping, and Green Building ordinances. The County's adoption of these ordinances paved the way for the City to later adopt its own LID ordinance (City of Los Angeles, 2012).

Even though the City has made progress in recent years to enhance stormwater capture policies, there is still more that can be done. The current Landscape Ordinance could benefit from a handbook, similar to that done for the County's Drought-Tolerant Landscaping Ordinance, in order to guide the development of landscapes that can capture and use stormwater. Furthermore, The City's Hillside Ordinance (City of Los Angeles, 2011a) and Building and Safety Code could benefit from increased research and mapping to better define infiltration constraints and allow for expanded stormwater capture and use.

Finally, LADWP could improve stormwater capture efforts by adopting the Draft Stream Protection Ordinance (City of Los Angeles, 2007) or an amended version of it. It is recommended that the ordinance be revised in order to have a greater likelihood acceptance to decrease proposed penalties and instead offer more incentives.

## REVIEW OF INCENTIVE PROGRAMS

Where local governments are unable to implement policies or ordinances, stormwater incentive programs are tools that local governments can use to encourage the capture, treatment, and infiltration of stormwater runoff on-site in order to enhance groundwater recharge throughout the City and augment regional water supplies. Incentive mechanisms that support stormwater capture could include:

- Stormwater Fee Discount – Require a stormwater fee that is based on stormwater runoff quality and/or volume. If property owners reduce the need for service by reducing the volume of runoff through on-site stormwater capture, the fee is reduced.
- Development Incentives – Offered to developers during the process of applying for development permits. Examples may include zoning upgrades, expedited permitting, reduced stormwater requirements, and increases in floor area ratios to incentivize installation of on-site stormwater capture facilities.
- Grants/Ratepayer Incentives – Provide direct funding to property owners and/or community groups for implementing a range of stormwater capture practices, such as offsetting potable use or implementing stormwater capture.
- Rebates & Installation Financing – Provide funding tax credits, or reimbursements to property owners who install specific practices.
- Awards & Recognition Programs – Provide marketing opportunities and public outreach for exemplary projects. May include monetary reward.
- Stormwater Storage Contracts – Agreement between one party ("Seller") that owns or has an ownership interest in recoverable stormwater and a second party ("Buyer") that has an interest in purchasing the function and use of said storage.

In addition to these types of incentive programs, responsible entities can create additional incentives for stormwater capture by relaxing permit requirements to encourage increased quantity and quality of planted areas in development sites. This would provide developers and designers with flexibility to meet development standards through practices that promote on-site capture, treatment, and infiltration of stormwater runoff.

No single stormwater program is expected to achieve the goals of the SCMP alone. Rather, a broad menu of options specifically tailored to promote groundwater recharge and reduce potable water demand is needed. Based on a review of a number of local and non-local incentive programs (see TM 1.3), recommendations were developed for tailoring incentive programs to promote infiltration in areas where groundwater recharge is feasible, and in areas where groundwater recharge is not feasible, to promote stormwater capture and on-site use.

**Incentives**

In general, private property owners may require significant incentives or contractual agreements to retrofit properties to meet public needs. Incentives must offer sufficient economic value and be relatively easy to implement to garner participation levels high enough to yield significant groundwater recharge and/or potable water demand reduction.

Groundwater recharge is most feasible in areas with specific geophysical characteristics (for a detailed discussion of these characteristics, see Technical Memorandum 2 of the SMCP). In these areas, incentive programs should target infiltration-based practices, such as rain gardens, bioretention, infiltration basins, and permeable pavement. If rain barrels or other storage-based practices are incentivized in these areas, then the overflow could then be directed to on-site infiltration areas where feasible.

Outside of groundwater recharge areas, infiltration of harvested rain and stormwater will not augment the groundwater basin. Therefore, in these locations, it would be more effective to incentivize capture, storage, and on-site use of stormwater to offset potable water demand.

The existing City programs reviewed (LADWP Residential Drought Resistant Landscape Incentive Program, for example) generally provide rebates to property owners that build, operate, and maintain on-site stormwater facilities, as well as technical information and assistance. Other incentives mechanisms that could be employed to further incentivize these practices include grants, awards or public recognition for exemplary projects, and stormwater fee discounts (see recommendations below regarding evaluation of utility fees and rates).

The existing incentive programs are currently geared toward single family homeowners and businesses in the City. Therefore, the City could consider extending the programs to more customers, such as multi-family residential and institutional (i.e., churches, college campuses, etc.), to encourage implementation on larger parcels and promote greater public education.

**Utility Fees and Rates**

Stormwater and water fee & rate structures should be reviewed and adjusted (if needed) to align with City program goals. Potential adjustments may include increasing fees and/or rates to cover the cost of expanding programs and /or increasing the gradation in rate tiers to effectively incentivize on-site stormwater capture and reduced potable water use.

For example, if the difference between Tier 1 and Tier 2 water rates[1] were high compared to a stormwater fee discount being offered, then the value of the discount may effectively incentivize participation. Further, if the difference in rate tiers were high enough to substantially offset long-term costs, then aggregated distributed systems, such as those operating in the California rooftop solar industry, could install, operate, and maintain stormwater capture systems and charge a water rate to the property owners that is less than the rate that they would pay for Tier 2 water.

## REVIEW OF STATE AND FEDERAL REGULATORY DRIVERS

The ability to implement projects to capture stormwater will be influenced by a highly-complex regulatory environment and the State and Federal levels. Understanding this regulatory environment is essential to planning for and implementing stormwater capture projects, and to integrating and managing the region's water resources effectively. The complexities underscore the need for integration among agencies. This section identifies key regulatory requirements that may affect stormwater capture planning, and investigates how these regulatory drivers may work together or conflict with the goals and vision of the SCMP.

State and federal laws, regulations, and requirements relating to water quality and supply, and the regulatory programs managed by distinct regulatory agencies or divisions to implement them, can create incentives and/or conflicts and challenges that must be considered when planning for stormwater capture and use.

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[1] When a water user (district, municipality, customer, etc.) uses water in amounts regularly allocated to them, based on water rights, prior year demands, or standardized allocations, the user pays for the water at cost, called Tier I. If a user uses more water than allocated, they must pay a higher rate, called Tier II, for this additional water.

A number of different agencies regulate water for its various uses with oversight and guidance from the EPA. The State Water Resources Control Board (SWRCB) and the Los Angeles RWQCB have authority under the federal Clean Water Act (EPA, 1972) and the State's Porter-Cologne Water Quality Control Act (SWRCB, 1969) to regulate the discharge of water (of whatever origin) to the surface and groundwaters of the Los Angeles region.

Water that is treated and distributed for municipal and domestic uses ("drinking water") is regulated by the California Department of Public Health (CDPH) Drinking Water Program, which is within the Division of Drinking Water and Environmental Management, and which administers both the federal and California Safe Drinking Water Acts. The Department of Toxic Substances Control (DTSC) and the water boards, again with oversight from EPA, regulate groundwater that is contaminated with hazardous substances and other pollutants.

In addition, the Los Angeles County Flood Control District (LACFCD) operates a complex flood control system designed to protect property and human life by channelizing storm flows and sending water to the ocean (see TM 1.3 for discussion). Because water is handled and regulated by many different agencies (each of which handles a different "kind" of water), conflicts and inefficiencies arise. Stormwater capture projects may require coordination among all of these agencies and regulations.

Most stormwater capture projects implemented to date have focused on centralized facilities (see TM 1.3); the potential for stormwater capture and direct use via smaller, more distributed recharge is increasing (also see TM 1.3), particularly given requirements for local retention, infiltration, and recharge.

Achieving a significant increase in stormwater capture and use will require storage, so that stormwater captured during wet periods can be used during dry periods. The region's groundwater basins offer by far the greatest potential for storage of captured stormwater, but each groundwater basin is unique and has unique opportunities and constraints (see discussion above). The San Fernando and Central Basins likely offer the greatest opportunity to store large volumes of stormwater, but the San Fernando Basin is challenged by groundwater contamination, and the Central Basin challenged by limited locations for recharge, and, until recently, a well-defined storage plan.

This section is organized as follows:

- Overview of Key Regulatory Drivers

- Review of Recent Regulatory Drivers with Potential Opportunities for the SCMP
- Review of Regulatory Drivers Posing Potential Conflicts with the SCMP
- Summary of Key Findings and Recommendations

**Key Regulatory Drivers**

This section provides an overview of key regulatory drivers.

Clean Water Act (CWA)/Porter-Cologne Water Quality Control Act

The Clean Water Act (CWA) (EPA, 1972) builds upon earlier laws and regulations and was promulgated to attain the goals of restoring and maintaining the *"chemical, physical, and biological integrity of the Nation's waters,"* and to promote the goals that waters be *"fishable"* and *"swimmable"* wherever attainable. Under the CWA, water quality standards form the basis for water quality regulation. Water quality standards consist of designated beneficial uses, water quality criteria or objectives, and anti-degradation requirements. Designated beneficial uses express the desired or planned uses of a specific water body, such as recreation or drinking water supply. Water quality objectives are the allowable concentrations of constituents or the specific conditions that protect the designated beneficial uses, and may be either narrative or numeric. The State's anti-degradation policy implements federal anti-degradation requirements and stipulates that existing uses must be protected, and that *"high quality waters"* be maintained and protected.

The Porter-Cologne Water Quality Control Act (or California Water code, CWC) (SWRCB, 1969) implements the CWA on a state level, and also includes groundwater as *"waters of the State."* The CWC establishes the California SWRCB and nine RWQCBs to implement the federal CWA and state water quality regulations. The CWC requires that each RWQCB develop a Water Quality Control Plan (basin plan) that outlines the water quality standards and a plan of implementation, and that the State Water Board develop a water quality plan for the State's ocean waters (the Ocean Plan). In addition, the California Toxics Rule (CTR), which was promulgated by EPA in May 2000 (EPA, 2000), provides numeric water quality criteria for certain *"priority pollutants."* The CTR water quality criteria are implemented by the SWRCB's *"Policy for the Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California"* (the State Implementation Plan, or SIP), which was adopted in March 2000.

Together, these regulations provide the basis for regulation of point and nonpoint source discharges within California. These regulations are enforced through discharge requirements, typically issued via National Pollution Discharge Elimination System (NPDES) permits, Waste Discharge Requirements (WDRs), or waivers of WDR. Water quality standards can also be implemented via Total Maximum Daily Loads (TMDLs), which specify the amount by which both point and nonpoint sources must be reduced to attain ambient water quality standards.

Federal/California Safe Drinking Water Act (SDWA)

The Federal and California Safe Drinking Water Acts (SDWA) (EPA, 1974; CA Office of Environmental Health Hazard Assessment, 1986) differ from the CWA and CWC in that they intend to protect municipal water quality at the point of delivery *("at the tap")* instead of in the environment. The CDPH currently implements both the federal and California SDWA, although it has recently been proposed to move these functions to the SWRCB.

The SDWA also has the potential to impede stormwater capture projects that require cleanup of contaminated groundwater basins, in that even when contaminated groundwater can be treated to meet drinking water standards, using treated water for potable uses can be challenging. The CDPH's Policy Memorandum 97-005 (CDPH, 1997) provides guidance for "*direct domestic use of extremely impaired sources"* and has a primary goal of assuring "*that all Californians are, to the extent possible, provided a reliable supply of safe drinking water."* The policy promotes the *"basic principle that only the best quality sources of water reasonably available to a water utility should be used for drinking"* and places a preference on using the water sources that present the least risk to the public, based on the assumption that contaminated sources always pose a greater health risk because treatment may fail. As a result, it has been difficult to incorporate treated groundwater as a significant water supply source, particularly true where multiple contaminants exist, as the policy specifies that *"generally, … allowing direct potable use of an extremely impaired source should be limited to a single toxic contaminant or a limited number of similar chemicals that can be reliably treated with the same process."* The policy also discourages blending of treated water with water from high quality sources. However, the memo does note that *"there are extremely impaired sources in California that need to be cleaned up and for which the resulting product water represents a significant resource that should not be wasted. In some situations, it may be reasonable to consider the use of these treated extremely impaired sources for domestic use."* Therefore the potential for extremely impaired groundwater to be used beneficially exists.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, aka *"Superfund"*) (EPA, 1980) is a federal law designed to clean up sites contaminated with hazardous substances and *"pollutants of concern."* Many groundwater basins in California contain designated Superfund sites, including the San Fernando Groundwater Basin. Ultimately, remediation of these sites, which the Superfund legislation attempts to achieve, or a detailed plan for managing contaminated groundwater may be required before they can be used efficiently for storage of captured stormwater, recycled water, or other *"new"* water sources. Unfortunately, and contrary to its name, Superfund has very limited financial resources, and the process of determining which party is responsible for remediation is time-consuming and contentious. Additionally, property owners may be wary of allowing stormwater generated offsite to be infiltrated on their property for fear that potential contamination of this water may incur unwanted liabilities. In the near-term, stormwater capture for recharge may be limited in areas constrained by these issues.

SWRCB Recycled Water Policy and Other Considerations Related to Recycled Water Use

The SWRCB Recycled Water Policy (SWRCB, 2013) recognizes the need to increase recycled water use in California. Specifically, this policy mandates the quantity of water to be recycled in the near future; establishes the roles of the SWRCB, RWQCBs, CDPH, and California DWR; and explains the role of Salt/Nutrient Management Plans (SNMPs). The policy requires every groundwater basin in California to have a SNMP. These plans specify the practices used to capture, treat, and store stormwater, and thus the relevant infrastructure that needs to be designed, constructed, and implemented. Note that SNMPs are to be updated every five years, at which point they will consider the impacts of new stormwater capture and storage projects to the region.

Note also that increasing recycled water use may require increasing stormwater capture, both so that salinity objectives in groundwater basins can be met and to meet recycled water blending requirements imposed by CDPH. According to CDPH's 2008 Draft Regulation for Groundwater Recharge Reuse (CDPH, 2008), the initial maximum recycled water contribution (RWC) for surface application groundwater recharge reuse projects (GRRPs) would be 20% unless reverse osmosis and subsequent advanced oxidation treatment are used, in which case the blending requirements would be individually reviewed by the CDPH. Thus, the use of recycled water to recharge groundwater basins will require the addition of another source of recharge water to meet blending requirements, and stormwater is the most likely candidate for this other water source. These blending requirements are based on a rolling five year average, so the variable flow of stormwater does not present an impediment to its use for this purposed.

EPA Approach to Integrated Planning/Stormwater

The EPA has recently issued guidance on *"integrated planning,"* in which one or more agencies assess opportunities for water quality improvement and determine how to spend limited resources to achieve the greatest benefit. EPA's 2011 memorandum found that, *"Today, the EPA, states, and municipalities often focus on each [CWA] requirement individually for protecting water quality…This approach may have the unintended consequence of constraining a municipality from implementing the most cost-effective solutions in a sequence that addresses the most serious water quality issues first,"* (EPA, 2011). Integrated planning refers to the process of assessing a municipality's financial capabilities in addition to its wastewater and systematically funding these programs according to their needs. In addition, the framework introduces the idea of collaborating with other organizations to pursue mutually cost-effective solutions. Essentially, integrated planning provides a means of establishing and implementing regional priorities in a cost-effective way. Conclusions from this memorandum that are particularly relevant to the SCMP include:

- An Integrated planning approach to water resources management can facilitate the use of sustainable and comprehensive solutions, including green infrastructure, that protect human health, improve water quality, manage stormwater as a resource, and support other economic benefits and quality of life attributes that enhance the vitality of communities in a cost-efficient manner.
- Integrated planning can assist in accounting for State requirements and planning efforts and incorporate State input on priority setting and other key implementation issues. This can be done through:
    - Use of existing flexibilities in the CWA and its implementing regulations, policies and guidance,
    - Maximizing the effectiveness of funds through analysis of alternatives and the selection and sequencing of actions needed to address human health and water quality related challenges and non-compliance,
    - Evaluate and address community impacts and consider disproportionate burdens resulting from current approaches as well as proposed options.

This approach may help to align water infrastructure projects with other community priorities, extend the projected adequacy of current water supplies by balancing needs and financial reality, and implement integrated stormwater management controls for wet weather flows to provide augmented water supply (aquifer storage and recovery).

**Recent Regulatory Drivers with Potential Opportunities for the Stormwater Capture Master Plan**

Additional regulatory policies and programs acknowledge the fact that water conservation measures, including increased stormwater capture, are necessary for meeting future water supply goals. Recent regulatory drivers that could influence the future of stormwater capture are discussed herein.

Assembly Bill No. 1881: The Water Conservation in Landscaping Act

Enacted in 2006 and in effect since January 1st of 2010, Assembly Bill 1881 (AB 1881, The Water Conservation in Landscaping Act) (CDWR, 2006) mandated improved water efficiency in landscaping for both new and existing development statewide. The law required that all municipalities within the State implement a model ordinance as described within the bill, or create one equivalent to the model.

Of significance to stormwater, the bill mandates that municipalities require grading plans as part of their landscaping ordinance. The bill states that grading plans are highly encouraged to require retention of runoff on site, but stops short of making it a requirement. In this way, the bill makes room for including stormwater capture as component of AB 1881 compliance, but it is incumbent upon localities themselves to adopt such a strategy.

AB 1881 does contain requirements that may influence stormwater capture in the City by decreasing the quantity of dry weather runoff. For example, AB 1881 restricts the use of overhead irrigation within 24 feet of impermeable surfaces. Stipulations such as this, combined with a successful implementation of AB 1881, should lead to an overall reduction in landscaping contributions to dry weather runoff.

SBX7-7: California Water Conservation Act of 2009

Enacted in 2009, Senate Bill SBX7-7 (SBX7-7, The Water Conservation Act of 2009) (CDWR, 2009) mandates a 20% reduction in urban per capita water use by 2020. SBX7-7 seeks to achieve these reductions by requiring urban water retailers to develop 2015 and 2020 urban water use targets. The bill requires agricultural suppliers to implement efficient water management practices.

Similar to AB 1881, SBX7-7 is aimed at water conservation. While it includes no requirements for stormwater capture as a means of achieving water conservation, it makes room for such strategies to be implemented at the local level.

With regard to stormwater capture, SBX7-7 mandates that CDWR *"shall promote implementation of regional water resources management practices through increased incentives and removal of barriers consistent with state and federal law."* If this provision of the bill is successfully implemented, it could facilitate the adoption of stormwater capture strategies by promoting standards of resources management, including LID and BMP implementation.

Rainwater Harvesting Guidelines (City of Los Angeles)

In November 2009, The City of Los Angeles Rainwater Harvesting Program released *A Homeowner's "How-To" Guide* (City of Los Angeles, 2009). The guide demonstrates that any property owner can manage rainwater in some way, whether through a rain barrel, a rain garden, or redirecting a downspout to a pervious area, and illustrates the large potential for small-scale stormwater capture projects. The guide promotes both use of captured rainwater as well as infiltration. While the guide promotes all types of solutions, the SCMP could specify instances in which use is favorable to recharge, such as in areas above or tributary to unconfined aquifers, or in areas where infiltration has the potential to negatively impact groundwater contamination.

2012 MS4 Permit

In November 2012, the RWQCB adopted a new NPDES permit for the municipal separate storm sewer system ("MS4") (Los Angeles RWQCB, 2012), which became effective in December 2012. The MS4 permit governs municipal discharges of stormwater and non-storm water (including dry weather discharges) by the LACFCD, the County, and 84 cities within the watersheds of Los Angeles County. In addition to incorporating new requirements from 33 TMDLs and specifying certain BMPs, the 2012 MS4 permit incorporates several new features that are likely to result in increased infiltration of stormwater. For example, the 2012 MS4 permit allows permittees to develop Watershed Management Programs (WMPs) and Enhanced Watershed Management Programs (EWMPs). The EWMP compliance path is designed to enable permittees to collaborate within specific Watershed Management areas in order to implement multi-benefit regional projects that, where feasible, retain all non-stormwater runoff and stormwater runoff from the 85$^{th}$ percentile, 24-hour storm event.

Permittees that collaborate to develop WMPs or EWMPs are also required to demonstrate that there are LID ordinances in place, or develop LID ordinances. In addition, they must develop and implement green streets policy for transportation corridors. These requirements are likely, in the long run, to result in increased infiltration of stormwater and non-stormwater flows.

<u>Los Angeles County/U.S. Bureau of Reclamation Basin Study (Ongoing)</u>

The Los Angeles Basin Stormwater Conservation Study is a partnership among the U.S. Bureau of Reclamation (USBR), the LACFCD, and several local agencies to bridge the gap between current and future water supply and demand in the region. The Basin Study will investigate long-term flood control and water conservation impacts in Los Angeles County and will recommend potential changes to the operation of stormwater capture systems, modifications to existing facilities, and development of new facilities (USBR, 2009). Additionally, it will investigate the impacts of climate change on stormwater capture and conservation. The final version of the report is expected in 2015, and its recommendations should be considered and incorporated, where appropriate, into the SCMP.

**Regulatory Drivers Posing Potential Conflicts for SCMP**

<u>Potentially Responsible Party (PRP) Rules</u>

There are several areas that could provide additional physical space and conditions for stormwater capture. As neighborhood-level infiltration projects have demonstrated, nearly any open space can be developed for similar projects. One such example of available space is public school campuses, or specifically, their playground facilities, which could be renovated to promote infiltration. However, public school administrators have expressed concerns regarding the environmental liability associated with implementing such projects (i.e. by receiving stormwater polluted with contaminants of concern, the school could become designated as a Superfund site per CERCLA, and the school would be considered a PRP). Thus schools have not proceeded with implementation of stormwater capture projects. Enabling such projects may require legislation to resolve issues related to the potential environmental liability.

<u>General Waste Discharge Requirements Permit Regulating Discharge in Groundwater Aquifers</u>

There are a number of WDRs that regulate discharges to groundwater basins. In 2008 and 2009, the Los Angeles RWQCB issued WDRs and Water Recycling Requirements for groundwater enhancement and treatment program for non-potable (Los Angeles RWQCB, 2008) use and for Title 22 recycled water for non-irrigation uses over the groundwater basins underlying the coastal watersheds (Los Angeles RWQCB, 2009b), respectively. The 2009 Order specifies various end-uses of the recycled water, each corresponding to a specified level of treatment and based on Title 22 requirements; it explicitly states that it is not applicable to stormwater discharges or storage. Similarly, the 2008 Order focuses on the level of treatment for recycled water to be discharged to groundwater, but does not apply to stormwater. Finally, a 1993 Order establishes WDRs for specified discharges to groundwater in the Santa Clara River and Los Angeles River Basins (Los Angeles RWQCB, 1993); similar to the other two Orders, stormwater discharges are not regulated by this permit. However, as water agencies begin planning for stormwater capture, they should be aware of the limits in these permits that are intended to protect groundwater quality.

**Summary and Recommendations**

Key findings and recommendations for the Regulatory Drivers section are presented herein.

<u>Findings</u>

In recent years, many water agencies have identified stormwater capture and storage as a key component of the City's future water supply portfolio. The SCMP serves to promote this goal by assessing the technical and regulatory hurdles that need to be addressed so that a successful stormwater capture and storage program can be established and maintained in the Los Angeles Region.

Increasing stormwater use will require storing water that arrives and is captured during wet periods for use during dry conditions. Because groundwater basins offer by far the greatest potential to store large volumes of water, groundwater basins will be needed for any significant stormwater capture and storage project. In particular, the San Fernando and Central Basins offer significant potential for storage, but their use is currently limited by contamination and by the lack of a storage plan.

Groundwater regulation, especially regulation of contaminated groundwater, is complicated in that several agencies enforce and oversee their respective programs, and the standards imposed by different agencies often conflict. For instance, a groundwater remediation project must comply with regulations specified by DTSC, EPA, a RWQCB, and CDPH. In addition, finding an end use for treated groundwater (e.g., potable water supply or discharge to surface streams) is particularly challenging. A successful stormwater capture and storage program depends on efficient use of these groundwater basins, which will in turn require close coordination among regulatory agencies.

Recently, several pieces of legislation that could promote stormwater capture and storage have been passed on a regional and state-wide level. The State Recycled Water Policy mandates specific goals for stormwater use by 2020 and 2030. Assembly Bill No. 1881 and Senate Bill SBX7-7 specify water conservation measures that promote stormwater capture and storage as a means of compliance. Guidance documents such as Los Angeles Rainwater Harvesting Program's Homeowner's "How-To" Guide are becoming available to help individuals set up small-scale stormwater capture and use systems.

In addition, several current projects will aid the development of the SCMP. The USBR/LACFCD Basin Study will provide specific recommendations for basin management that can ultimately be applied to stormwater storage programs. Similarly, processes such as the Central Basin Judgment Amendment Process may help facilitate the use of groundwater basins for storage of stormwater and other "new" water supplies, and can serve as an example for regulators to develop stormwater storage policies in basins across the County.

Potential conflicts to the SCMP are PRP restrictions and restrictions on discharges. PRP restrictions refer to instances in which a stakeholder is not willing or able to develop a stormwater capture and/or storage project due to external constraints such as environmental liability. In addition, there is a suite of RWQCB policies that place strict limits on discharges to groundwater and discharges of groundwater to surface waters; these limitations may restrict our ability to clean up and manage contaminated groundwater basins, and to efficiently store and extract captured stormwater.

Recommendations

The success of the SCMP will depend in part on its technical feasibility, cost benefit ratio, the availability of funding, and its ability to conform to regulations. Regulatory success hinges on the ability of different regulatory and water agencies to work collaboratively in managing a resource that spans the boundaries of several agencies. For instance, LACFCD will need to work with LADWP to move stormwater from the point of origin to a point of recharge, and will need a RWQCB-issued permit to perform this work. Developing conceptual agreement between these parties is a critical step before moving forward; communication needs to continue now in small-scale, local processes, such as the development of enhanced watershed management plans, to lay the foundation for a wide-scale master plan.

WRDs may apply drinking water standards to discharges to groundwater basins designated for groundwater recharge, with the notion that the water will eventually provide water supply.

However, this is impractical because those standards are enforced at the point of use (i.e., the tap) rather than the environment, and extracted water is treated prior to delivery. Thus, such limits may prevent the discharge of stormwater, whose quality is widely variable by nature and cannot always comply with strict numeric limitations. LADWP may need to work with the RWQCB to obtain a more appropriate approach to regulating waters intended for recharge.

Finally, the SCMP must recognize that stormwater is but one part of a comprehensive, integrated water supply strategy. Increasing recycled water use and augmenting groundwater supplies with recycled water, for example, will require close coordination with stormwater capture plans and implementation. Contaminated groundwater supplies will need to be managed and remediated to enable the use of groundwater basins; to do this, an end use must be found for treated groundwater, and opportunities for creative, collaborative partnerships between water agencies, PRPs, and regulatory agencies should be explored. Ultimately, regulatory agencies, water supply agencies, flood control districts, and many other stakeholders and agencies will need to work closely together to integrate multiple regulatory requirements, and to demonstrate flexibility where it is needed to achieve regional goals.

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# APPENDIX F. TM 2.1 STORMWATER CAPTURE POTENTIAL CITYWIDE AND BY SUBWATERSHED

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# Technical Memorandum 2.1

| | |
|---|---|
| Date: | May 8, 2014; Revised August 2015 |
| To: | Rafael Villegas, LADWP |
| From: | Mark Hanna, Rebecca Batchelder, Aaron Poresky, Scott Mansell, Will Lewis, Geosyntec Los Angeles |
| Subject: | Stormwater Capture Master Plan: Tasks 2.1 and 2.2–Quantify Stormwater Capture Potential Citywide and by Subwatersheds<br>Geosyntec Project: LA0282 |

## PURPOSE AND OBJECTIVE

The purpose of Tasks 2.1 and 2.2 of the Los Angeles Department of Water and Power's Stormwater Capture Master Plan (SCMP) was to quantify the stormwater capture in the City of Los Angeles and tributary areas in the existing condition and to determine the volume of stormwater that could potentially be captured using aquifer recharge (infiltrated stormwater) and direct use (stormwater captured and used for non-potable demand) at both centralized and distributed facilities. Geophysical and anthropogenic constraints, opportunities, and priorities were considered in this analysis to ground this estimate in the reality of the physical and political landscape of Los Angeles and establish attainable goals for stormwater capture. Two future scenarios (aggressive and conservative with regards to stormwater capture) were considered to establish a range of potential capture.

This technical memorandum presents the delineation of the subwatersheds, the two hydrologic models used, the quantification of existing capture, the constraints, opportunities, priorities, and methods used to develop scenarios for potential capture, and the quantification of potential capture under these future scenarios. While the purpose of Task 2 is to quantify the potential stormwater capture, Task 3 of the SCMP will identify specific alternatives that will begin to meet this potential.

It is important to note that the stormwater capture potential estimated for this task is the long term potential, or potential that could be realistically achieved by 2099, **not** the potential capture that should be expected from the implementation of the SCMP, which has a 20 year timeline. Figure 1 illustrates this distinction.

## SUBWATERSHED DELINEATION AND AQUIFER CLASSES

The purpose of this task was to divide the study area into regional subwatersheds (areas that drain to a single location) that would allow for stormwater capture potential results to be meaningfully interpreted as well as allow for distinct regions to be handled differently within the model.

### Subwatershed Delineation

The LA County LSPC model includes 1001 subwatersheds in which are either partially within the boundaries of the City of Los Angeles or that are upstream of an area within city boundaries (we refer to these small subwatersheds as subbasins for the remainder of this report to distinguish them for the larger regional subwatersheds that were developed for this analysis). This includes portions of the greater Los Angeles River, Ballona Creek, Dominguez Channel, and Malibu Creek Watersheds (Figure 2). Each of these subbasins was split between the fraction that lies within the City and the fraction that lies outside of the City. For subbasins that were split between City and non-City areas, it was assumed that all non-City areas flowed onto City areas for the purposes of accounting for flows in and out of City boundaries.

These 1001 subbasins were grouped into 17 regional subwatersheds using major watersheds (as listed above and shown on Figure 2), centralized facilities, the river network, and aquifer delineations (Figure 3). Major watersheds were the first delineation, so that each regional subwatershed is contained within a single watershed. Next, these groupings were subdivided into areas that were tributary to centralized facilities (dams and spreading grounds). In a few cases where several of these centralized facilities were in series along a river, multiple facilities were included in a single regional subwatershed. For example, the Pacoima Spreading Grounds regional watershed includes the areas draining to the Pacoima Dam and the Lopez Spreading Grounds (Figures 2 and 3). The regional subwatersheds were then divided to assign individual regional subwatersheds to major tributaries. For example Verdugo Wash was separated from the main Los Angeles River into its own regional subwatershed (Figure 3). The underlying aquifers were then used to further divide regional subwatersheds. For example, the Ballona Creek watershed was split into the Upper Ballona Creek and Lower Ballona Creek regional subwatersheds using the location where the river network left the boundaries of the Los Angeles Forebay (Figure 3). Finally, remaining coastal areas that were not part of a major watershed were grouped by location into two regional subwatersheds. Table 1 shows the area and imperviousness of these regional subwatersheds for the total SCMP study area and the City of Los Angeles area.

**Table 1. Regional subwatershed attributes**

| Regional Subwatershed | Total Watershed Area (acres) | Area Within City of LA (acres) | % Impervious (Total) | % Impervious (City) |
|---|---|---|---|---|
| **Big Tujunga Dam** | 52,574 | 0 | 0% | - |
| **Devil's Gate Dam** | 20,413 | 0 | 8% | - |
| **Dominguez Channel** | 46,006 | 6,095 | 63% | 70% |
| **Hansen-Tujunga SG** | 45,492 | 11,485 | 5% | 19% |
| **Lower LAR** | 22,622 | 15,047 | 61% | 63% |
| **Narrows and Arroyo Seco** | 25,856 | 13,816 | 41% | 44% |
| **North SM Bay** | 33,634 | 24,967 | 16% | 13% |
| **Lopez-Pacoima SG** | 30,388 | 6,099 | 11% | 41% |
| **South SM Bay/Pen** | 32,829 | 15,531 | 48% | 54% |
| **Verdugo Wash** | 16,197 | 1,251 | 23% | 18% |
| **Northeast San Fernando Valley** | 19,632 | 8,753 | 27% | 14% |
| **East San Fernando Valley** | 45,403 | 41,500 | 49% | 48% |
| **Branford SB** | 3,127 | 2,955 | 56% | 56% |
| **West San Fernando Valley** | 100,012 | 73,208 | 28% | 36% |
| **Lower Ballona Creek** | 64,233 | 49,500 | 46% | 46% |
| **Upper Ballona Creek** | 15,984 | 15,984 | 55% | 55% |
| **Other LAR** | 14,393 | 10,566 | 61% | 62% |

## Aquifer Classes

Aquifer extents were obtained as discussed in Technical Memorandum 1.2: Gather and Review Background Information (December 4, 2013). Each aquifer underlying the City of Los Angeles was classified according to the ability of the City to pump the aquifer for use in their distribution network. Aquifer classification was used to categorize existing and potential recharge by aquifer, prioritize capture facility implementation, and determine the most appropriate type of capture. The class assigned to each aquifer is shown in Table 2.

Aquifers under LADWP’s control were assigned to Class 1. These aquifers are all in the San Fernando Valley where groundwater recharge will be most directly beneficial to the City (Figure 4). Aquifers under regional control, but still potentially usable for the City of Los Angeles were assigned to Class 2. These were located primarily near the Los Angeles Forebay area near Glendale, Pasadena, and Hollywood (Figure 4). Finally, perched aquifers or aquifers where recharge is unlikely to be usable for the City of Los Angeles in the near future were assigned to

Class 3. These were located primarily in the western and southwestern portions of the city closest to the coast (Figure 4). Areas that do not have an underlying aquifer, such as mountainous areas, were unclassified. Table 3 defines the aquifer classes.

**Table 2. Classification of aquifers within the City of Los Angeles**

| Groundwater Basin | Class |
|---|---|
| **San Fernando** | 1 |
| **Sylmar** | 1 |
| **Eagle Rock** | 2 |
| **Hollywood** | 2 |
| **L.A. Forebay (to Central)** | 2 |
| **(Perched Above) Central** | 3 |
| **(PA) Santa Monica** | 3 |
| **(PA) West Coast** | 3 |
| **(PA) San Gabriel** | 3 |

**Table 3. Portion of the City of Los Angeles overlying each aquifer class**

| Aquifer Class | % Of City Area |
|---|---|
| **1** | 38% |
| **2** | 13% |
| **3** | 20% |
| **Unclassified** | 29% |

## EXISTING CAPTURE

For this task, a watershed model was employed to estimate the current stormwater capture occurring in the City, both in existing centralized facilities and incidental distributed capture on pervious surfaces.

### Modeling Approach

LSPC

The Los Angeles County's Loading Simulation Program in C++ (LSPC) was chosen as the primary model to determine existing recharge because it is calibrated for the study area and has the ability to simulate continuous rainfall, irrigation, evapotranspiration, runoff, percolation, routing in stream networks, storage in dams, and storage and infiltration in spreading grounds. The County's LSPC model was also developed to include representations of the existing dams and spreading grounds in the SCMP study area making results between City and County modeling efforts consistent with each other. It is also adaptable and customizable for implementation of additional distributed and centralized facilities in future tasks.

The coefficients which determine how much irrigation is applied to irrigated land uses in the model were calibrated based on the average annual irrigation values in the 2010 Urban Water Management Plan (LADWP, 2010). The adjustment of these values did not have a significant effect on runoff rates during storm events, so the calibration of LSPC for runoff was still considered valid.

A more detailed discussion of the modeling approach used is presented in the Geosyntec Technical Memorandum entitled: "Stormwater Capture Master Plan: Recommended Hydrologic Modeling Approach" (September 30, 2013).

<u>Model Corroboration and Adjustment</u>

While LSPC offers many advantages for this application, it was primarily created and calibrated for quantifying runoff and water quality rather than stormwater infiltration. Rainfall and irrigation applied to the land can either runoff directly to the stream, percolate as interflow or shallow groundwater to the stream, evapotranspire, or reach the aquifer as deep groundwater (Figure 5). Because runoff volumes were calibrated against actual data, there was confidence in the predicted runoff rates. However, the split between the other fates for water that does not runoff is driven by user-defined parameters, and therefore has higher uncertainty. Most critically for this application, there was uncertainty in how water that flows below the shallow soil layer is split between evapotranspiration and deep groundwater.

Because of this uncertainty in how accurately LSPC would predict how much of the water that does not run off reaches deep groundwater, the Groundwater Augmentation Model (GWAM) developed jointly by the US Bureau of Reclamation and the Council for Watershed Health was used to corroborate the model results. GWAM does not have the routing or BMP modeling capabilities that LSPC has, but it contains many more soil and vegetation types and therefore models evapotranspiration more robustly than LSPC (Figure 5), as discussed in the "Stormwater Capture Master Plan: Recommended Hydrologic Modeling Approach" (9/30/2013). GWAM calibrated the volume of aquifer recharge to measured values from the U.S. Geological Survey (Reichard et al., 2003). Therefore, LSPC was relied upon for determining the split between the water that is retained and the water than runs off, but GWAM was relied upon for determining how much of the water that does not run off reaches deep groundwater in order to leverage the strengths of both models.

Both models were run for the same period of record (1986-2011), and the average annual volumes of precipitation, irrigation, evapotranspiration, runoff, and deep groundwater from both models were compared for each overlapping subbasin. This comparison showed that the results were quite consistent between the two models for precipitation, irrigation, and runoff volumes (Figure 6). While a small amount of scatter exists, especially at larger volumes, there is no systematic deviation from the 1:1 line indicating that the models provide overall consistent results for these parameters. Furthermore, total average annual precipitation, irrigation, and runoff volumes differ by only 3%, 7%, and 5%, respectively between two models. Therefore, no adjustment was made to these parameters of the water budget, and the consistency between the two models increased confidence in the model results.

However, LSCP systematically modeled a lower fraction of the water infiltrated into shallow groundwater being lost to evapotranspiration than in GWAM. Because GWAM is the more reliable model for this split, it was determined that LSPC was likely overestimating the portion of infiltrated water that was making it past the root zone. To correct this, the split between recharge and evapotranspiration in LSPC was adjusted until the total average annual recharge volume for the overlapping basins were within 10% of the results from GWAM (this was accomplished with a 25% reduction in the recharge volume). This adjustment resulted in a good agreement between the models (Figure 7). The adjusted models do not show a systematic deviance from the 1:1 line and the scatter around the line is reasonably small, especially at smaller volumes. Both models also showed a fairly consistent split of approximately 15% of the infiltrated water going to recharge and remaining 85% going to evapotranspiration for all subbasins (Figure 7).

## Existing Capture Results

<u>Water Budget in Existing Conditions</u>

Model inputs and results for the existing condition are summarized in Figure 8 as a water budget for outdoor water use within the City. Approximately half (50%) of the 831,400 acre-feet of incoming water came from precipitation, while 20% entered the City boundaries from upstream areas[1]. A relatively large portion (30%) of the inflow came from irrigation in urban vegetation and agricultural land uses within the City boundary (Figure 8). This volume (247,100 acre-feet) agrees well with the values in the 2010 Urban Water Plan (244,000 acre-feet and 249,000 acre-feet, using two separate methods) (LADWP, 2010).

In the existing condition, approximately 11% (92,400 acre-feet) of this incoming water goes to recharge. Approximately 3.5% (29,400 acre-feet) of the incoming flow is captured in the existing centralized spreading grounds. The 2013 annual report for the Upper Los Angeles River Area (ULARA) Watermaster indicates that the long term annual average (1968-2012 water years) total recharge in existing spreading grounds (not including imported water) is 27,033 acre-feet, a difference of 9% from what the model predicts (LADWP, 2013). Given that the period of record is not the same as the model, and the parameterization and uncertainty in the model, this indicates a very good agreement with measured values.

The remaining 7.5% (63,000 acre-feet) of the incoming flow naturally reaches the deep groundwater through pervious land areas throughout the City. This form of infiltration is referred to as incidental distributed recharge throughout this technical memorandum (Figure 8). However, only water that is infiltrated above aquifers accessible to the City (approximately 35,000 acre-feet) is contributing to local water supply. acre-feetacre-feet

The vast majority of the incoming flow to the City leaves as surface discharge (44%) or evapotranspiration (45%) (Figure 8). The high fraction of the volume that evapotranspires is the result of the high irrigation volume which is intended to completely evapotranspire. The 365,600 acre-feet of surface discharge is where potential for increased stormwater capture lies. As stated previously, it would not be feasible or desirable to infiltrate 100% of this existing runoff. As such, the following sections of this report describe the methodology for estimating what percentage of this available runoff could be realistically captured.

Geographic Distribution of Recharge

Table 4 shows the average annual recharge in the existing spreading grounds from the model and from the ULARA annual report. Note that the LSPC model combines the Hansen and Tujunga Spreading Grounds, so their volumes are reported together. Hansen and Tujunga Spreading

[1] Note that this figure includes some flow from non-City areas within subbasins that were split between City and non-City boundaries that may not actually flow towards City boundaries. However, these are very small compared to the other upstream sources, and uncertainty about drainage patterns within individual subbasins does not allow for detailed delineation of subbasins at an even finer scale.

Grounds accounts for the majority of the recharge volume in centralized facilities, with much more recharge than the other three spreading ground combined.

**Table 4. Average annual recharge in existing centralized facilities.**

| Centralized Facility | Modeled Average Annual Capture (acre-feet) | Monitored Average Annual Volume (LADWP, 2013) (acre-feet) |
|---|---|---|
| Pacoima Spreading Ground | 5,380 | 6,847 |
| Lopez Spreading Ground | 490 | 589 |
| Hansen and Tujunga Spreading Grounds | 23,130 | 19,045 |
| Branford Spreading Basin | 370 | 551 |

Figure 9 shows the average annual incidental distributed recharge rates in each subbasin within the City in acre-feet per acre. As can be seen from this figure, the highest recharge rates currently occur in the western portion of the San Fernando Valley due primarily to soils with better drainage characteristics in that area as well a higher percentage of pervious land area.

Figure 10 shows the combined average annual incidental distributed recharge and the recharge in centralized facilities for each regional subwatershed for aquifers that can contribute to water supply. As with the recharge rates, the total recharge volume is highest in the West San Fernando Valley and East San Fernando Valley subwatersheds, and most of this is going into Class 1 aquifers. When combined with centralized facilities, the Hansen-Tujunga Spreading Ground subwatershed contributes the most recharge overall.

## POTENTIAL CAPTURE

### Approach

The purpose of this analysis was to determine how much of the inflow to the City could realistically be captured. This capture comes in several different forms:

1. Recharge of aquifers from centralized facilities (e.g., dams and spreading grounds)
2. Recharge of aquifers from distributed infiltration BMPs (e.g., rain gardens, etc.)
3. Recharge of aquifers from incidental distributed recharge (pervious land uses)
4. Capture of stormwater for direct use (e.g., cisterns, etc.)

It is not realistic, nor desirable, to capture all rainfall. Areas of the City differ in terms of the feasibility or desirability of infiltration and capture. For example, some areas are constrained by high groundwater tables such that infiltration in these areas is not sufficiently treated prior to reaching the water table which can contribute to groundwater pollution. Other areas have poor drainage or high liquefaction potential making infiltration difficult which may limit those areas to direct use types of capture only. To estimate feasible capture, the following steps were taken:

1. Identified of which areas of the City were most feasible for BMP implementation based on their characteristics, opportunities, and constraints;
2. Defined two future BMP implementation scenarios that varied based on the categorization developed in step 1;
3. Modeled future BMP implementation scenarios.

These steps are described in further detail in the following sections.

**Categorization of City Areas**

Areas of the City were analyzed for their geophysical characteristics and anthropogenic constraints related to their ability to capture water. Geophysical characteristics are static characteristics that are not likely to change in the future (e.g. geology) while anthropogenic characteristics are those characteristics that could be mitigated or changed in the future (e.g. contamination in aquifers).

<u>Geophysical Characteristics</u>

The geophysical characteristics considered included:

- **Obstacles to infiltration**: Areas with mapped landslides, a depth to groundwater <10', or a slope >10%
- **Soils**: Hydrologic soil type and infiltration rate (Hydrologic Soil Group A-D)
- **Geology**: Pervious or impervious
- **Aquifer**: Aquifer class according to its usability for City of Los Angeles
- **Liquefaction potential**: Based on US Army Corps of Engineers mapped areas of high liquefaction potential

Using these characteristics, each area of the City was categorized into one of three geophysical categories as shown in Figure 11 and summarized below:

- **Category A**: These areas have no obstacles to infiltration, infiltrative soils, pervious geology, and overlie the highest priority aquifers. They are very conducive to infiltration BMPs.
- **Category B**: These areas have no obstacles to infiltration, but may have either soil with poor drainage, impervious geology, high liquefaction potential, or overlie lower priority aquifers. These areas are somewhat conducive to infiltration BMPs.
- **Category C**: These areas may have obstacles to infiltration, or have a combination of soils with poor drainage, impervious geology, high liquefaction potential, or they may overlie lower priority aquifers. These areas are most conducive to direct use BMPs.

Figure 12 shows the geographic distribution of the geophysical categories within the City. Most of the Category A and B areas are in the San Fernando Valley and over the Los Angeles Forebay, indicating that these are the areas where additional BMP implementation will be most beneficial. Category C areas can still have BMP implementation, but it will likely need to focus on direct use BMPs which are typically not able to capture as much as infiltration BMPs as cost effectively.

Anthropogenic Constraints

The anthropogenic constraints are factors making infiltration less feasible or desirable under current conditions that may be changed in the future. The sources used for this information were discussed in detail in Technical Memorandum 1.2: Gather and Review Background Information (December 4, 2013). The constraints included in this analysis are:

- **Contaminant plumes and contaminated groundwater:** mapped contaminant plumes where any infiltrated water would become polluted
- **Superfund Sites:** locations of contamination on the EPA's Superfund list for cleanup where infiltration is likely to be contaminated
- **Dewatering Permits:** locations where groundwater is pumped away in order to protect foundations where additional stormwater infiltration would merely increase the amount of pumping required
- **Production Wells:** locations where groundwater is extracted where infiltration could lead to pollution of groundwater without sufficient time for it to be treated prior to pumping
- **Heavy Industrial Land uses:** land uses most likely to contribute a high contaminant load to groundwater

Areas subject to these constraints were mapped using all available data. For contaminant plumes, dewatering permits, and production wells, data were not available for all areas of the City, although data were available for the majority of the geophysical Category A and B areas. Therefore, there may be some additional anthropogenic constraints which were not covered in this analysis, but these are likely to be in geophysical Category C areas, which are already constrained for infiltration.

The total area affected by anthropogenic constraints for each subwatershed was quantified by summing the areas covered by polygon datasets (e.g., contaminant plumes) and the areas within 300 feet of a point dataset (e.g., dewatering permits). The fraction of all industrial land uses within the subwatershed that were classified as heavy industrial was also quantified, and areas overlapped by multiple anthropogenic were not double-counted. The locations of the anthropogenically constrained areas are shown in Figure 13. The fraction of each regional subwatershed affected by anthropogenic constraints is shown in Table 5.

Because anthropogenic constraints are characteristics that could be changed in the future (e.g., contaminant plumes could be mitigated), consideration of anthropogenic constraints was a factor used in scenario development. When anthropogenic constraints were considered for a scenario, the fraction of the area of each subwatershed affected by anthropogenic constraints was removed from geophysical Category A and B areas and added to geophysical Category C areas. For industrial areas, in addition to the other anthropogenic constraints, the fraction of the industrial land that was heavy industrial was removed from geophysical Category A and B areas and added to geophysical Category C areas. This reclassification process is described further under the conservative scenario discussed below. In general terms, this process reclassified areas that would have otherwise been considered good opportunities for aquifer recharge, and classified them as areas more suited to direct use BMPs.

**Table 5. Percent of each subwatershed affected by anthropogenic constraints**

| Regional Watershed | % of Total Watershed Area Constrained by factors other than Heavy Industrial Land Use | % of Total Industrial Constrained by Heavy Industrial Land Use |
|---|---|---|
| **Dominguez Channel** | 1% | 52% |
| **Hansen-Tujunga SG** | 1% | 6% |
| **Lower LAR** | 1% | 79% |
| **Narrows and Arroyo Seco** | 5% | 71% |
| **North SM Bay** | 0.3% | 68% |
| **Lopez-Pacoima SG** | 0.2% | 64% |
| **South SM Bay/Pen** | 1% | 70% |
| **Verdugo Wash** | 0.2% | 36% |
| **Northeast San Fernando Valley** | 2% | 82% |
| **East San Fernando Valley** | 8% | 57% |
| **Branford SB** | 6% | 69% |
| **West San Fernando Valley** | 0.3% | 71% |
| **Lower Ballona Creek** | 1% | 81% |
| **Upper Ballona Creek** | 3% | 20% |
| **Other LAR** | 1% | 87% |

## Future Scenarios

Using the geophysical categorization and anthropogenic constraints, two future scenarios were developed by altering the following variables:

- **Anthropogenic constraints:** Anthropogenic issues were either considered to constrain BMP implementation, or they were assumed to be resolved and no longer constraining BMP development.
- **BMP implementation rates:** The fraction of an area where BMPs were implemented was changed based on geophysical categorization and level of aggressiveness.
- **BMP size:** The capture volume and drawdown time of BMPs was changed based on geophysical categorization.
- **Centralized facility capture rate:** The percent of runoff captured by centralized facilities (after distributed BMPs applied) at each subwatershed was varied based on aquifer class and level of aggressiveness.

In development of these variables, the Los Angeles Basin Study (LA Department of Public Works 2013) was used as guidance, and input was sought from the Technical Advisory Team. Similar to the Basin Study, only the developed, 100% impervious land uses in LSPC were assumed to have BMP implementation. No BMPs were applied to the pervious land uses. The Basin Study also estimated reasonable BMP implementation rates for each of these developed land uses to be achieved by 2095 based on the expert opinions of members of the Water Augmentation Study Technical Advisory Committee (WAS-TAC). These were recently updated to the values shown in Table 6. These were used as the starting point to estimate implementation rates for each scenario which are discussed in detail for each scenario below.

**Table 6. WAS-TAC expert consensus on reasonable BMP implementation rates by 2095**

| Land Use Description | Percent of Area with BMP Implementation |
|---|---|
| **High Density Single Family Residential** | 30% |
| **Low Density Single Family Residential Moderate Slope** | 20% |
| **Low Density Single Family Residential High Slope** | 5% |
| **Multi-family Residential** | 30% |
| **Commercial** | 35% |
| **Institutional** | 75% |
| **Industrial** | 60% |
| **Transportation** | 65% |
| **Secondary Roads** | 55% |

The Technical Advisory Team recommended basing the BMP capture depth on multiples of the 85$^{th}$ percentile storm depth required for all development and redevelopment in the City of Los Angeles MS4 permit. The 85$^{th}$ percentile, 24-hour storm depth was calculated for all 71 rain gages used in the model within the SCMP study area, so each subbasin has an 85$^{th}$ percentile storm depth specific to its region. Because this is the minimum depth of capture required for all redevelopment by the MS4 permit for the City of Los Angeles, it was assumed to apply to all land uses, even in geophysical Category C areas. In geophysical categories A, B, and C, the 85$^{th}$ percentile design depth were multiplied by 1.5, 1.2, and 1, respectively, due to the assumption that more capture will take place where it is more desirable and less constrained.

The drawdown time for the BMPs was also affected by the geophysical categorization because BMPs in category A areas are likely to drain much faster than BMPs in Category C areas. For example, an infiltration BMP in fast-draining soils (typical of a Category A area) will have a short drawdown time, while a cistern used for direct use (typical of a Category C area) will drain very slowly as the water is used for irrigation. The drawdown times assigned to geophysical Category A, B, and C was 24 hours, 48 hours, and 15 days, respectively. The sections below describe the details of each future scenario.

Aggressive Scenario

This scenario is meant to represent a future condition in which stormwater capture is pursued aggressively and impediments to stormwater capture are resolved to the extent possible. It was assumed that all anthropogenic constraints were mitigated, so the geophysical categorization was not adjusted for them. The implementation rates for Category C areas were taken directly from the WAS-TAC implementation estimates. These were increased by 10% and 20% to obtain the BMP implementation for Categories B and A, respectively (Table 7). Capture in proposed centralized facilities was calculated separately for each subwatershed. In each subwatershed, the volume captured in distributed facilities in that subwatershed was subtracted from the runoff volume. The volume captured in any existing centralized facilities in that subwatershed was then subtracted from the remaining runoff. For subwatersheds overlying Class 1 or 2 aquifers, 60% of the remaining runoff was also captured in centralized facilities. For subwatersheds overlying Class 3 or unclassified aquifers, 30% of the remaining runoff was also captured. The total capture for centralized facilities was equal to the sum of the volume captured in existing facilities and potential future facilities.

**Table 7. BMP implementation rates for each geophysical categorization in the Aggressive Scenario.**

| Land use | A | B | C |
|---|---|---|---|
| High Density Single Family Residential | 50% | 40% | 30% |
| Low Density Single Family Residential with Moderate Slope | 40% | 30% | 20% |
| Low Density Single Family Residential with Steep Slope | 25% | 15% | 5% |
| Multi-family Residential | 50% | 40% | 30% |
| Commercial | 55% | 45% | 35% |
| Institutional | 95% | 85% | 75% |
| Industrial | 80% | 70% | 60% |
| Transportation | 85% | 75% | 65% |
| Secondary Roads | 75% | 65% | 55% |

Conservative Scenario

This scenario was meant to be an estimate of what volume could be potentially captured within the City even under more conservative assumptions. As such, it is meant as the lower bound of potential capture. Anthropogenic constraints were applied for this scenario so that the geophysical categorization was affected by them. This had the effect of skewing the categorization for impervious land uses (those that will receive BMP implementation) more to category C (Figure 14).

The distributed BMP implementation rates for geophysical category C areas were set at 50% of the Category C areas for the aggressive scenario. These values were increased by 10% and 20% to obtain the distributed BMP implementation rates for categories B and A, respectively (Table 8). Capture in proposed centralized facilities was calculated separately for each subwatershed. In each subwatershed, the volume captured in distributed facilities in that subwatershed was subtracted from the runoff volume. The volume captured in any existing centralized facilities in that subwatershed was then subtracted from the remaining runoff. For subwatersheds overlying Class 1 or 2 aquifers, 30% of the remaining runoff was also captured in centralized facilities. For subwatersheds overlying Class 3 or unclassified aquifers, 15% of the remaining runoff was also captured. The total capture for centralized facilities was equal to the sum of the volume captured in existing facilities and potential future facilities.

**Table 8. BMP implementation rates for each geophysical categorization in the Conservative Scenario.**

| Land use | A | B | C |
|---|---|---|---|
| High Density Single Family Residential | 35% | 25% | 15% |
| Low Density Single Family Residential with Moderate Slope | 30% | 20% | 10% |
| Low Density Single Family Residential with Steep Slope | 22% | 12% | 2% |
| Multi-family Residential | 35% | 25% | 15% |
| Commercial | 37% | 27% | 17% |
| Institutional | 57% | 47% | 37% |
| Industrial | 50% | 40% | 30% |
| Transportation | 52% | 42% | 32% |
| Secondary Roads | 47% | 37% | 27% |

## Modeling Approach

### Distributed Capture

To model these scenarios, a method was developed to simulate the implementation of the various distributed BMPs into the model. With 1001 subbasins with widely varying attributes, varying types of BMPs, and no information regarding design details, it was not feasible to place hundreds or thousands of individual distributed BMPs into the LSPC model. To model distributed BMPs, a series of unit-scale LSPC models were created to determine the percent capture in a generic

BMP capturing runoff from 1-acre of impervious land under various locations (rain gages), sizes, and drawdown times (Figure 15).

The model uses a volume-discharge relationship to split runoff for the generic BMP between capture (representing infiltration or direct use) and overflow, which runs off downstream. A unit-scale model was created and run for the entire period of record (1986-2011) for all 71 rain gages in the model, for 10 BMP sizes, and 10 drawdown times making a total of 7100 separate unit-scale LSPC models in order to capture all possibilities of location, size, and drawdown times. This process was automated for efficiency. The modeled BMP sizes varied to allow capture of 0.1 to 3 inches of rainfall over the 1-acre area. Drawdown times ranged between 2 hours and 15 days. For each of the 7100 models, the percent capture was determined as the total volume captured in the BMP divided by the total volume of runoff from the 1-acre of land. These percent captures were then used to create nomographs for every rain gage in the model. Figure 16 shows three examples of the 71 nomographs for rain gages from different regions. Using these nomographs, the percent capture for can be determined for any BMP size with any drawdown time capturing runoff from impervious land uses anywhere within the SCMP study area. For example, a BMP with a capture depth of 1 in/acre, and a 24 hour drawdown time in Burbank would have a percent capture of 80% (Figure 16). Because these are scaled to 1-acre impervious area, and all treated areas within the model are impervious, the percent capture can be scaled up (or down) for any size of contributing impervious area to the BMP.

The percent of volume captured obtained from these nomographs were used to determine the percent capture for each BMP size and drawdown time throughout the City. This percent capture was then multiplied by the BMP implementation percentage to obtain the total percent of runoff volume captured in distributed BMPs for each land use in each subbasin. The runoff volume from the existing condition from that land use from that subbasin was then reduced by that percentage, and the reduced volume was added to the capture volume. This was done for all land uses in all subbasins within the City to obtain the total capture in distributed facilities, and the results were broken down by aquifer type, regional subwatershed, and land use.

<u>Centralized Facilities</u>

Potential future centralized facilities were modeled by assuming they would capture a specified fraction of the water that runs off after implementation of the distributed BMPs and accounting for existing centralized capture. In this case, centralized capture is only based on what is not captured in distributed facilities and accounts for all existing centralized capture. This avoids the double counting that would occur from considering centralized and distributed capture separately. For subwatersheds with outlets that were either overlying Class 3 aquifers or unclassified aquifers, the assumed percent capture was half of that of subwatersheds overlying Class 1 or Class 2 aquifers. This was done for all 15 regional subwatersheds with a portion of the subwatershed within the City. Because the Big Tujunga Dam subwatershed is outside City boundaries, but contributes flow to the Hansen-Tujunga Spreading Grounds subwatershed, runoff from this subwatershed was considered in determining the volume captured in centralized facilities for the Hansen-Tujunga Spreading Ground subwatershed. The Devil's Gate Dam subwatershed is also completely outside the City but contributes flow to the City. However, this reservoir is used by other jurisdictions in the area, and was therefore not assumed to contribute flow to centralized facilities in the downstream Narrows and Arroyo Seco subwatershed.

The fraction of runoff captured in centralized facilities follows a similar nomograph as the distributed facilities where the capture rates do not increase proportionally to BMP size. These curves have a "knee" where additional BMP volume gives lessening returns in the percent capture while still increasing costs. The chosen capture rates in the conservative and aggressive scenarios vary by subwatershed due to differences in existing capture rates and aquifer class. However, values were chosen that were likely to be below the knee and at or just above the knee for conservative and aggressive scenarios, respectively though this varies with location and drawdown time.

**Potential Capture Results**

Theoretical Maximum

Before the future scenarios were evaluated, a theoretical maximum condition was established. This condition represents physical stormwater capture potential without the application of feasibility constraints. The theoretical maximum was calculated by using 90% distributed BMP implementation for all land uses and all geophysical categorizations assuming removal of all anthropogenic constraints. In addition, 90% of the remaining runoff is captured in potential centralized facilities for subwatersheds that overlie Class 1 and 2 aquifers and 45% of the remaining runoff in subwatersheds overlying Class 3 or unclassified aquifers.

The theoretical maximum capture obtained is 189,200 additional acre-feet of capture in centralized facilities and 82,900 acre-feet in distributed capture. However, because feasibility is not considered, this condition is not considered to be a realistic future scenario. It is provided for informational purposes only.

Total Capture

Figure 17 shows the average annual capture for the existing condition and each scenario broken down by aquifer and between distributed capture and centralized capture.

Under the Aggressive Scenario, 141,800 additional acre-feet would be captured in centralized facilities, 106,500 of which would be in Class 1 or 2 aquifers (Figure 17). This represents a 482% increase in centralized capture above what is currently occurring. The average annual volume captured in distributed BMPs under this scenario is 51,700 acre-feet, 39,300 of which would be in Class 1 or 2 aquifers (the rest of which would be direct use capture) (see Table 9). This is an increase of approximately 148% in distributed capture above the incidental distributed capture currently occurring in pervious land uses over usable aquifers. Under this scenario, 21% of the total incoming volume to the City would be discharged as surface runoff, while 33% of the flows would be captured (Figure 18). Overall, this scenario represents approximately triple the capture that is currently occurring.

**Table 9. Total Capture - Aggressive Scenario.**

| **Aggressive Scenario Total Additional Capture (acre-ft per year)** | | | | |
|---|---|---|---|---|
| Capture Type | Aquifer Class | | | |
| | Class 1 | Class 2 | Class 3 | Unclassified |
| **Centralized - Total** | **120,300** | **15,600** | **35,300** | **0** |
| Existing | 29,400 | 0 | 0 | 0 |
| Potential | 90,900 | 15,600 | 35,300 | 0 |
| **Distributed - Total** | **57,900** | **16,300** | **8,200** | **4,200** |
| Existing | 29,900 | 5,100 | NA | NA |
| Potential | 28,000 | 11,300 | 8,200 (direct use) | 4,200 (direct use) |

Under the Conservative Scenario, 77,100 additional acre-feet would be captured in centralized facilities, 58,600 of which would be in Class 1 or 2 aquifers (Figure 17 and Table 10). This represents a 262% increase in centralized capture above what is currently occurring. The average annual volume captured in distributed BMPs under this scenario is 27,800 acre-feet, 21,400 of which would be in Class 1 or 2 aquifers (the rest of which would be direct use capture). This is an increase of approximately 79% in distributed capture above the incidental distributed capture currently occurring in pervious land uses. Under this scenario 31% of the total incoming flow would be discharged as surface runoff, while 24% of the flows would be captured (Figure 18). Overall, this scenario provides approximately double the capture of what is occurring in the existing condition.

**Table 10. Total Capture - Conservative Scenario.**

| **Conservative Scenario Total Additional Capture (acre-ft per year)** | | | | |
|---|---|---|---|---|
| Capture Type | Aquifer Class | | | |
| | Class 1 | Class 2 | Class 3 | Unclassified |
| Centralized - Total | 79,000 | 9,000 | 18,600 | 0 |
| Existing | 29,400 | 0 | 0 | 0 |
| Potential | 49,600 | 9,000 | 18,600 | 0 |
| Distributed - Total | 45,300 | 11,100 | 4,200 | 2,200 |
| Existing | 29,900 | 5,100 | NA | NA |
| Potential | 15,300 | 6,000 | 4,200 (direct use) | 2,200 (direct use) |

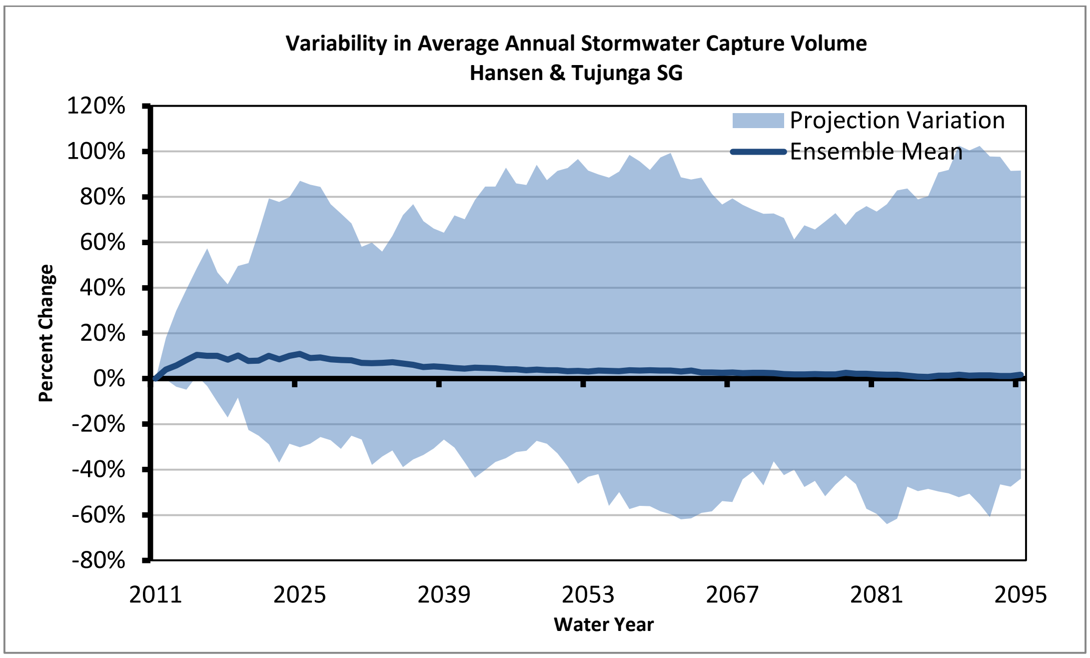
<u>Geographical Distribution of Potential Capture</u>

Figures 19-20 show the total distributed capture rates for each subbasin under the Aggressive, and Conservative Scenarios, respectively. Figures 21-22 show the increase in distributed capture rate from the existing conditions for the Aggressive and Conservative Scenarios, respectively. Under both the Aggressive and Conservative Scenarios, most distributed recharge is taking place in the San Fernando Valley and the LA Forebay (Figures 19 and 20). These locations are also where the greatest increase in distributed capture is taking place (Figures 21-22). This reflects the prioritization in the scenario development for the Class 1 and Class 2 aquifers.

The distributed and centralized capture usable by the City is broken down by regional subwatershed in Figures 23 and 24 for the Aggressive and Conservative Scenarios, respectively. While the volume changes, the distribution by subwatershed remains fairly constant in each scenario due to the fact that the centralized facilities are capturing a fraction of the runoff that overflows the distributed BMPs. The only exception is that Hansen-Tujunga SG subwatershed captures more water than the East San Fernando Valley subwatershed in the Conservative Scenario while the opposite is true in the Aggressive Scenario. Similar to the existing condition analysis, most of the capture is occurring in the West San Fernando Valley subwatershed, the Hansen-Tujunga Spreading Grounds subwatershed, the East San Fernando Valley subwatershed, and the Lower Ballona Creek subwatershed.

### Climate Change

Because the model uses historic, continuous rainfall data, it was not run into the future, and therefore does not account for anticipated effects of possible climate change on the volumes in the future scenarios. The SCMP did not model future climate projections, but did review the climate change projections used in the Los Angeles Basin Stormwater Conservation Study (Basin Study) and the preliminary results from the Basin Study to draw general conclusions on how climate change may impact the results to future stormwater capture. The 47 climate projections being analyzed in this study show a range of future conditions. Generally speaking, they show climate change will not greatly affect total precipitation volumes, but it will cause the total volume to come in more large storms and fewer small storms for the Los Angeles area. Temperatures are also expected to increase causing increased evapotranspiration. Preliminary results from the Basin Study show different climate change scenarios resulting in significantly different estimates of centralized stormwater capture. For instance, at Hansen and Tujunga Spreading Grounds, the range in projected changes in annual average capture spans from decreases of 60% to increases of 100%, as illustrated in the graph below (LADPW 2013).




In general, precipitation coming in fewer small storms coupled with increased temperatures could have the effect of decreasing capture rates because BMPs are less effective at capturing larger storms, and increased temperatures will increase evapotranspiration. Therefore, climate change is likely to decrease the average annual recharge volumes from what the model currently predicts for these scenarios. Another consideration under future climate change conditions is that hotter temperatures will increase evaporation. This could reduce the effectiveness of centralized facilities which have large standing water surfaces. Distributed BMPs would be less impacted by this condition because they generally don't have standing pools, and they capture stormwater close to where it falls, allowing less opportunity for evaporation.

However, as shown in the Basin Study, there is considerable uncertainty with regards to future climate projections. Figure 25 shows a generalized graph to illustrate the potential impacts of climate change.

## CONCLUSIONS

Currently, an annual average of 29,400 acre-feet of stormwater within the City is captured in centralized facilities, and 63,000 acre-feet is captured in pervious land uses, making a total recharge of 92,400 acre-feet, 64,400 acre-feet of which is occurring in aquifers usable by the City. The two scenarios (Aggressive and Conservative) have total capture volumes of approximately three and two times the existing capture volume, respectively. In the Aggressive Scenario, a total of 210,200 acre-feet of capture would occur in Class 1 and 2 aquifers (135,900 acre-feet in centralized capture and 74,300 acre-feet in distributed capture and incidental recharge). In the Conservative Scenario, 144,400 acre-feet of capture would occur in Class 1 and 2 aquifers (88,000 acre-feet in centralized capture and 56,400 acre-feet in distributed capture and incidental recharge).

## REFERENCES

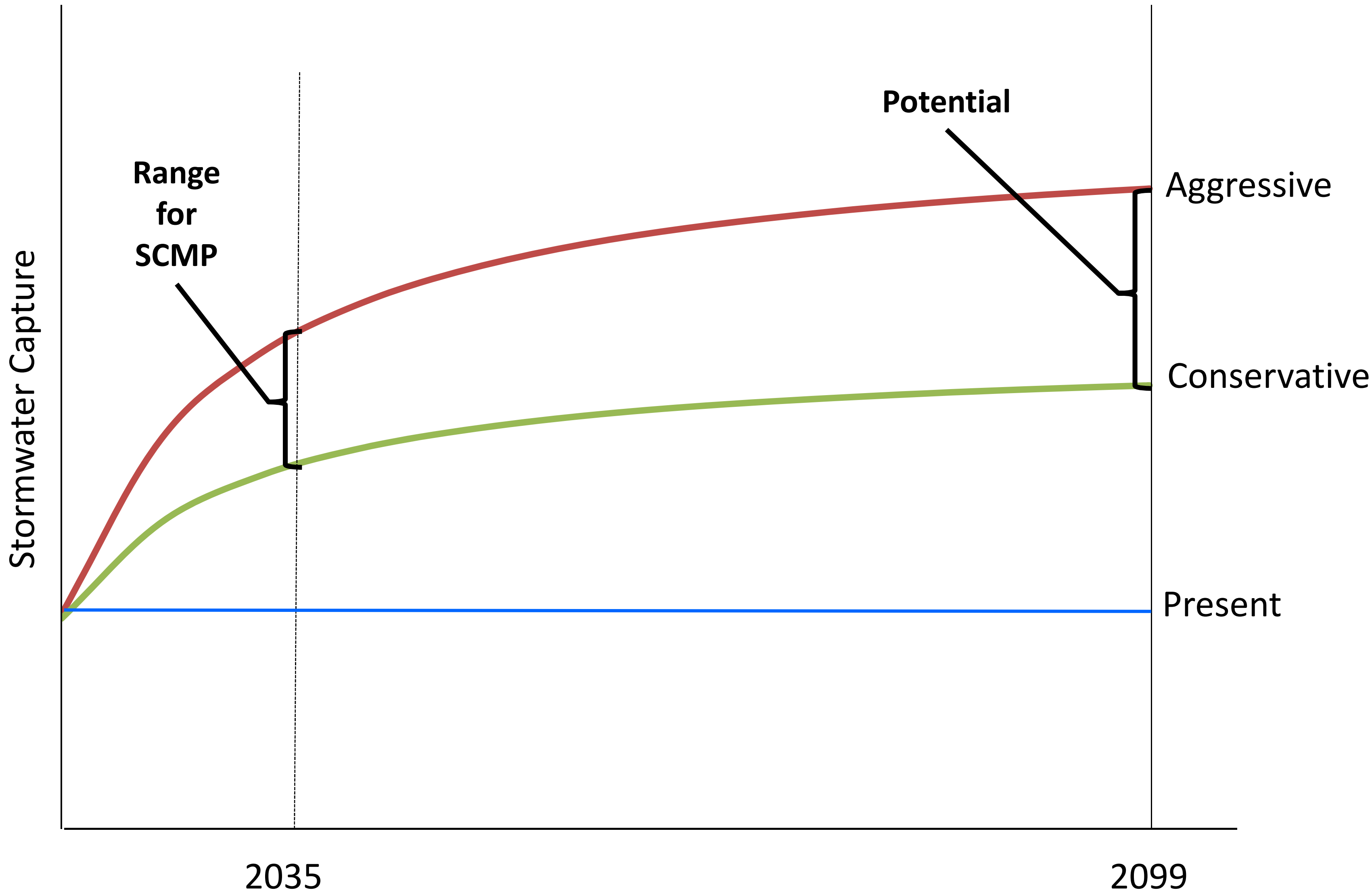
County of Los Angeles Department of Public Works (2013) Los Angeles Basin Stormwater Conservation Plan Task 3.2 Hydrologic Modeling Report

Los Angeles Department of Water and Power (2010) Urban Water Management Plan

Los Angeles Department of Water and Power (2013) Watermaster Service in the Upper Los Angeles River Area, Annual Report Water Year 2011-2012, Los Angeles County, California.

http://ularawatermaster.com/public_resources/WY_2011-12_ULARA_WM_Rpt_-5-2013.pdf

Reichard, E.G., Land, M., Crawford, S.M., Johnson, T, Everett, RR, Kulshan, TV, Ponti, DJ, Halford, KJ, Johnson, T.A., Paybins, K.S., Nishikawa, T., (2003) Geohydrology, Geochemistry, and Ground-water Simulation-Optimization of the Central and West Coast Basins, Los Angeles County, California. U.S. Geological Survey Report 03-4065.

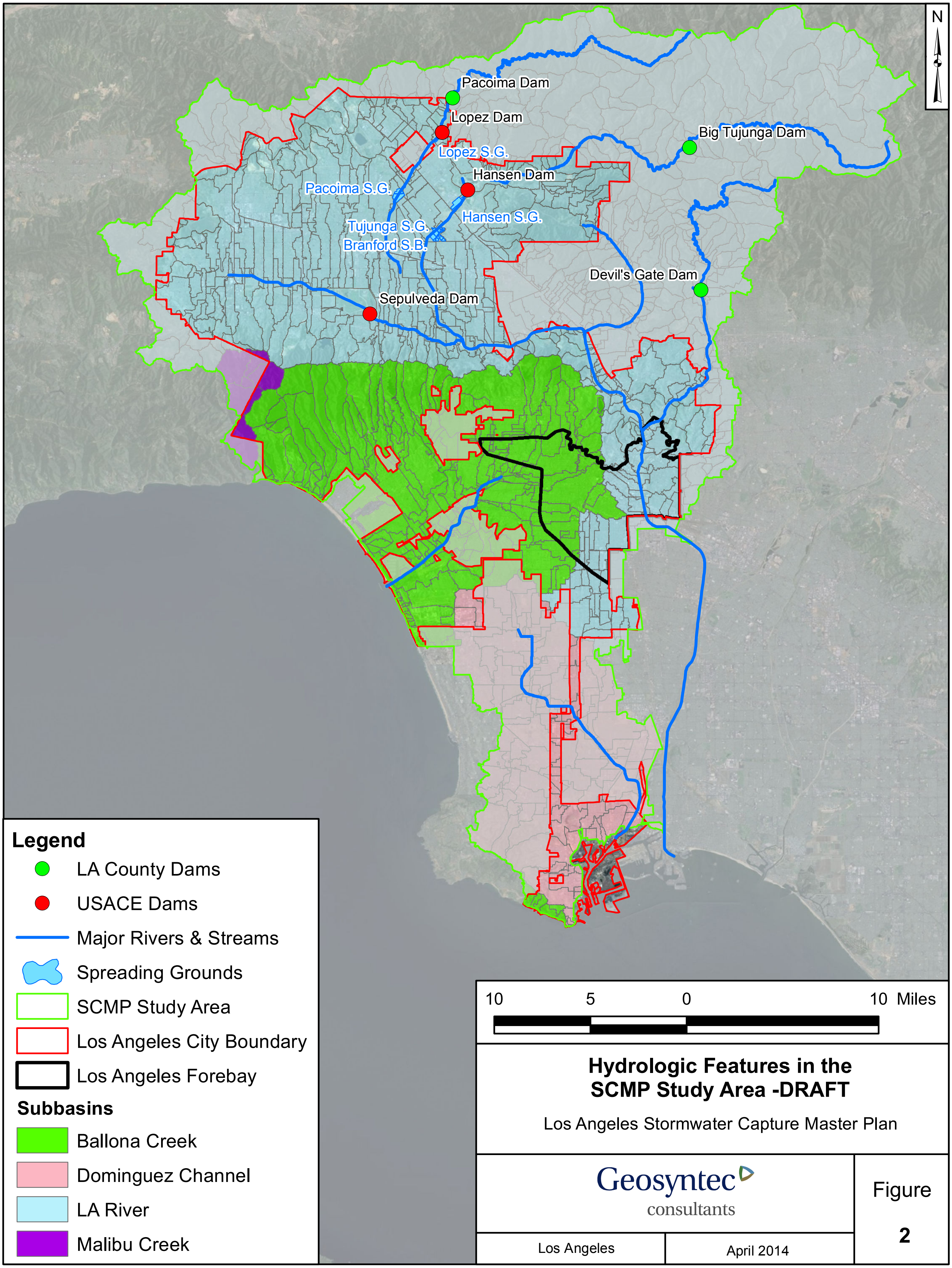



NOTE: This is a conceptual graph presented to illustrate the generalized relationship of stormwater capture potential over time. It is not based on actual data.

**Projected Additional Capture Volume and Purpose of the SCMP**

Los Angeles Stormwater Capture Master Plan

| | | |
|---|---|---|
| Geosyntec consultants | | Figure 1 |
| Los Angeles | April 2014 | |




**Hydrologic Features in the SCMP Study Area -DRAFT**

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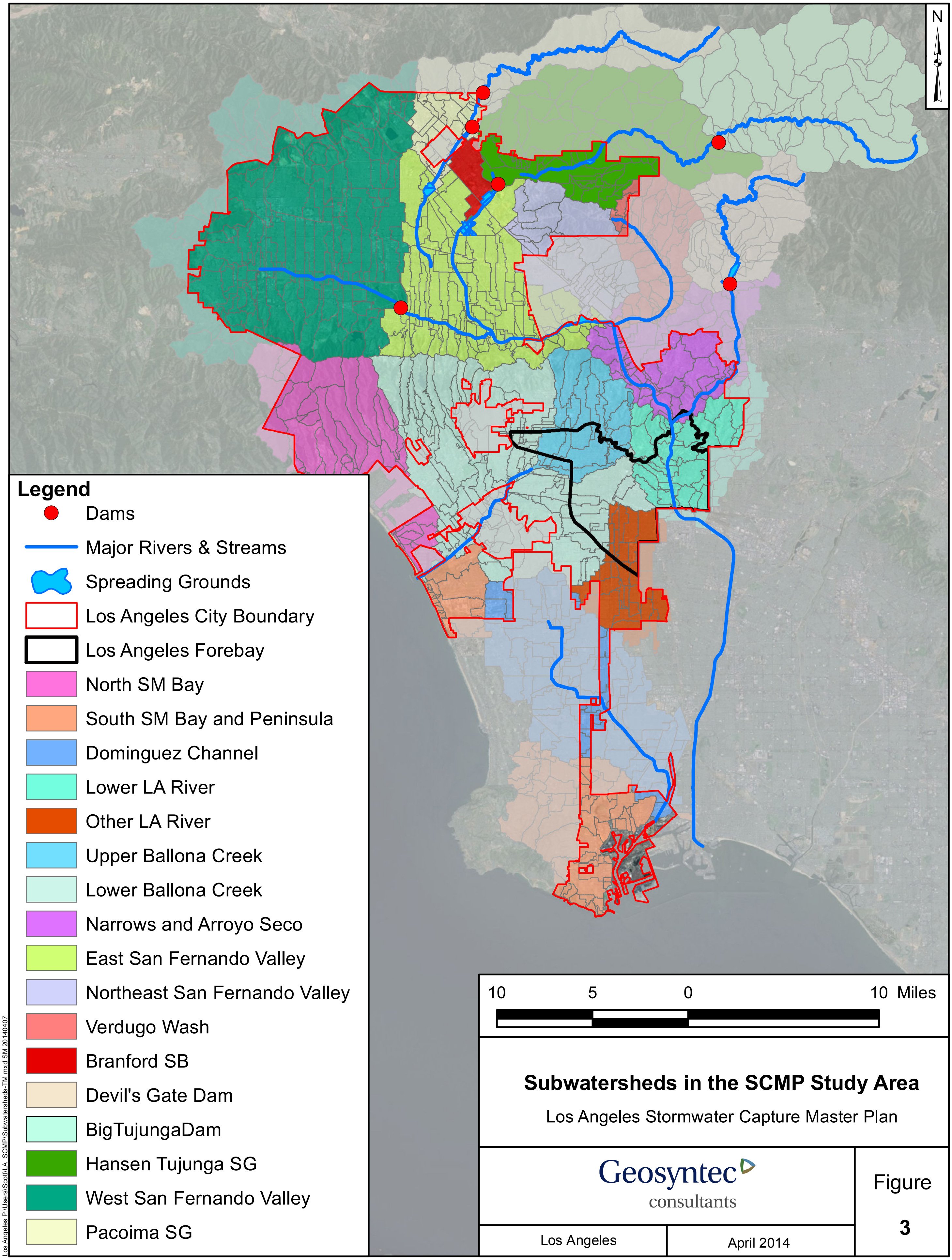
Figure 2



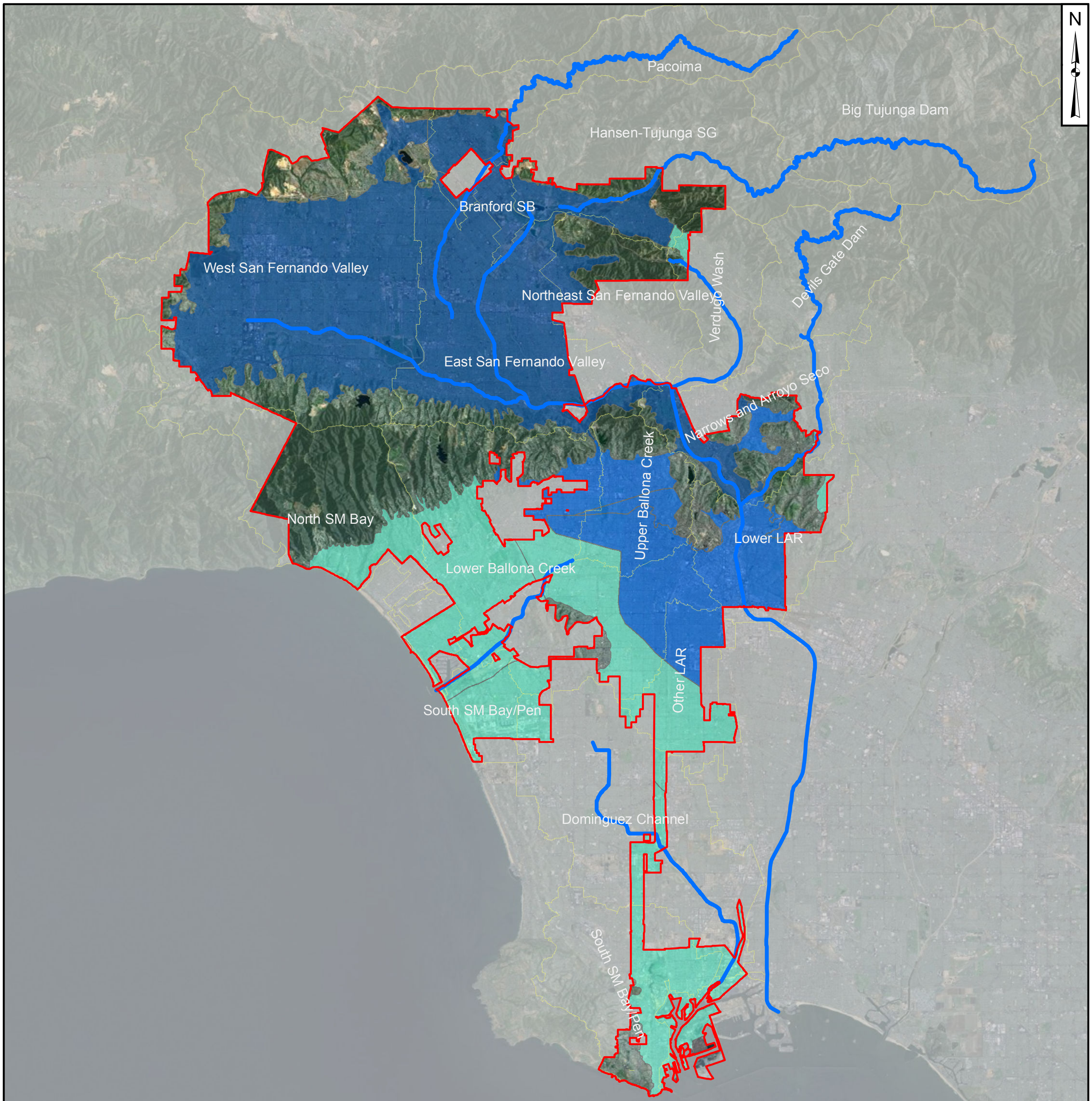

**Subwatersheds in the SCMP Study Area**

Los Angeles Stormwater Capture Master Plan

Geosyntec consultants

Los Angeles | April 2014 | Figure 3

Los Angeles P:\Users\Scott\LA_SCMP\Subwatersheds-TM.mxd SM 20140407




## Legend

- Los Angeles City Boundary
- Regional Subwatersheds
- Major Rivers & Streams

## Aquifer Class

- 1
- 2
- 3

10 5 0 10 Miles

**Aquifer Ranking by Usability within City of Los Angeles**

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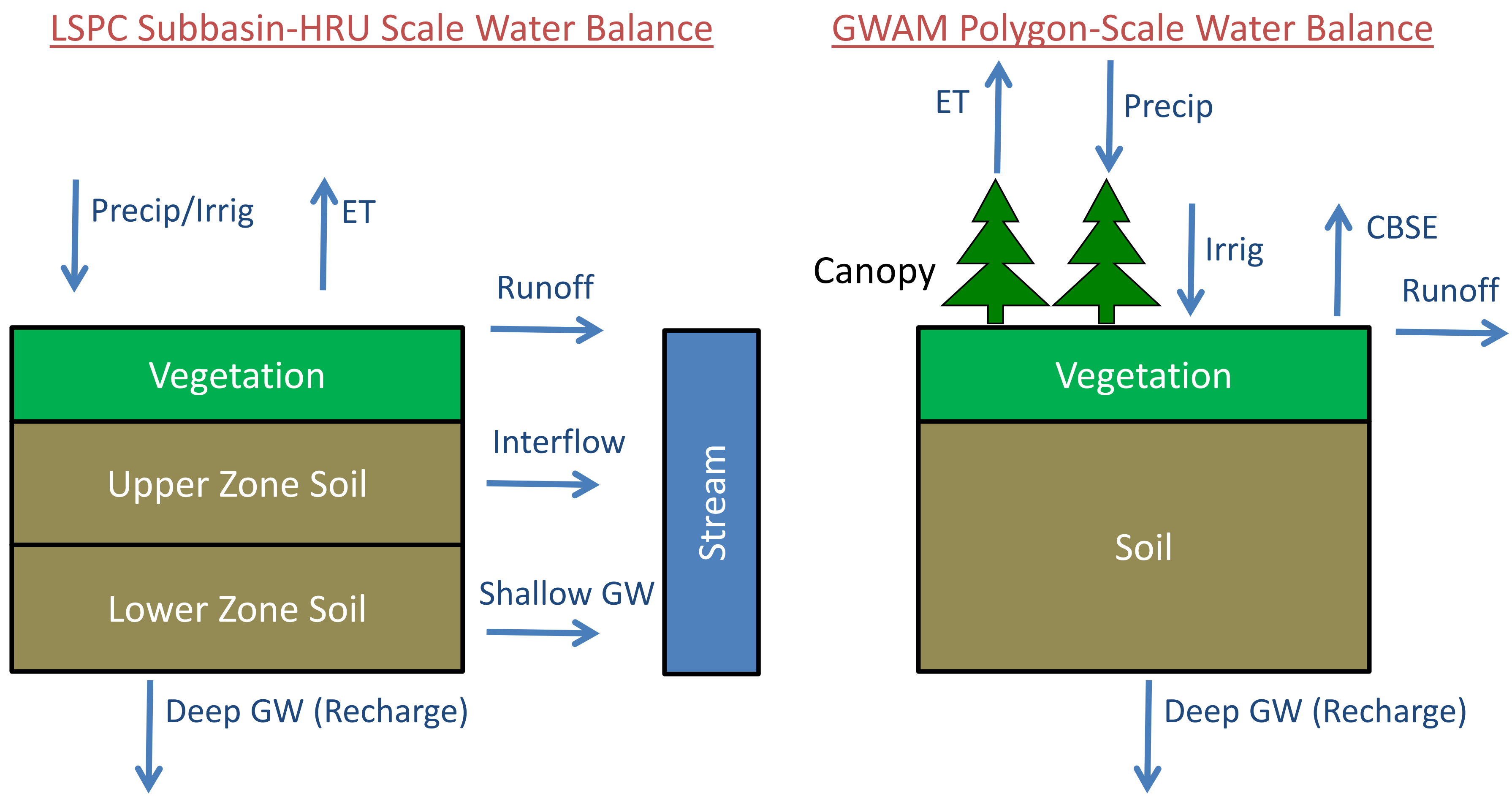
Figure 4

Los Angeles P:\Users\Scott\LA_SCMP\Aquifers-TM.mxd SM 20140402



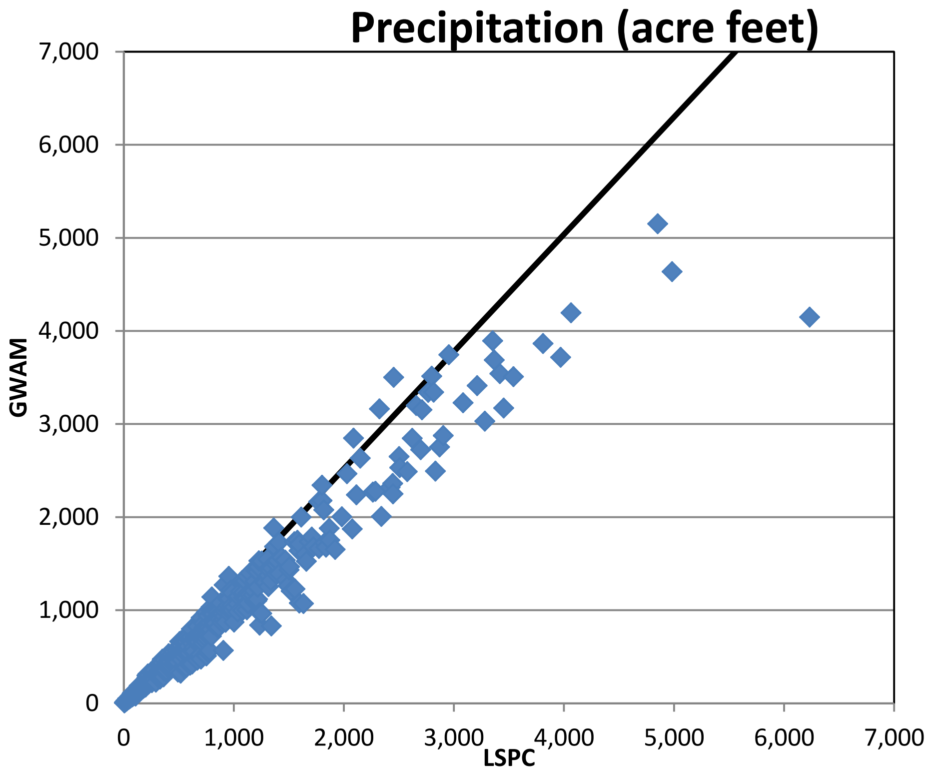

**Legend**

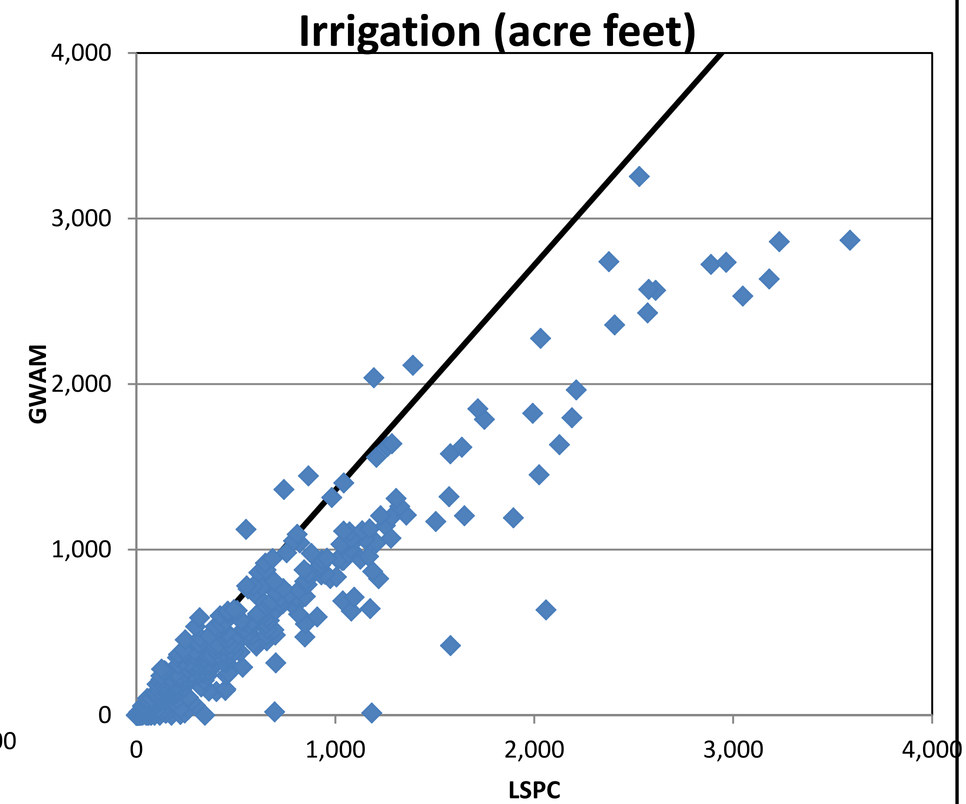
ET = Evapotranspiration

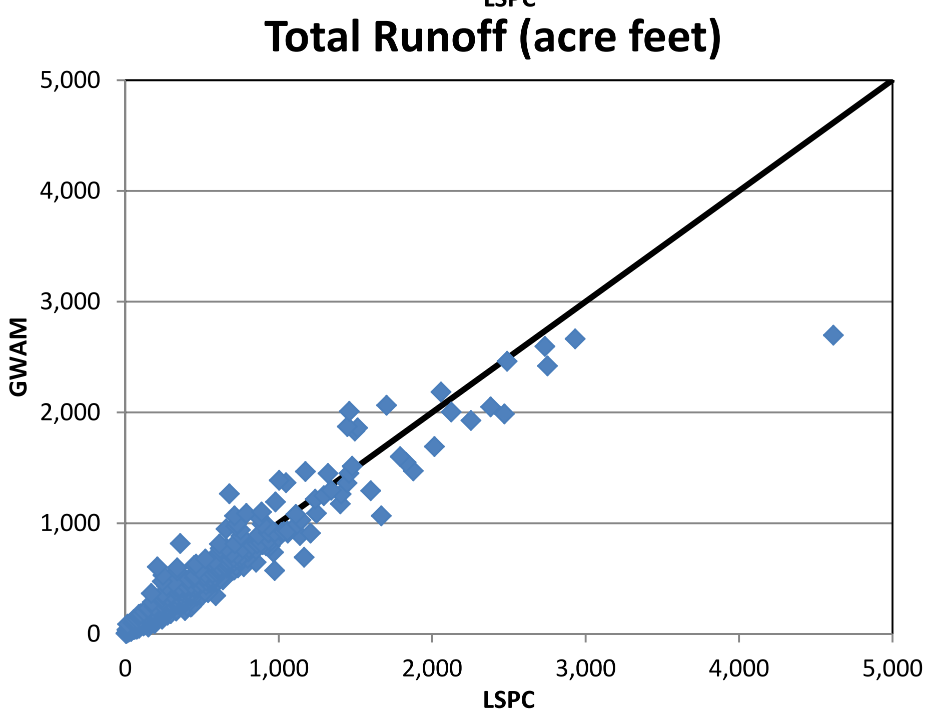
GW = Groundwater

CBSE = Canopy and Bare Surface Evaporation

| Water Budget Schematic in LSPC and GWAM Models<br>Los Angeles Stormwater Capture Master Plan | | |
|---|---|---|
| Geosyntec consultants | | Figure 5 |
| Los Angeles | April 2014 | |



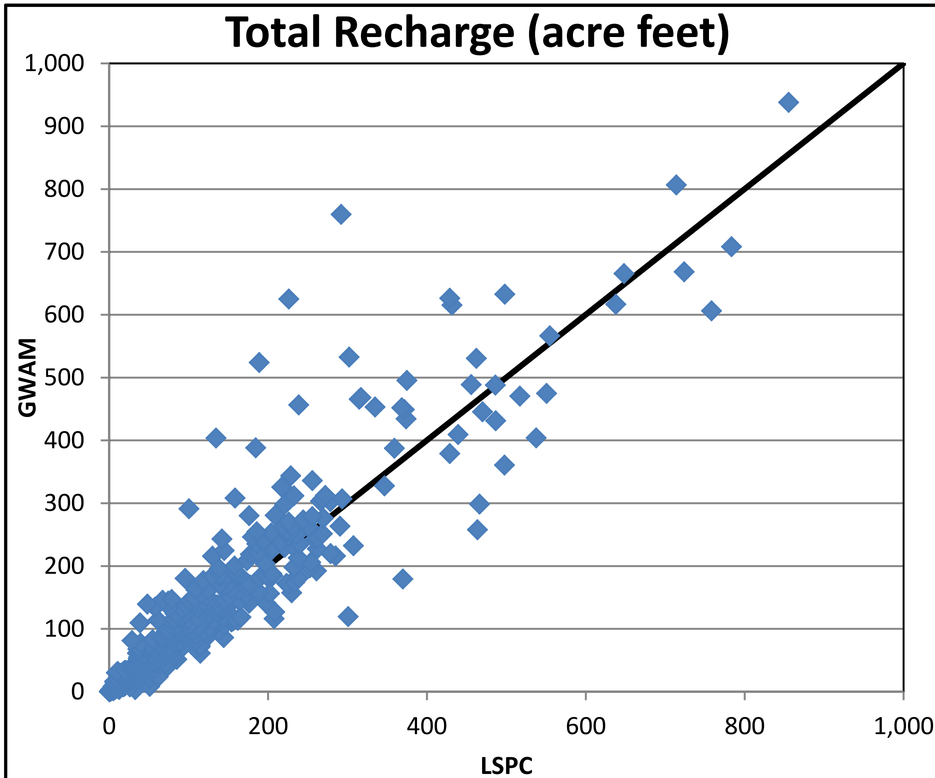

**Comparison Between**
**LSPC and GWAM Model Results**

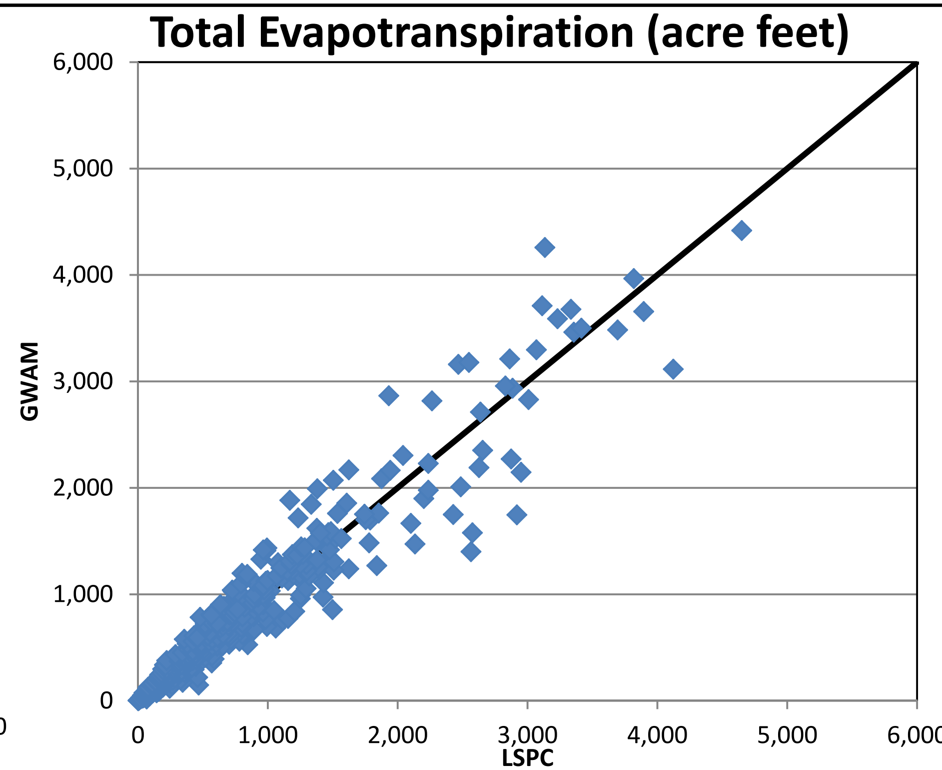
Los Angeles Stormwater Capture Master Plan

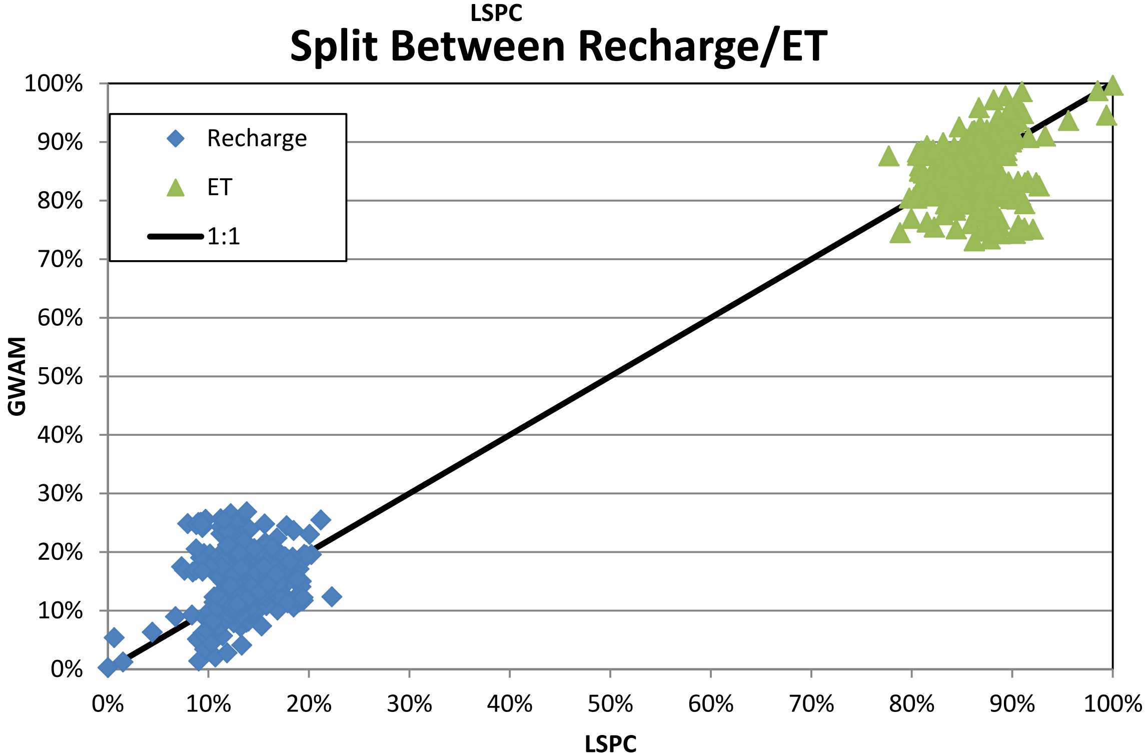
Geosyntec consultants

Los Angeles | April 2014

Figure 6




**LSPC and GWAM Model Results After Adjustment to LSPC Recharge/ET Split**

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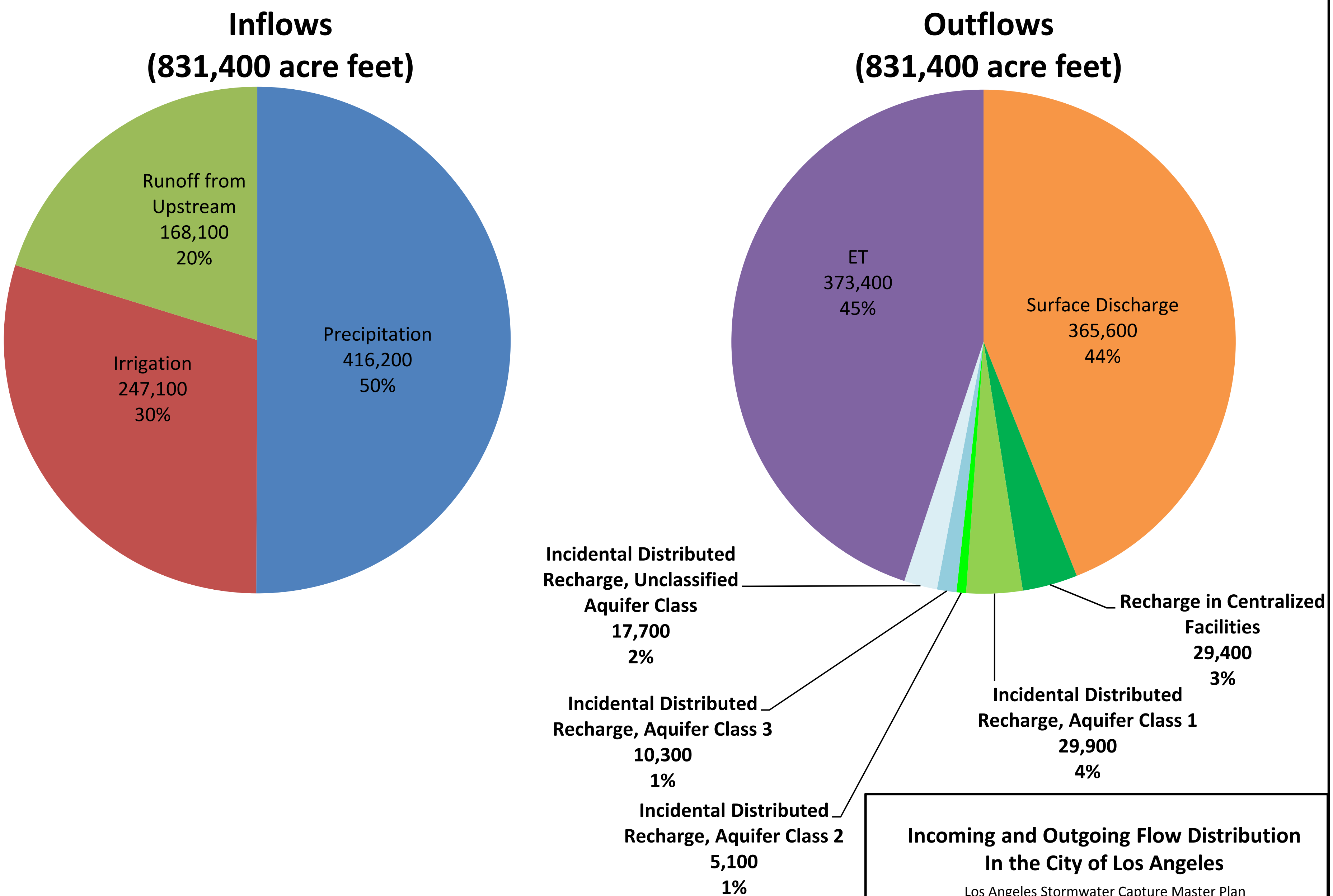
| | | |
|---|---|---|
| Los Angeles | April 2014 | Figure 7 |




**Incoming and Outgoing Flow Distribution**
**In the City of Los Angeles**

Los Angeles Stormwater Capture Master Plan

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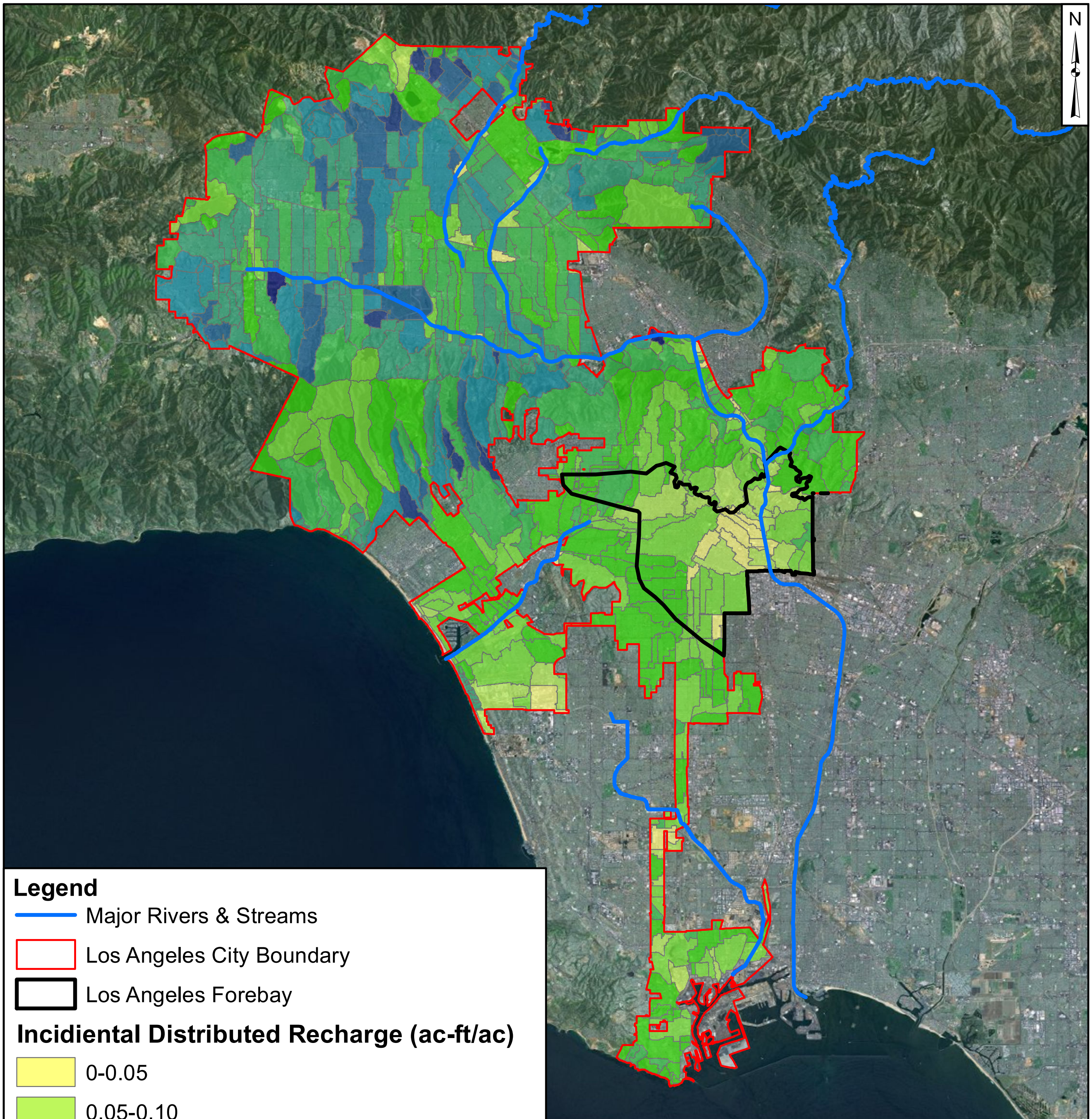
| Los Angeles | April 2014 | Figure 8 |
|---|---|---|




**Existing Stormwater Capture in the City of Los Angeles**

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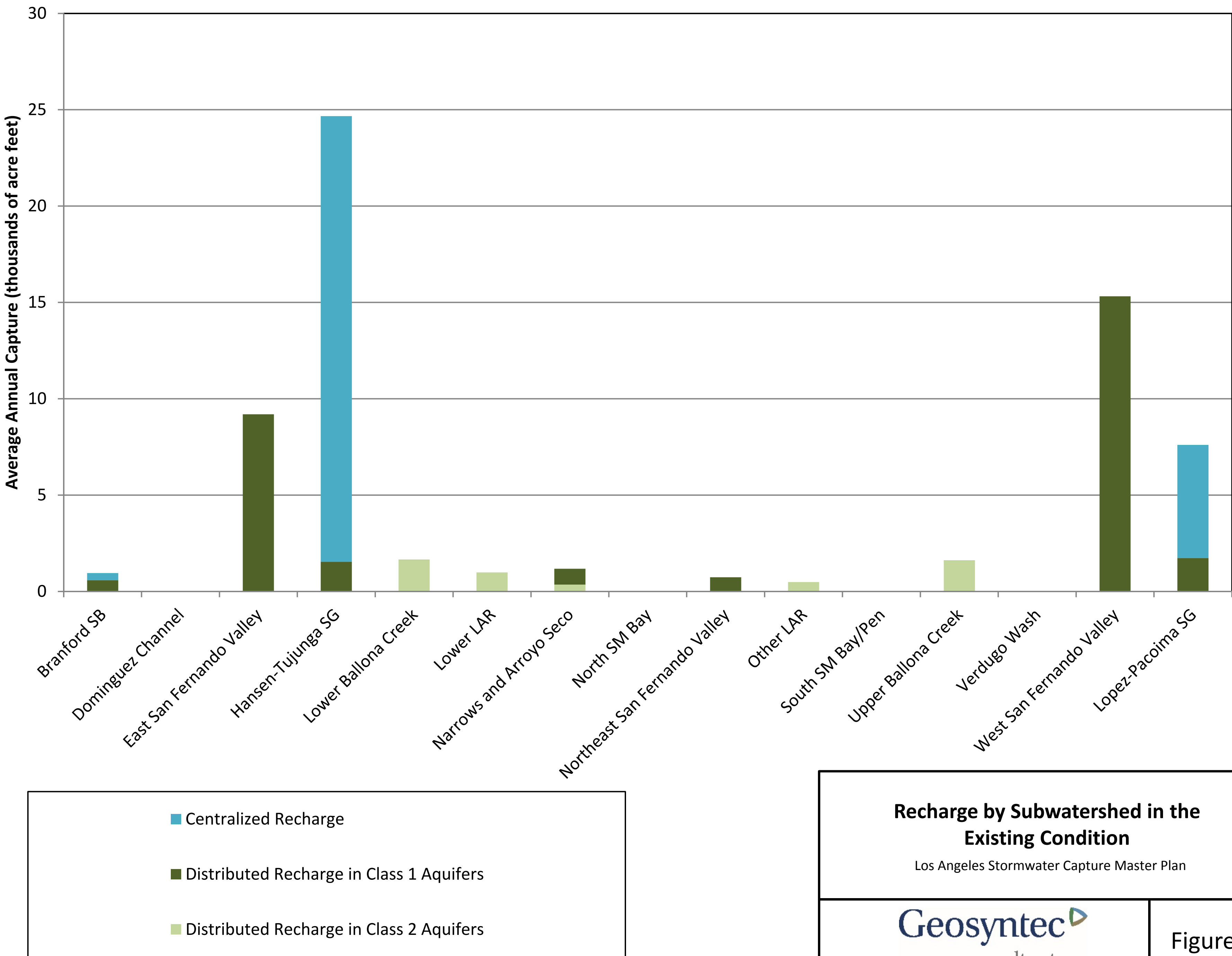
Figure 9

Los Angeles P:\Users\Scott\LA_SCMP\CitySubbasins-TM.mxd SM 20140407




**Recharge by Subwatershed in the Existing Condition**

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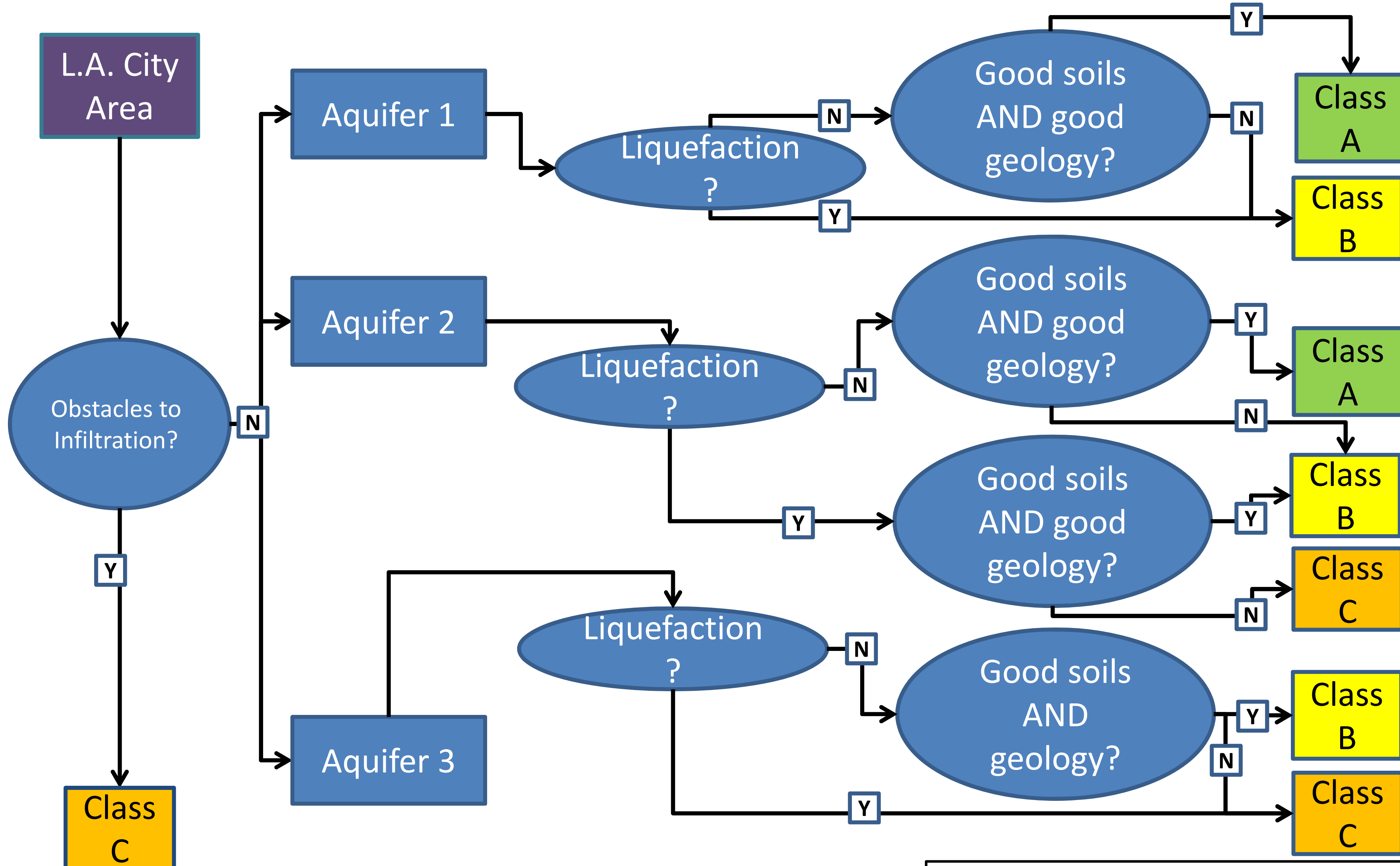
Figure 10




**Method of Geophysical Categorization for all Areas of the City of Los Angeles**

Los Angeles Stormwater Capture Master Plan

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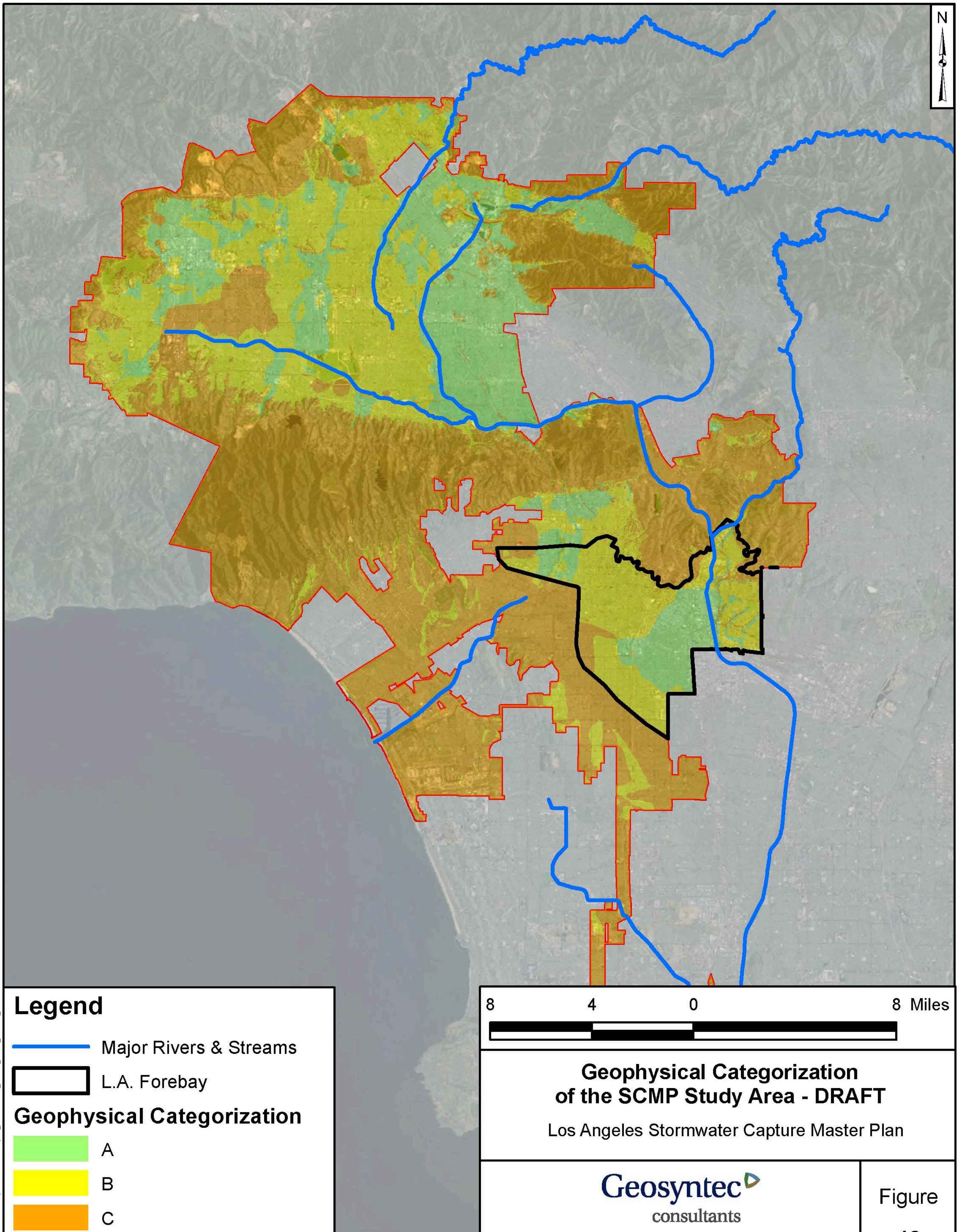
| Los Angeles | April 2014 | Figure 11 |
|---|---|---|




Data Sources
Geosyntec Consultants, LACDPW, and USGS

**Geophysical Categorization of the SCMP Study Area - DRAFT**

Los Angeles Stormwater Capture Master Plan

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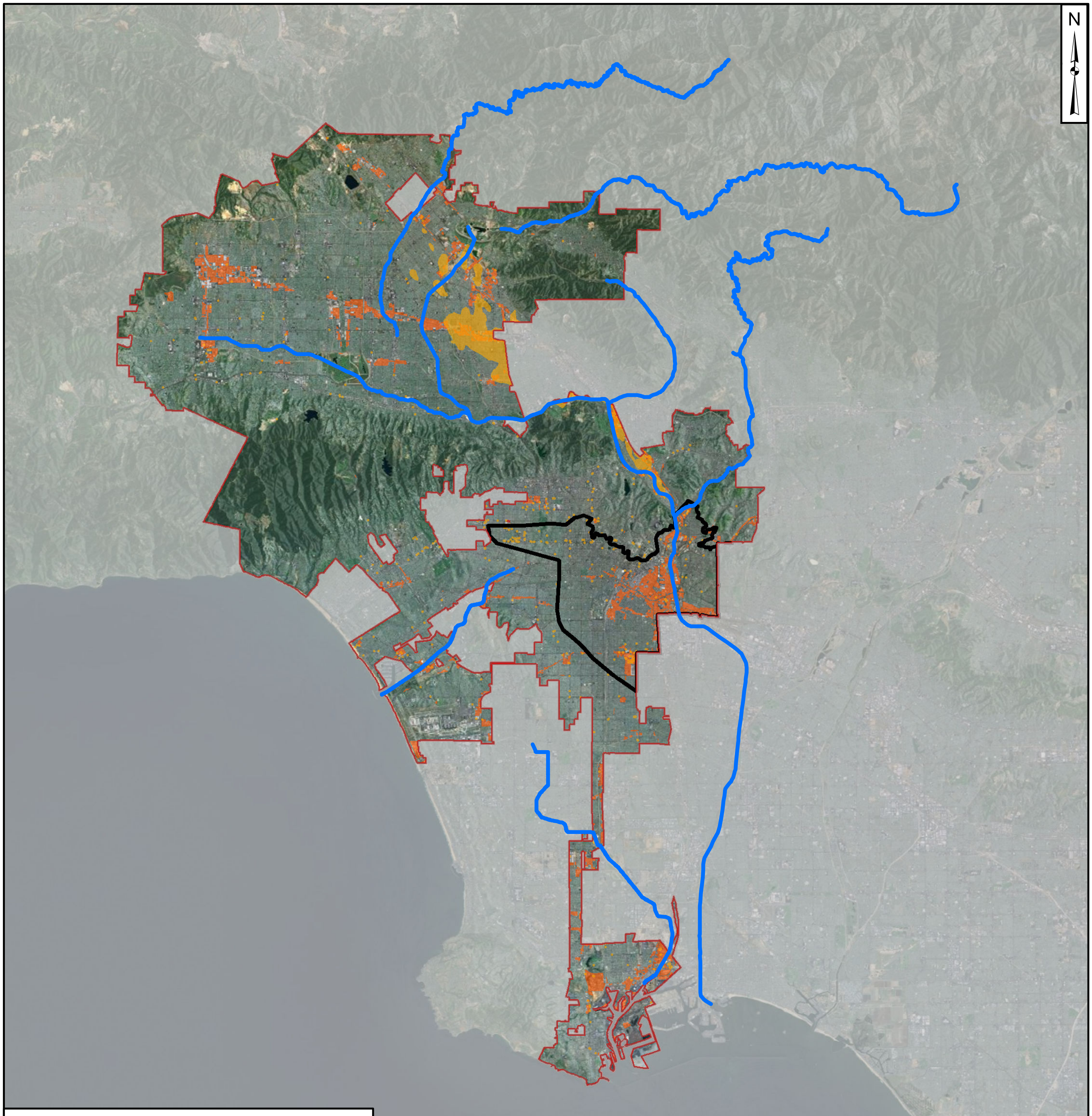
Los Angeles | April 2014

Figure 12




## Legend

- Major Rivers & Streams
- Los Angeles City Boundary
- L.A. Forebay

**Constraint**

- Anthropogenic
- Heavy Industrial Landuse

10 5 0 10 Miles

**Anthropogenic Constraints in the SCMP Study Area - DRAFT**

Los Angeles Stormwater Capture Master Plan

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Figure 13

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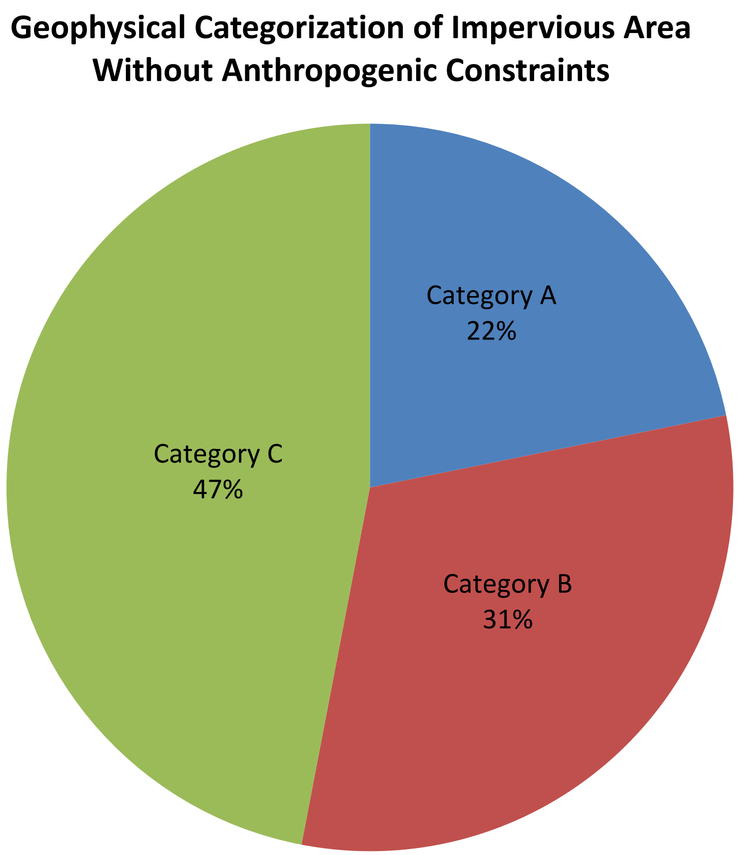
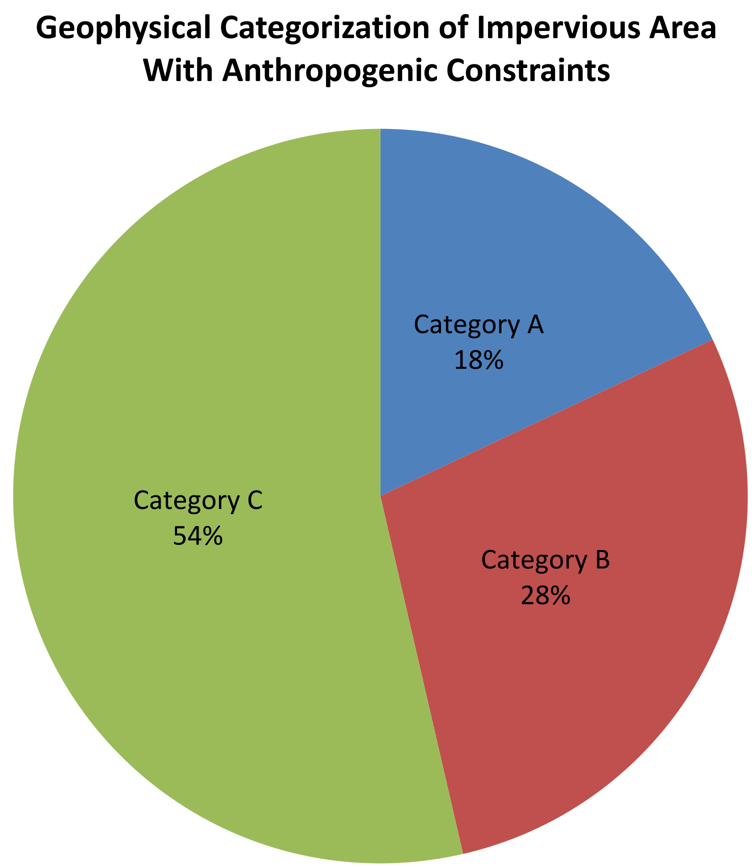
Data Sources
ULARA watermaster, DTSC, U.S. EPA, SCAG, LACDPW, LADWP, WRD of Southern California

Los_Angeles P:\GIS\Projects\LA0282\Project_MXD\Tech_Report_Anth_Heavy_Ind_030314.mxd SM 20140407




**The Effect of Anthropogenic Constraints on Geophysical Categorization**

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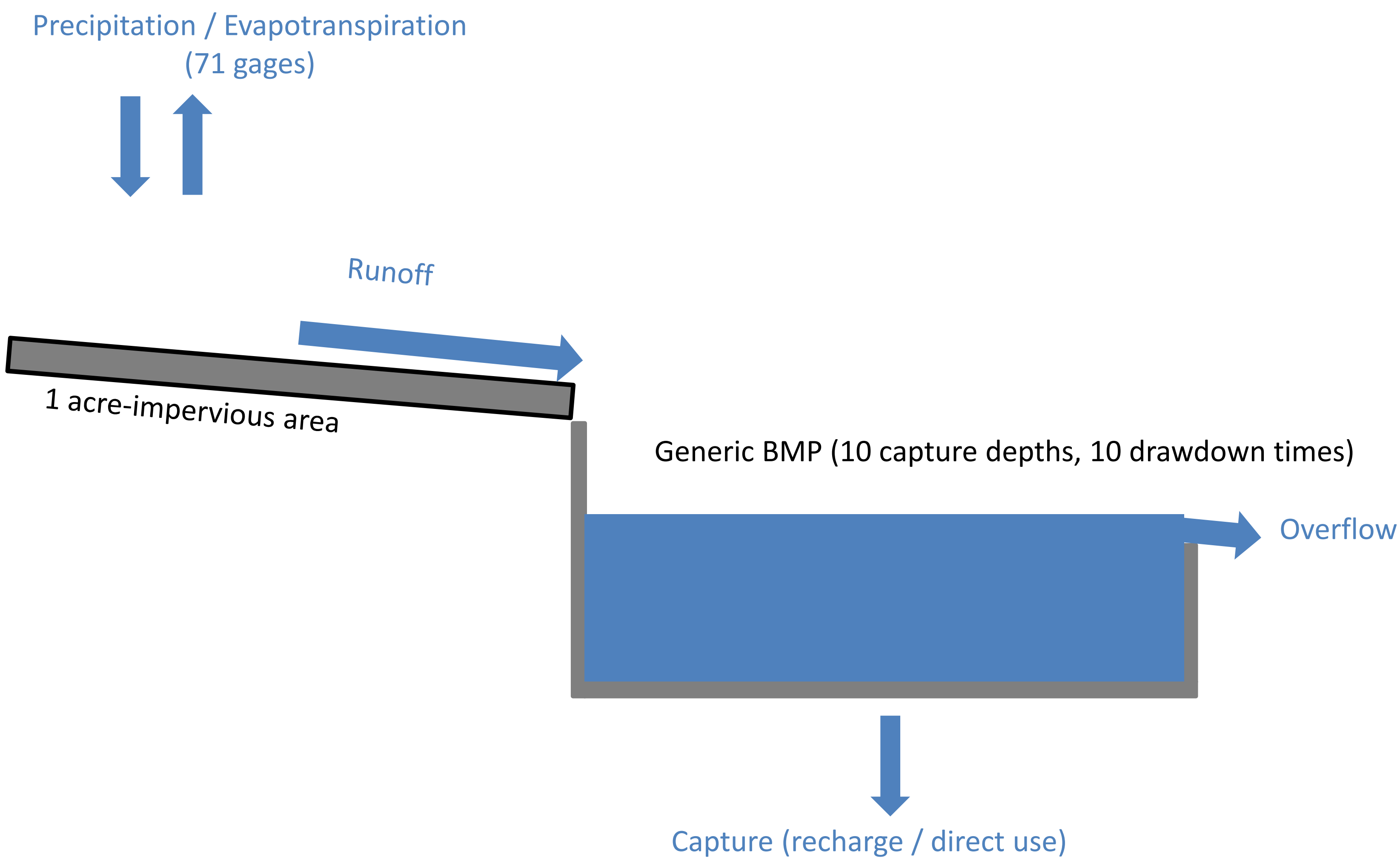
| | | |
|---|---|---|
| Los Angeles | April 2014 | Figure 14 |




**Unit BMP Modeling Schematic for Distributed BMPs**

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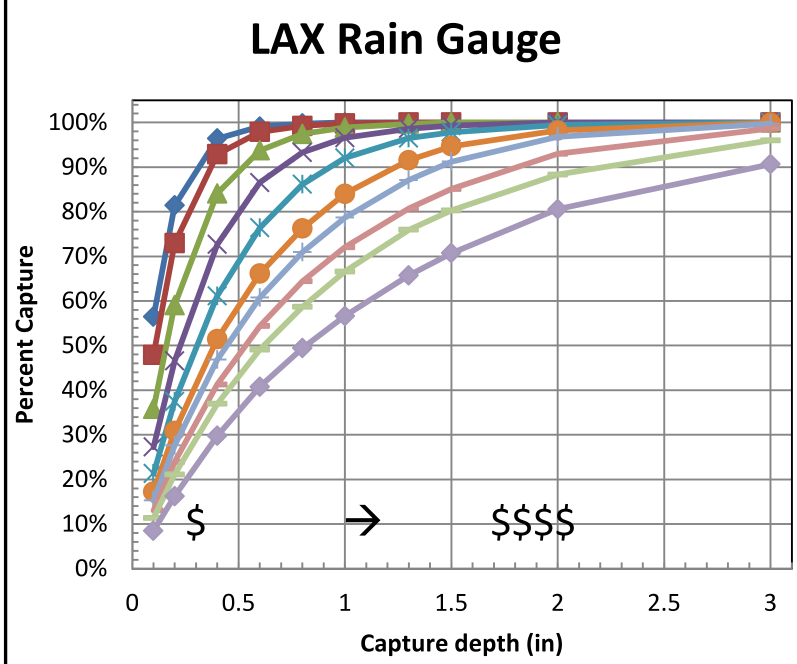
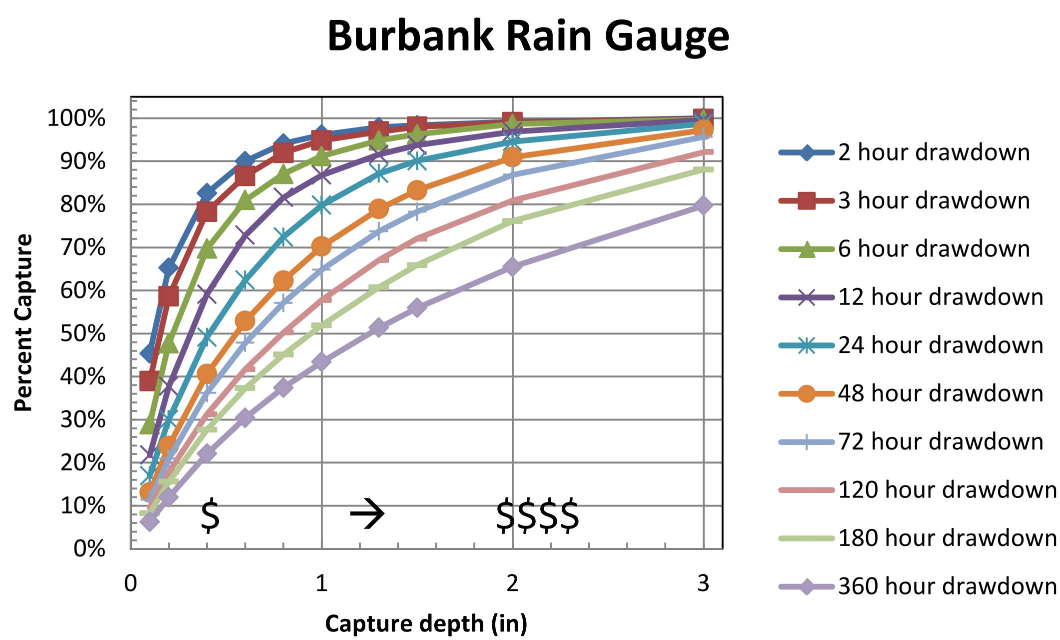
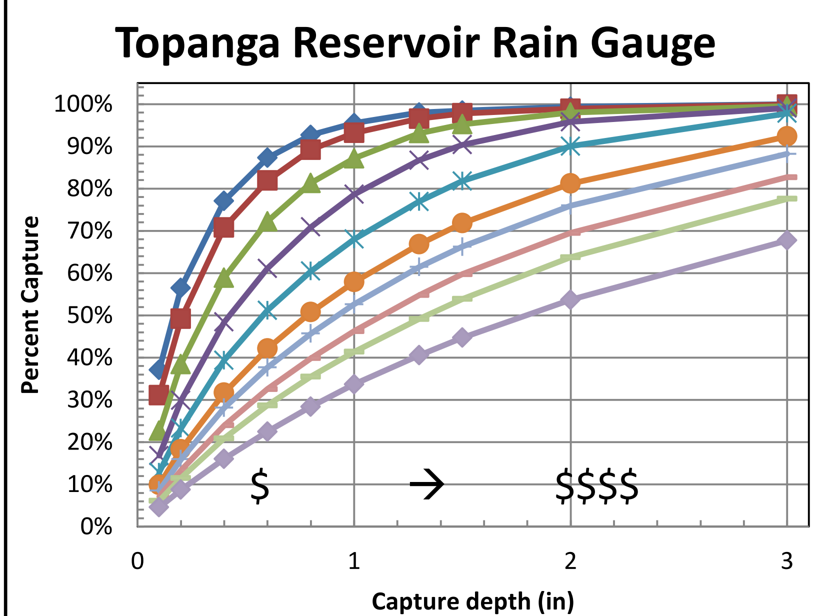
Figure 15




**Examples of Capture Nomographs from Unit BMP Modeling**

Los Angeles Stormwater Capture Master Plan

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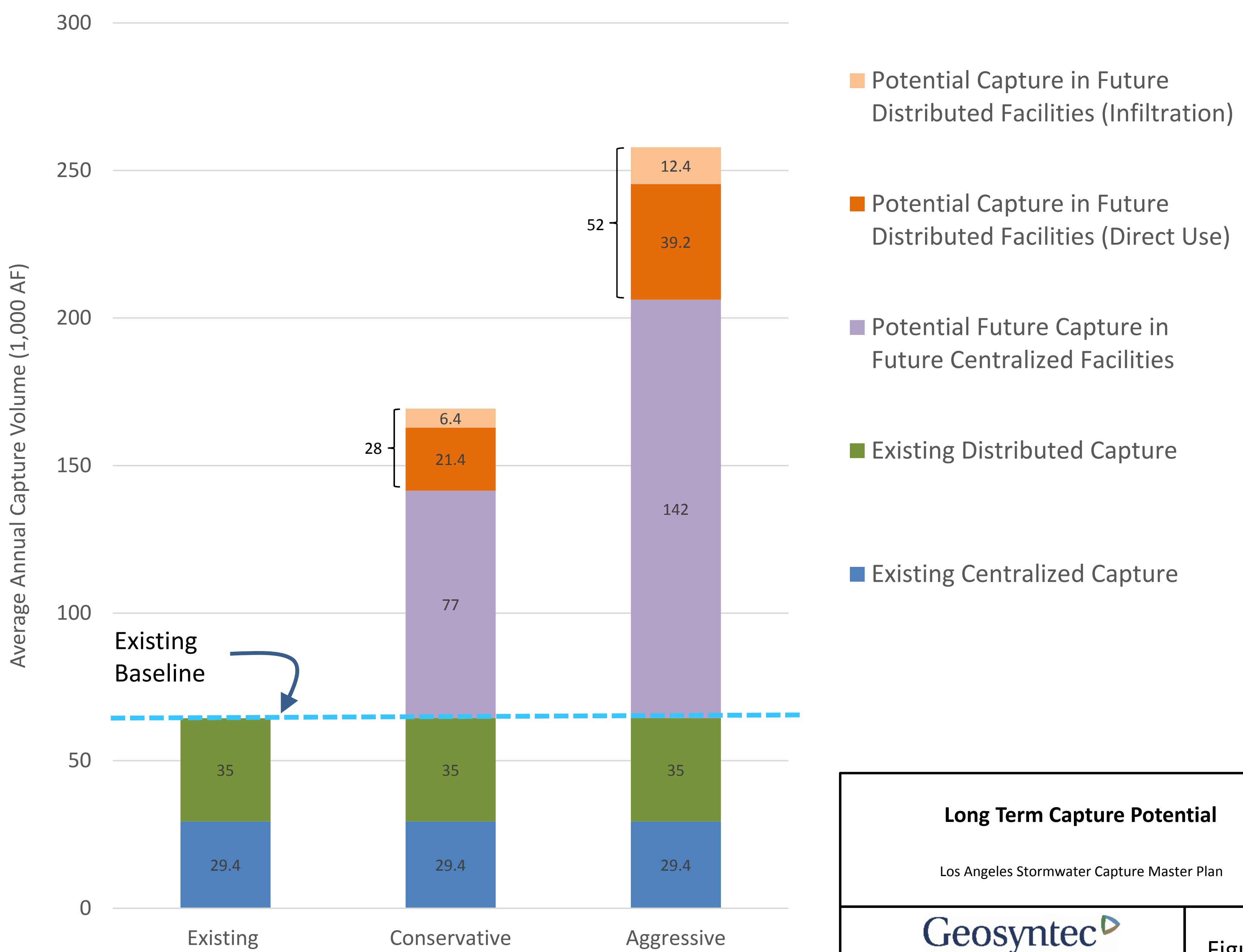
| | | |
|---|---|---|
| Los Angeles | April 2014 | Figure 16 |




**Long Term Capture Potential**

Los Angeles Stormwater Capture Master Plan

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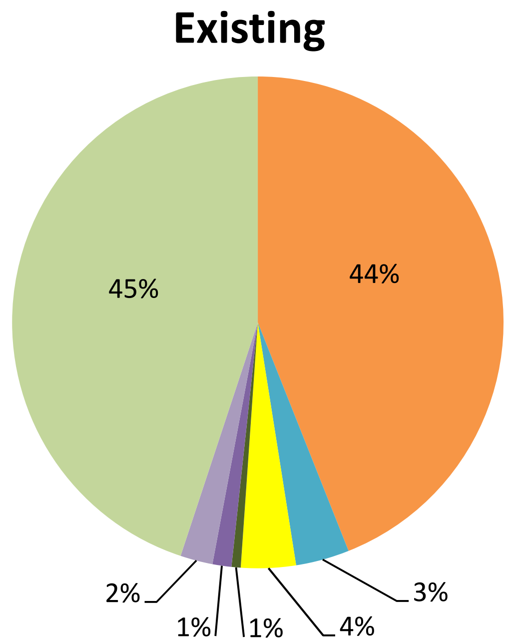
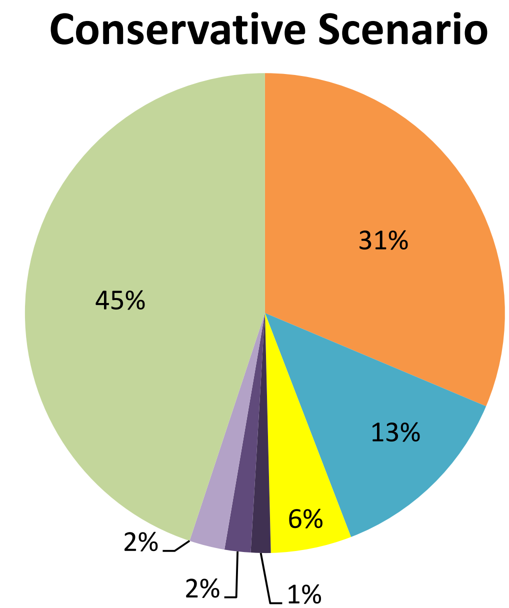
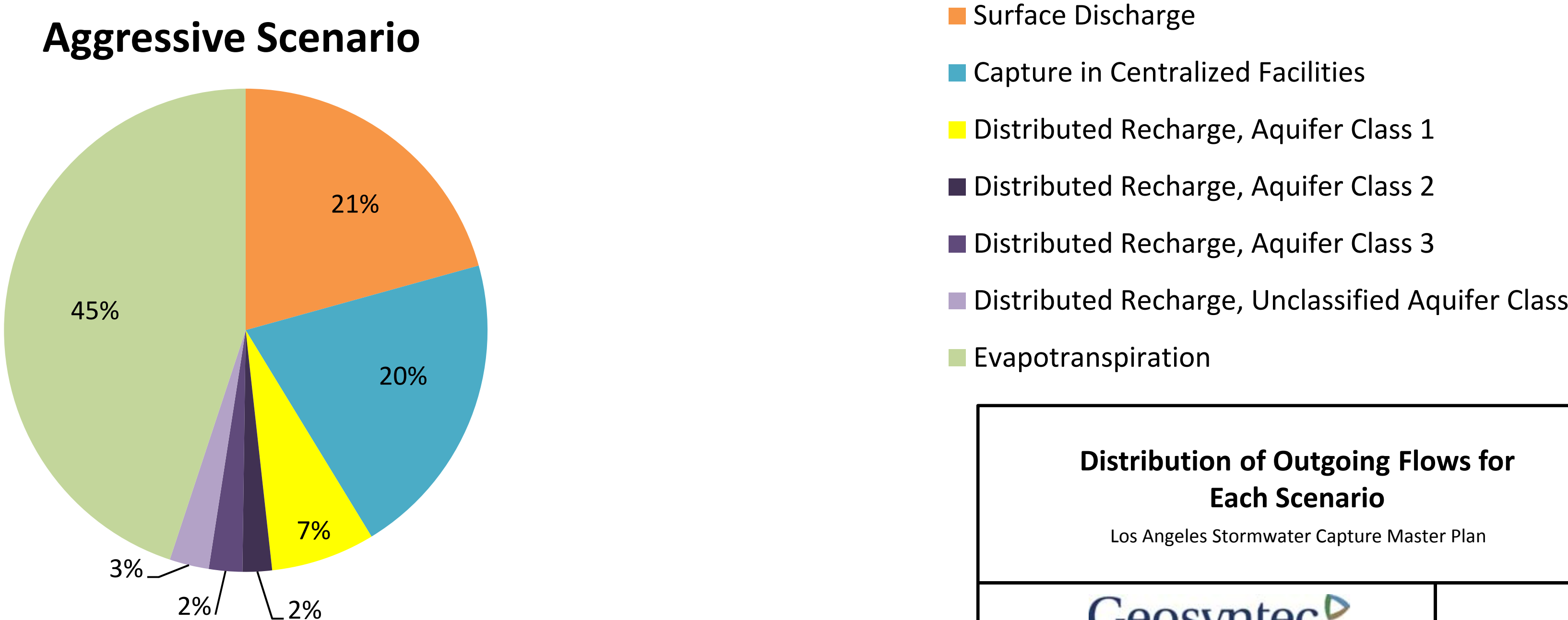
| | | |
|---|---|---|
| Los Angeles | April 2014 | Figure 17 |




**Distribution of Outgoing Flows for Each Scenario**

Los Angeles Stormwater Capture Master Plan

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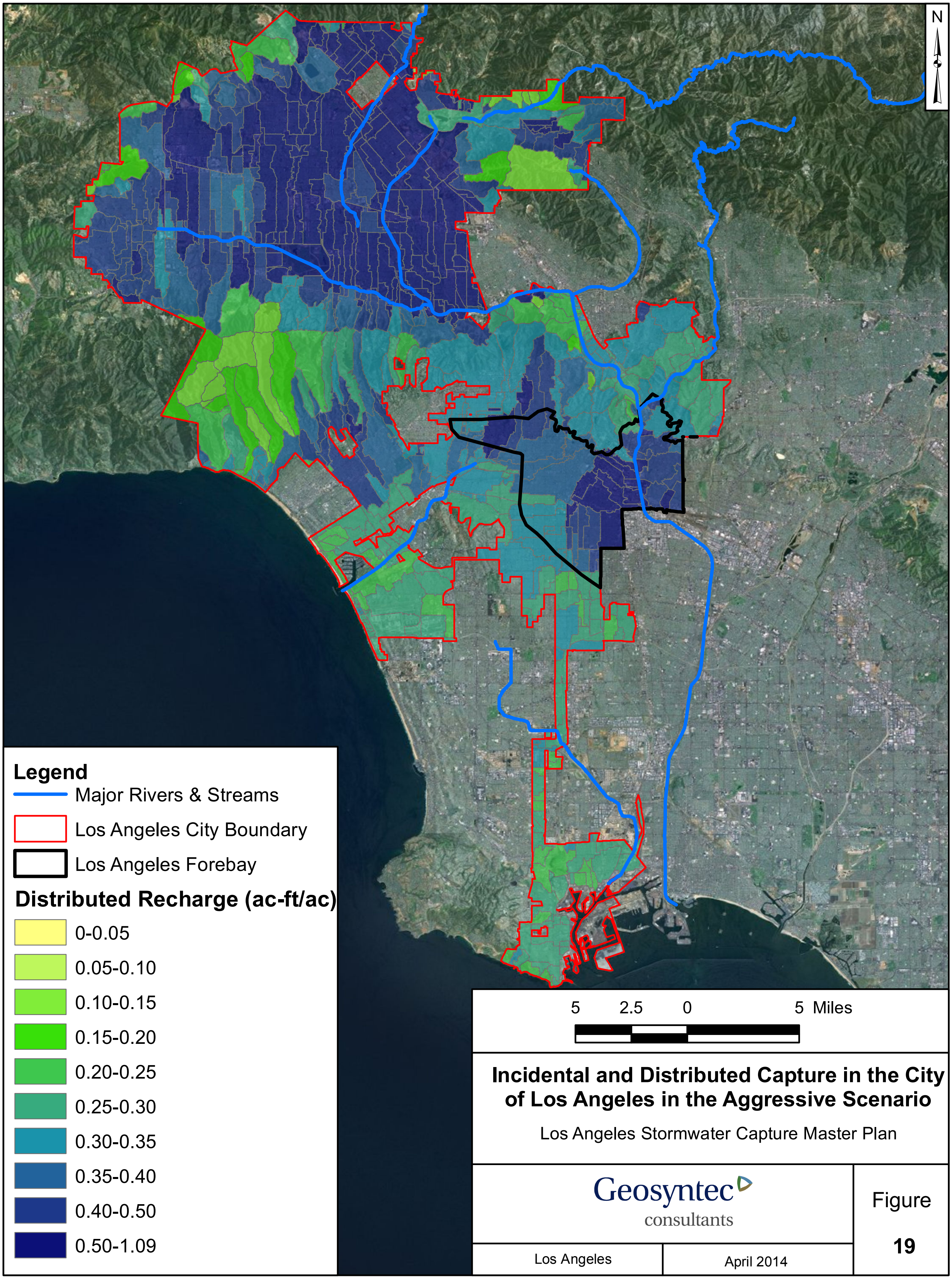
Figure 18




**Incidental and Distributed Capture in the City of Los Angeles in the Aggressive Scenario**

Los Angeles Stormwater Capture Master Plan

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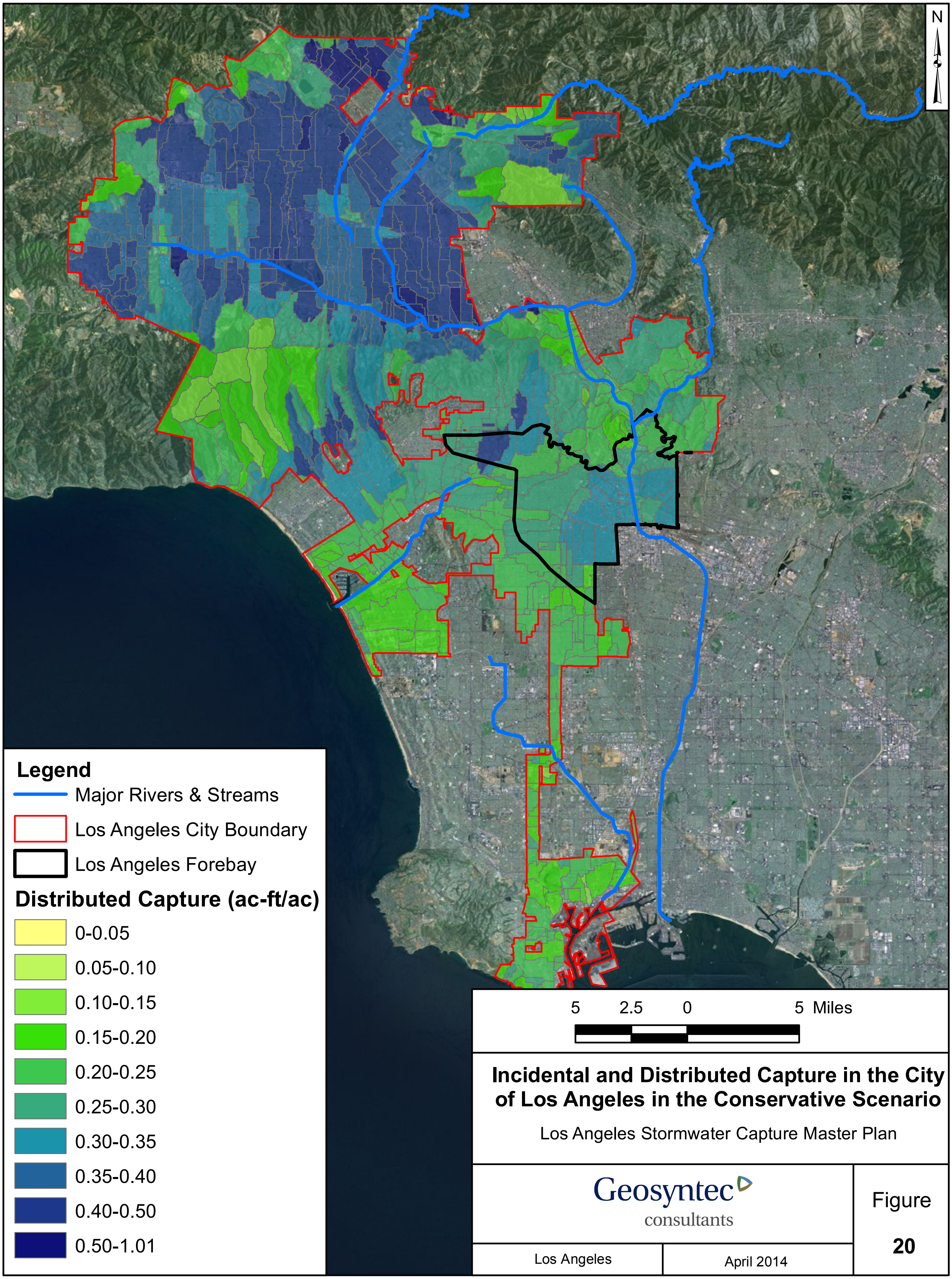
Figure 19




**Incidental and Distributed Capture in the City of Los Angeles in the Conservative Scenario**

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Figure **20**

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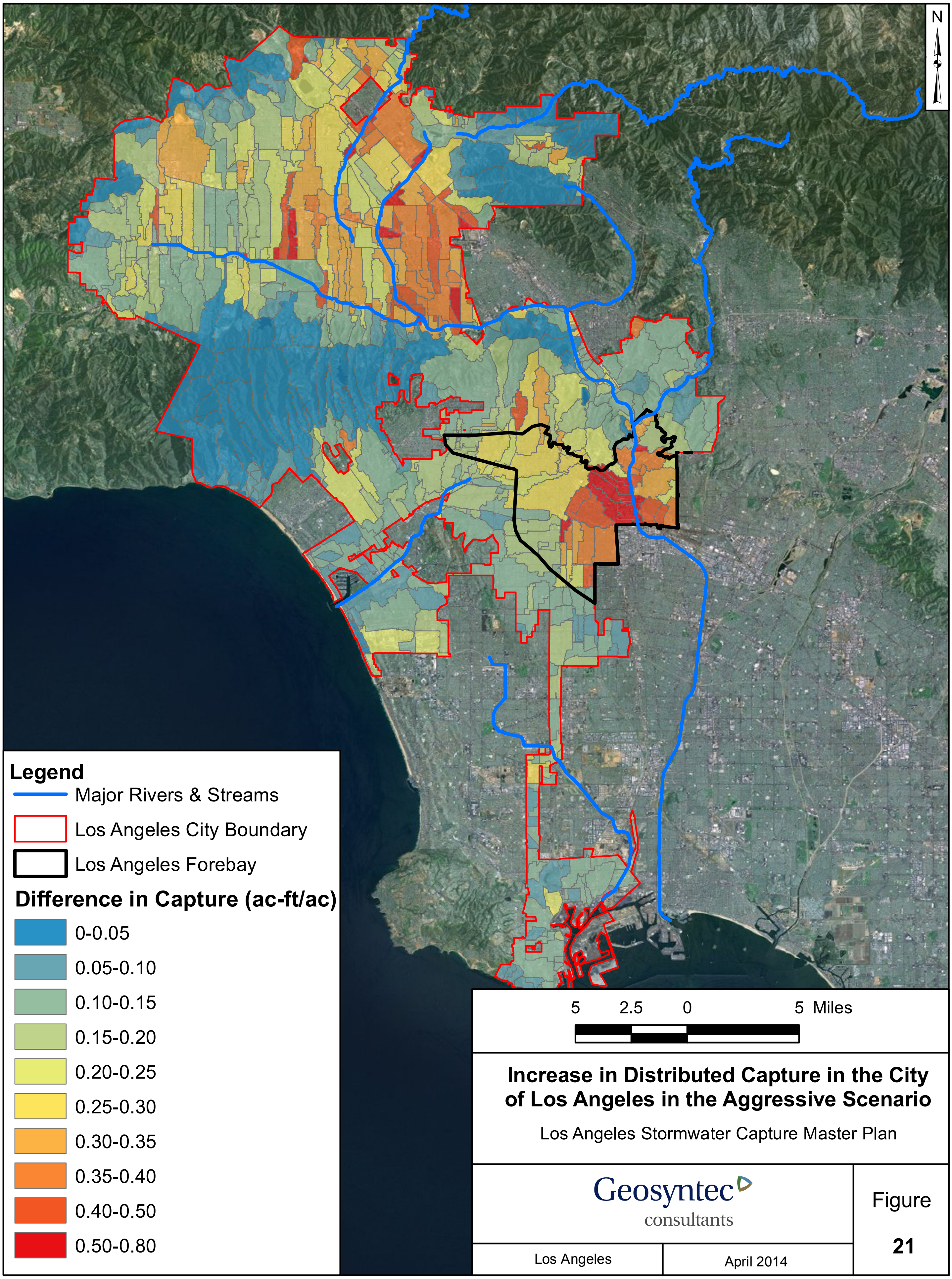


**Increase in Distributed Capture in the City of Los Angeles in the Aggressive Scenario**

Los Angeles Stormwater Capture Master Plan

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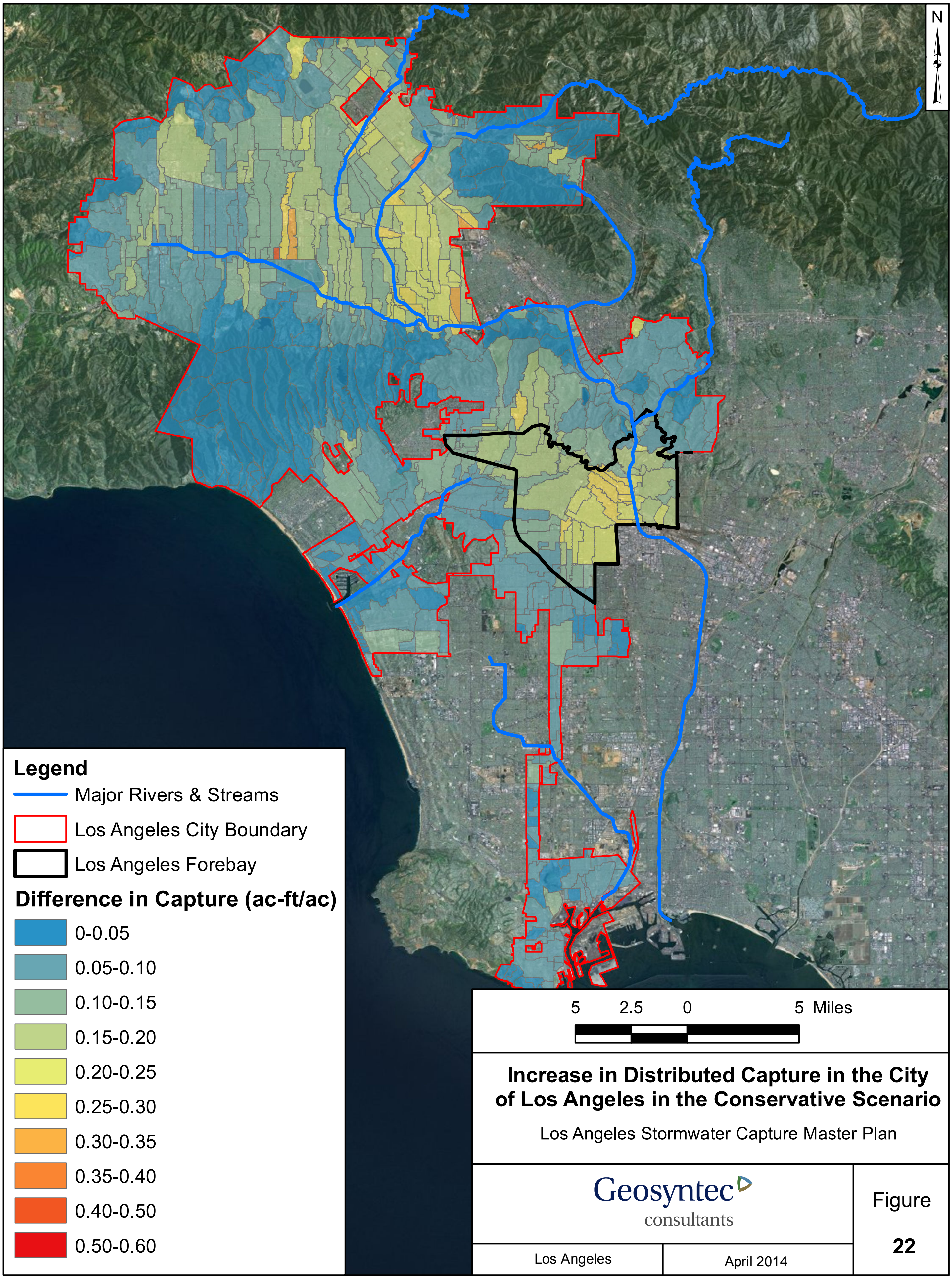
Figure 21




**Increase in Distributed Capture in the City of Los Angeles in the Conservative Scenario**

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Figure 22

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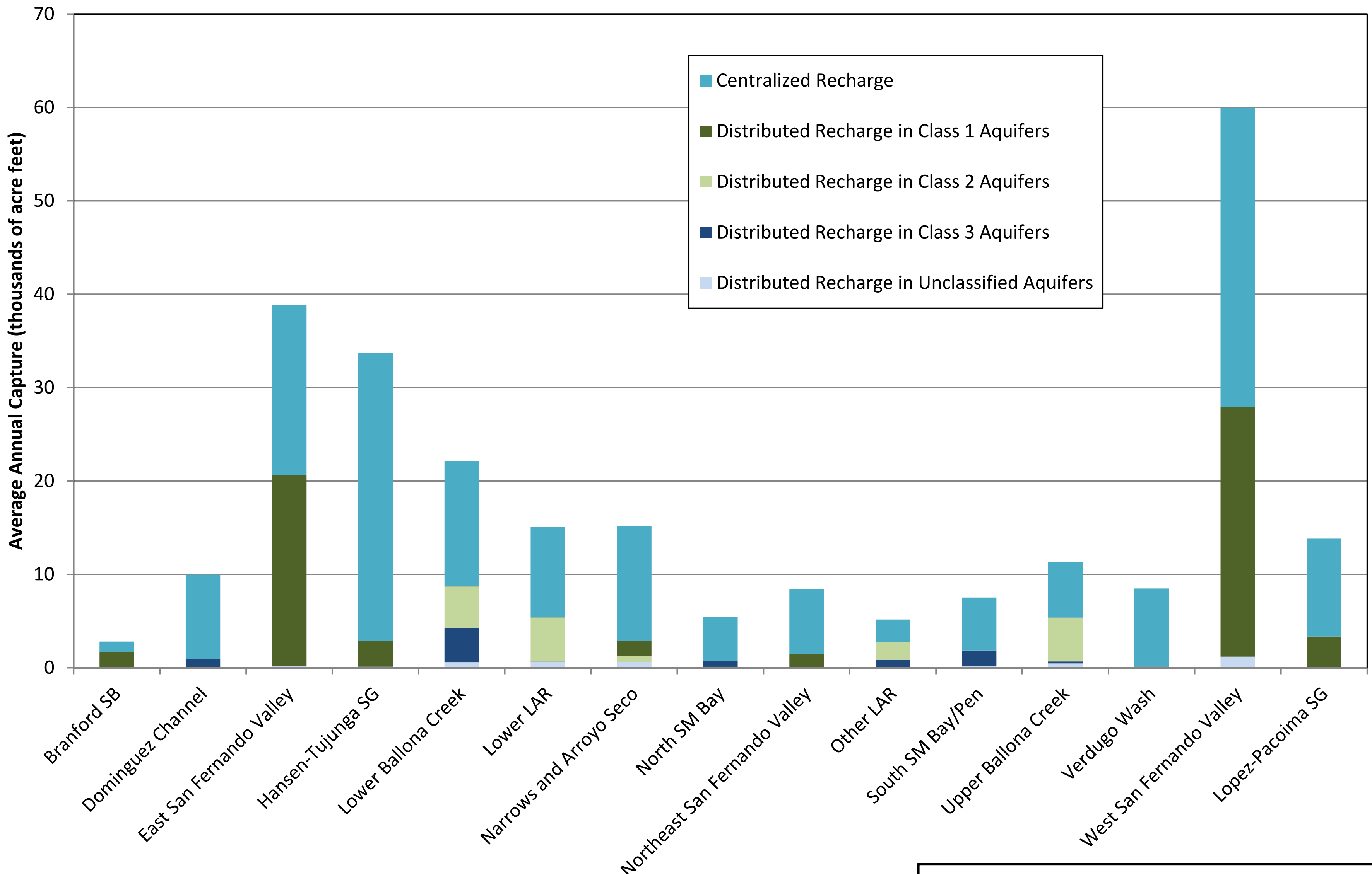


**Capture Volume by Subwatershed in the Aggressive Scenario**

Los Angeles Stormwater Capture Master Plan

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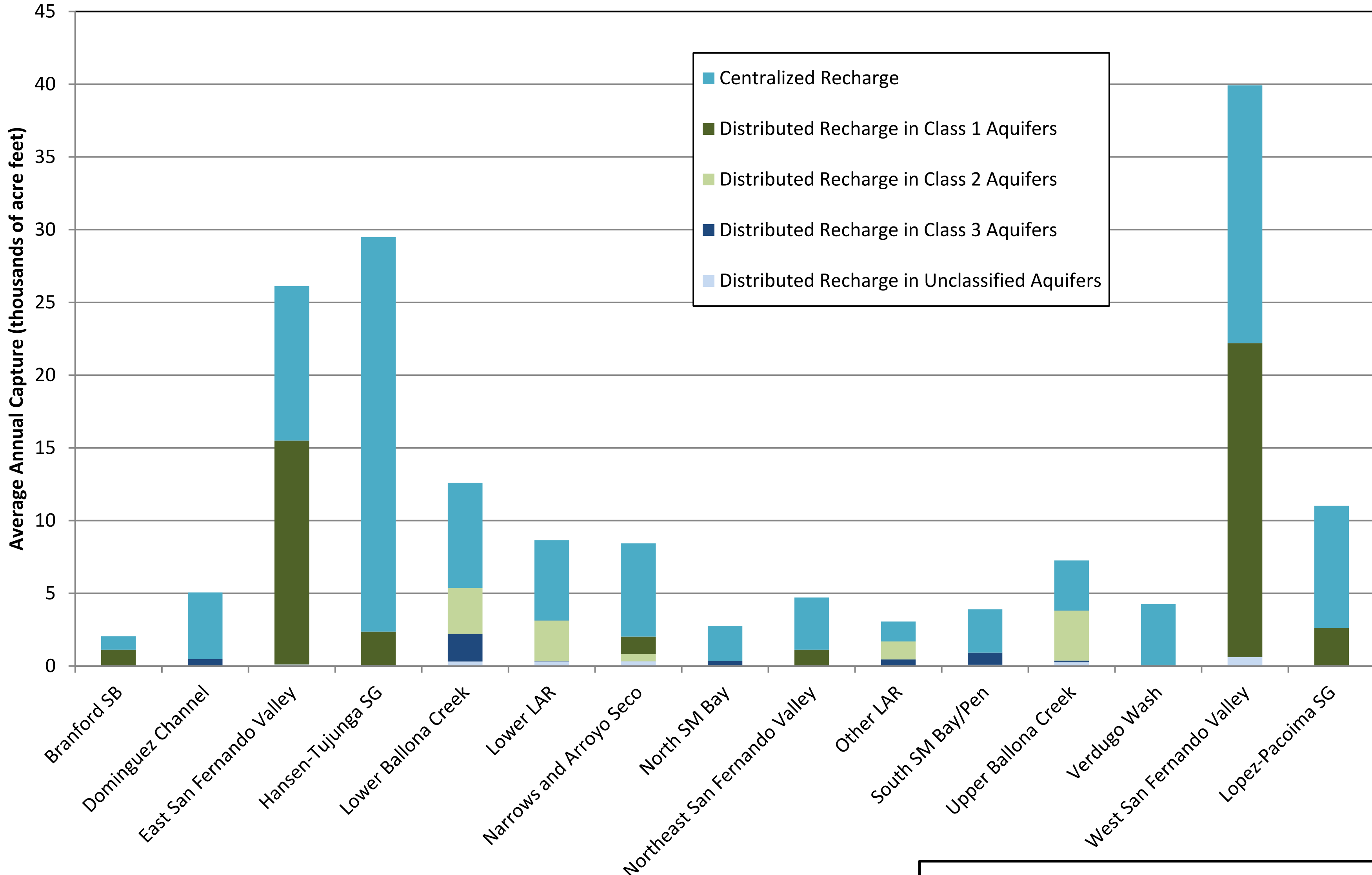
Figure 23




**Capture Volume by Subwatershed in the Conservative Scenario**

Los Angeles Stormwater Capture Master Plan

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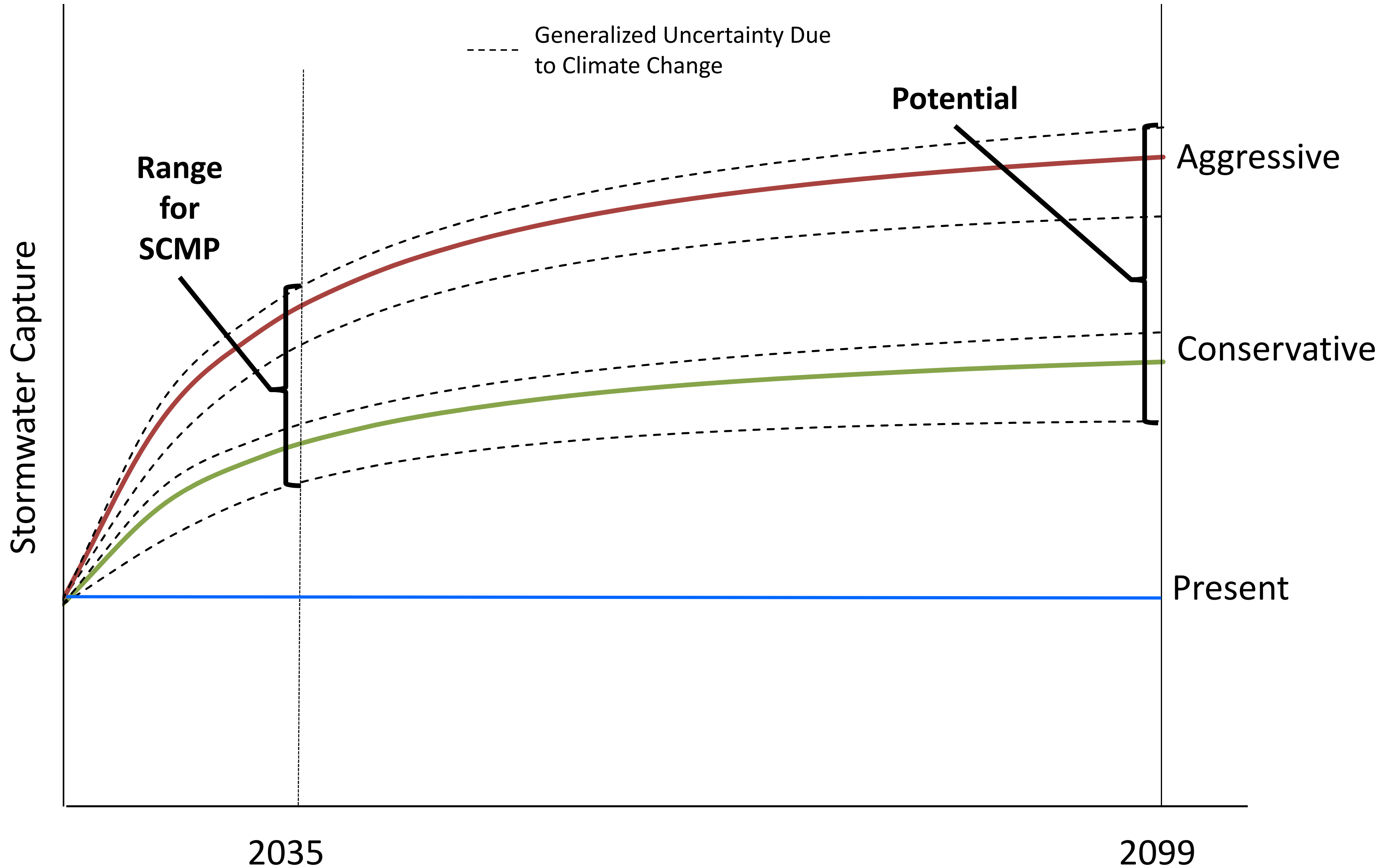
Figure 24




**Potential Effects of Climate Change On Stormwater Capture Predictions**

Los Angeles Stormwater Capture Master Plan

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| | | |
|---|---|---|
| Los Angeles | April 2014 | Figure 25 |

# APPENDIX G. CENTRALIZED PROJECT FACT SHEETS

Los Angeles Department
of Water and Power

# Stormwater Capture Master Plan

## Centralized Project Fact Sheets



Geosyntec consultants

| Project Name | Score | Status |
|---|---|---|
| Pacoima SG Upgrade | 87 | Concept Developed |
| Van Norman Complex | 83 | Project Moving Forward |
| Arundo Removal | 83 | Newly Proposed (NFF) |
| Spreading Grounds Optimization | 82 | Technology Based Soln. |
| Hansen Dam Water Conservation | 80 | Draft Feasibility Study |
| Lopez SG Upgrade | 73 | Paid for and Moving Forward |
| Branford Spreading Basin Enhancement | 73 | Concept Developed |
| Sepulveda Basin - HSG | 73 | Newly Proposed (GS) |
| Debris Basin Retrofits (x3) - X | 73 | Newly Proposed (GS) |
| Rory M Shaw Wetlands | 71 | Paid for and Moving Forward |
| Stormdrain Mining, Treat and Inject - X | 71 | Newly Proposed (WMG) |
| Pacoima Dam Sediment Removal | 69 | Paid for and Moving Forward |
| Big Tujunga Sediment Removal | 69 | Paid for and Moving Forward |
| Canterbury Power Line Easement | 67 | TWWGRMP |
| Old Pacoima Wash | 67 | Concept Identified |
| Lakeside | 67 | Concept Developed |
| East Valley Baseball Park | 66 | Newly Proposed (GS) |
| Whitsett Park Retrofit - X | 66 | Newly Proposed (GS) |
| Park Retrofit 2 - X | 66 | Newly Proposed (GS) |
| Park Retrofit 3 - X | 66 | Newly Proposed (GS) |
| North Hollywood Power Line Easement | 65 | Newly Proposed (GS) |
| Bull Creek | 65 | Concept Developed |
| Sod Farm | 65 | Newly Proposed (GS) |
| Sheldon Pit | 65 | Concept Developed |
| Boulevard Pit | 65 | TWWGRMP |
| Albion Dairy | 64 | Newly Proposed (WMG) |
| Lopez Dam | 62 | Concept Developed |
| Valley Generating Station Phase II | 60 | Concept Developed |
| Van Nuys Airport | 59 | Concept Developed |
| Stormdrain Mining, Treat and Direct Use - X | 59 | Newly Proposed (WMG) |
| Valley Generating Station Phase I | 58 | Concept Developed |
| Bus Depot at HSG | 58 | TWWGRMP |
| Whiteman Airport | 55 | Newly Proposed (WMG) |
| Floodplain Buyback, Check Dams - X | 54 | Newly Proposed (TRP) |
| Silver Lake | 51 | Newly Proposed (SLRC) |
| LA Forebay LAR Projects - X | 46 | Newly Proposed (LACFCD) |
| CalMat Pit - X | 37 | Concept Developed |
| LA River Park - X | 0 | Newly Proposed |
| Valley Village Gardens - X | 0 | Newly Proposed |
| LA Forebay Upper Ballona Creek Projects - X | 0 | Newly Proposed |

| |
|---|
| Evaluated for SCMP |
| Fact sheet developed |
| Selected for Concept Design |

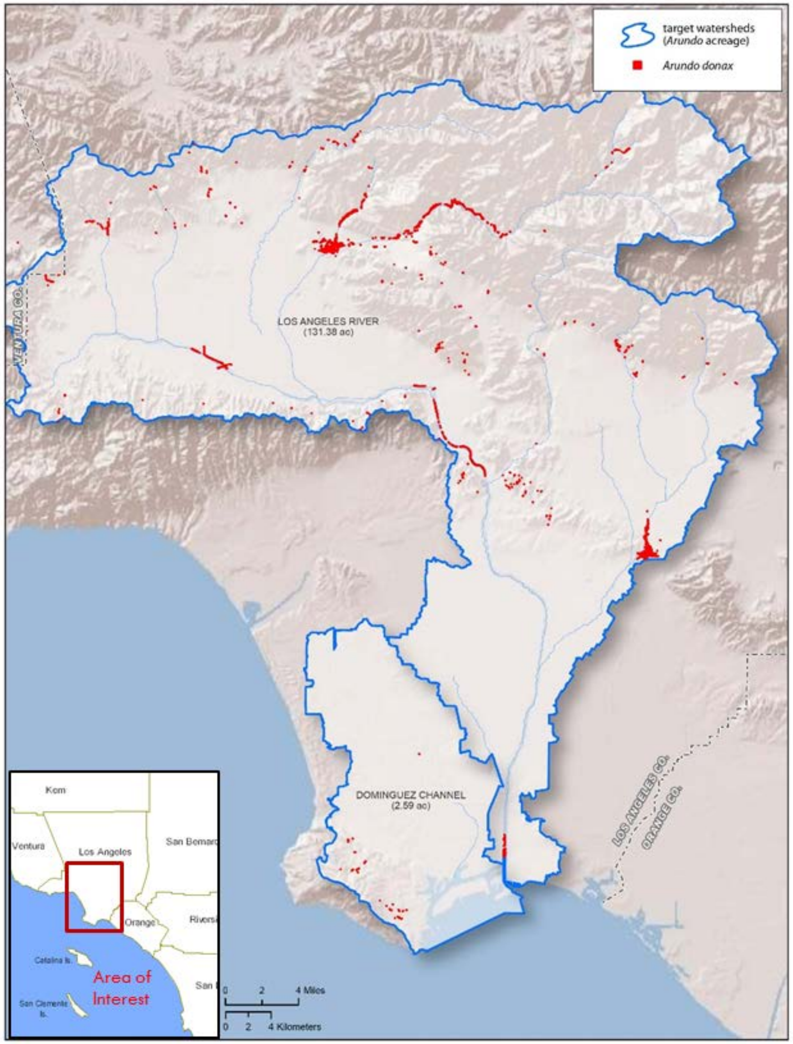
# Arundo Removal

The National Forrest Foundation (NFF) has been developing an Arundo Donax Control and Removal Plan for the Upper LA River Watershed. They inquired if LADWP would like to both partner with their efforts and coordinate the CEQA for the properties that LADWP owns in the Big Tujunga Canyon.

According to the info provided, Arundo is an invasive water intensive species of plant. An acre of Arundo removed would yield an additional 20 acre-feet per year (AFY) of water for capture and recharge at the downstream spreading basins. It is estimated that there is about 130 acres of Arundo in the LA River Watershed. Roughly half of 130 acres is located within the Tujunga Watershed. This has the potential to yield approximately 1300 AFY of water for capture and recharge. Depending on the treatment method, the cost may run from $36k-$72k per acre, over a ten year period. Total cost would range between $2.3M to $4.7M with a corresponding capitalized cost of $90-180 per acre-foot of water.

In order to properly eradicate the Arundo, it must treated at all locations in the canyons, including LADWP properties. The prescribed treatment options would take 7 to 10 years to implement. This would exceed any authority LADWP has in terms of length of contracts.

The NFF is moving forward on the CEQA for Arundo removal in the Upper LA River Watershed. They have requested $100k from LADWP to update the Arundo Survey fund eradication. NFF indicated that the Metropolitan Water District may be interested in funding up to 50% of the Arundo Removal. Also, advised the NFF that this project may be a good candidate for the Integrated Regional Water Management Program Prop. 84 Grant.



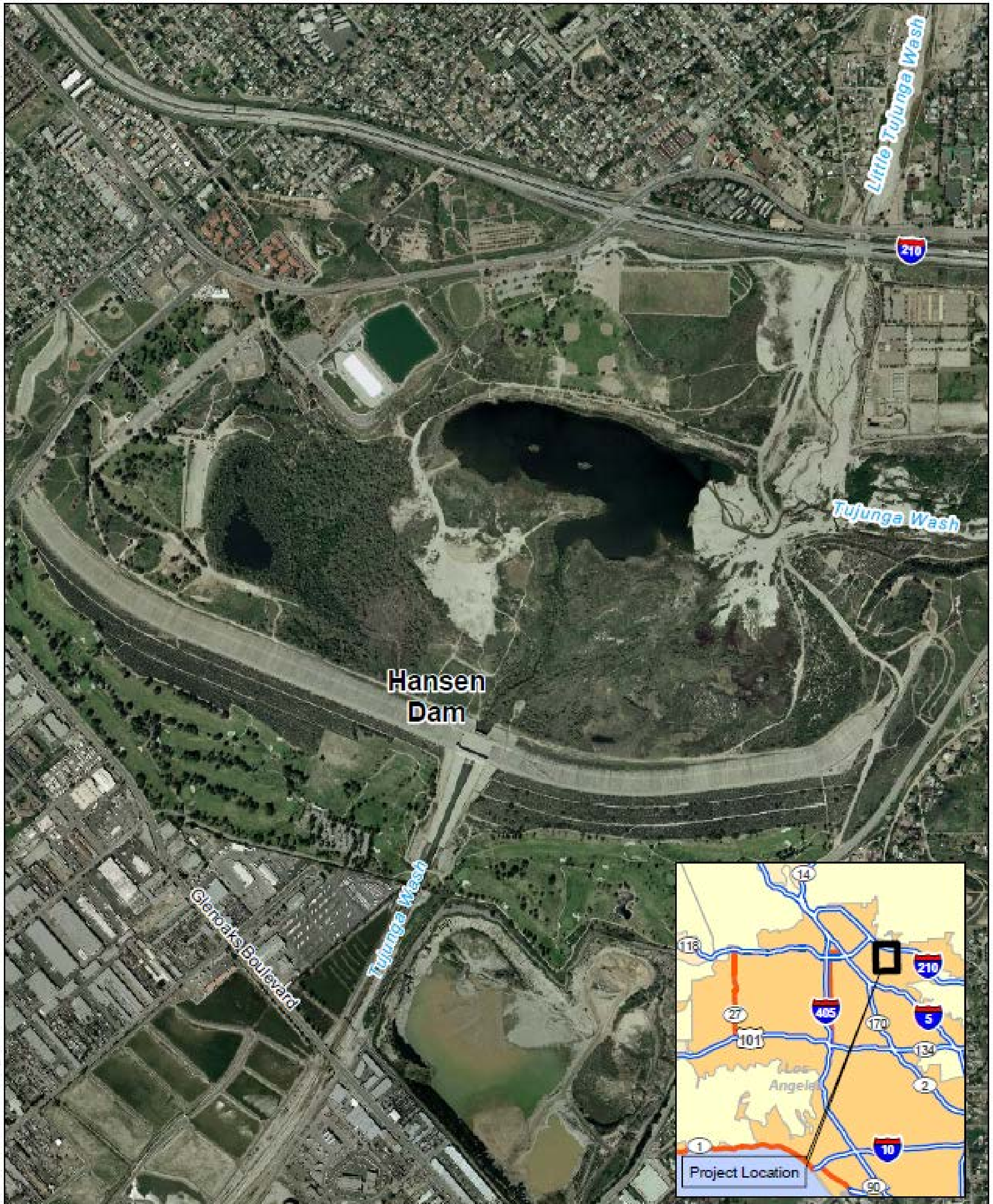
# Arundo Removal

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | Yes | Yes |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 4 | 20 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 3 | 18 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 5 | 15 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 5 | 15 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 5 | 15 |
| | | | | TOTAL | 83 |

# Hansen Dam Water Conservation

Hansen Dam Water Conservation Project is described in the Los Angeles County Drainage Area (LACDA) Water Conservation and Supply at Hansen and Lopez Dams Feasibility Study Final Report and Environmental Impact Statement (USACE, April 1999). The study development was cost shared by LACDPW. However, a sponsor for the construction, mitigation, monitoring, and operation and maintenance of the project has not yet been identified.

The only structural modification associated with the plan is the conversion of the two ungated outlets to slide gate outlets at elevation 1011 NGVD. Operational changes include allowing the water conservation pool to encroach into the flood control pool up to an elevation of 1,030 feet during the flood season (October 1 through February 28, as defined by USACE). During this time, if rain were forecast, the reservoir would be drawn down to 1010.5 feet, to accommodate flood flows. During the dry season (March 1 – September 30), water would be held for conservation at elevation 1000 feet. Once every even years during the dry season, water could be held to an elevation of 1030 feet. If the dam were operated as described, the plan would yield an average annual water conservation of 20,500 AF, which is a 20% increase over the existing conditions, and subsequent groundwater recharge of 3,400 AFY (USACE, April 1999). Estimated project cost is less than $3M.

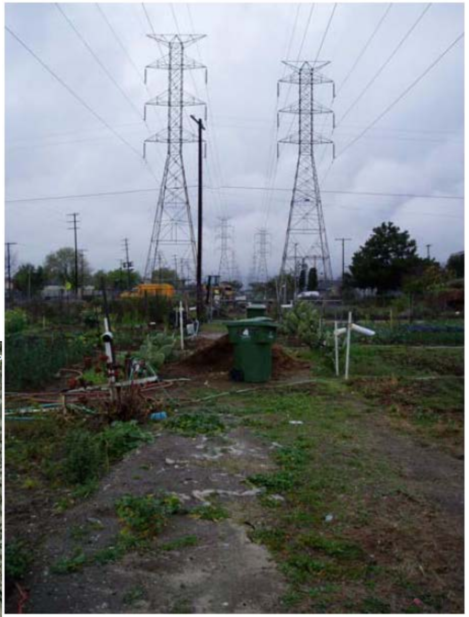


# Hansen Dam Water Conservation

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields;<br>b) anywhere (that is monitored) within the Central or West Coast Basins;<br>c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | YES | YES |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 4 | 20 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 5 | 30 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 3 | 9 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 3 | 9 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 4 | 12 |
| | | | | **TOTAL** | **80** |

# Canterbury Power Line

Canterbury Avenue Power Line Easement runs parallel with Pacoima Diversion Channel. The corridor extends between Pacoima Spreading Grounds and the lower Tujunga Wash. The Power Line Easement is owned by the LADWP. The corridor is approximately 12,800 feet long and 200 feet wide, with out-parcels for private property and streets. This project proposes to construct approximately 30 recharge basins within the corridor with depths ranging from 7-10 feet. The basins would act as an extension of Pacoima Spreading Grounds, with an added storage volume of 136 AF and new total percolation rate of 80 cfs (as compared to the assumed percolation rate of 65 cfs for the existing Pacoima Spreading Grounds alone). Constructing the Canterbury Avenue Power Line Easement project would yield an estimated annual recharge benefit of 1,472 AFY. Construction of the Canterbury Avenue Powerline Easement under the DWP easements will require following certain setback requirements to protect power infrastructure. The preliminary project cost which was used for project rankings was between $20M and $49.9M.

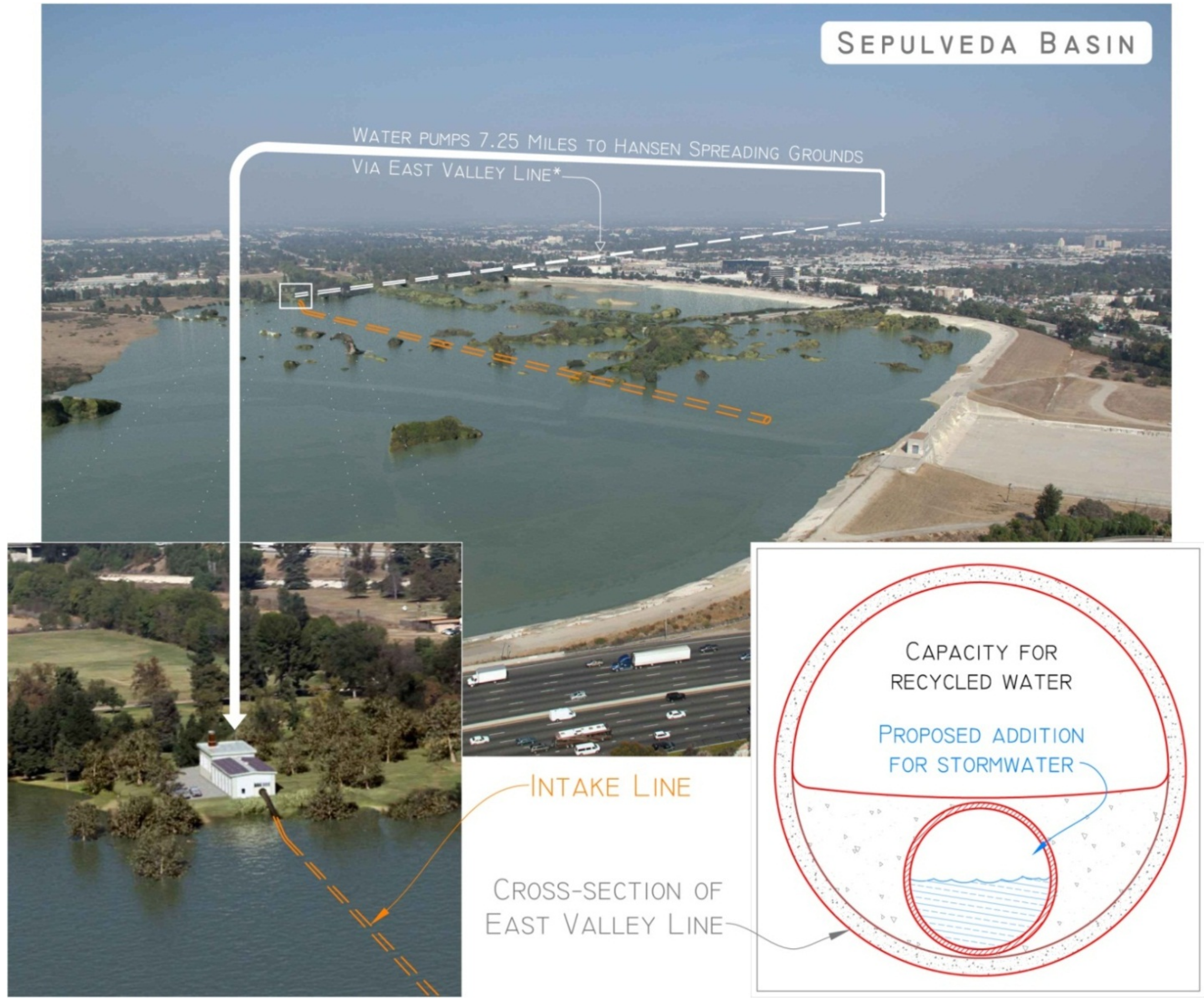


# Canterbury Power Line

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | YES | YES |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 2 | 10 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 4 | 24 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 5 | 15 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 5 | 15 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 3 | 9 |
| | | | | TOTAL | 67 |

# Sepulveda Basin – Hansen Spreading Grounds Pipeline

The Sepulveda Basin and Sepulveda Dam, located on the Los Angeles River, are owned and operated by the United States Army Corps of Engineers. This facility is a critical component to Los Angeles' flood control system. The basin has a storage capacity of 18,129 AF at the top of the spillway. When stormflows coming from the 152 square mile tributary area begin to subside, gates could be closed to impound water behind the dam to conserve it before it is lost to downstream reaches of the Los Angeles River and the Pacific Ocean. Using a new pump station, and potentially installing a smaller pipe within the East Valley pipeline, which runs from Sepulveda Basin to the Hansen Spreading Grounds, stormwater captured behind the Sepulveda Dam could be used to recharge the San Fernando Groundwater Basin aquifer. This project requires longer-term planning because the USACE needs to develop a feasibility study and the ultimate decision belongs with the federal government. Is it estimated that this project could provide upwards of 3,000 AFY of recharge benefit.





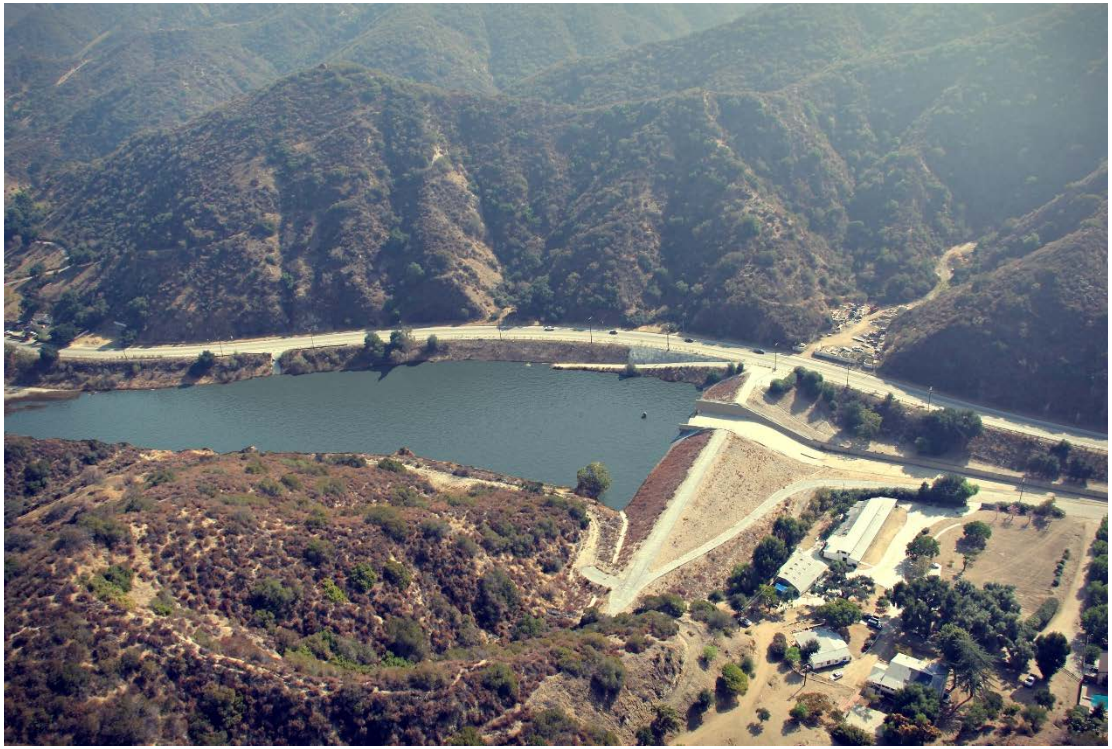
Geosyntec consultants

# Sepulveda Basin – Hansen Spreading Grounds Pipeline

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | Yes | Yes |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 2 | 10 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 5 | 30 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 3 | 9 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 5 | 15 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 3 | 9 |
| | | | | TOTAL | 73 |

# Debris Basin Retrofits

There are multiple debris basins in the foothills surrounding the urbanized valley floors within and around the City of Los Angeles. Debris basins are an important component in Los Angeles' flood control system. Most debris basins are owned and operated by the Los Angele County Department of Public Works. These debris basins range in size from several AF to more than 100 AF in capacity. Some debris basins are located upstream of several spreading facilities including the Pacoima, Hansen, and Tujunga Spreading Grounds. Certain debris basins could be retrofitted with control outflow works so runoff from rainfall tributary to the debris basins could be stored for a short period of time, then metered out to be captured in downstream spreading facilities. Careful analysis is necessary to understand which debris basins could become candidates for a retrofit of this type. Is it estimated that this project could provide between 1,000 and 1,500 AFY of recharge benefit. Estimated project cost is less than $3M.

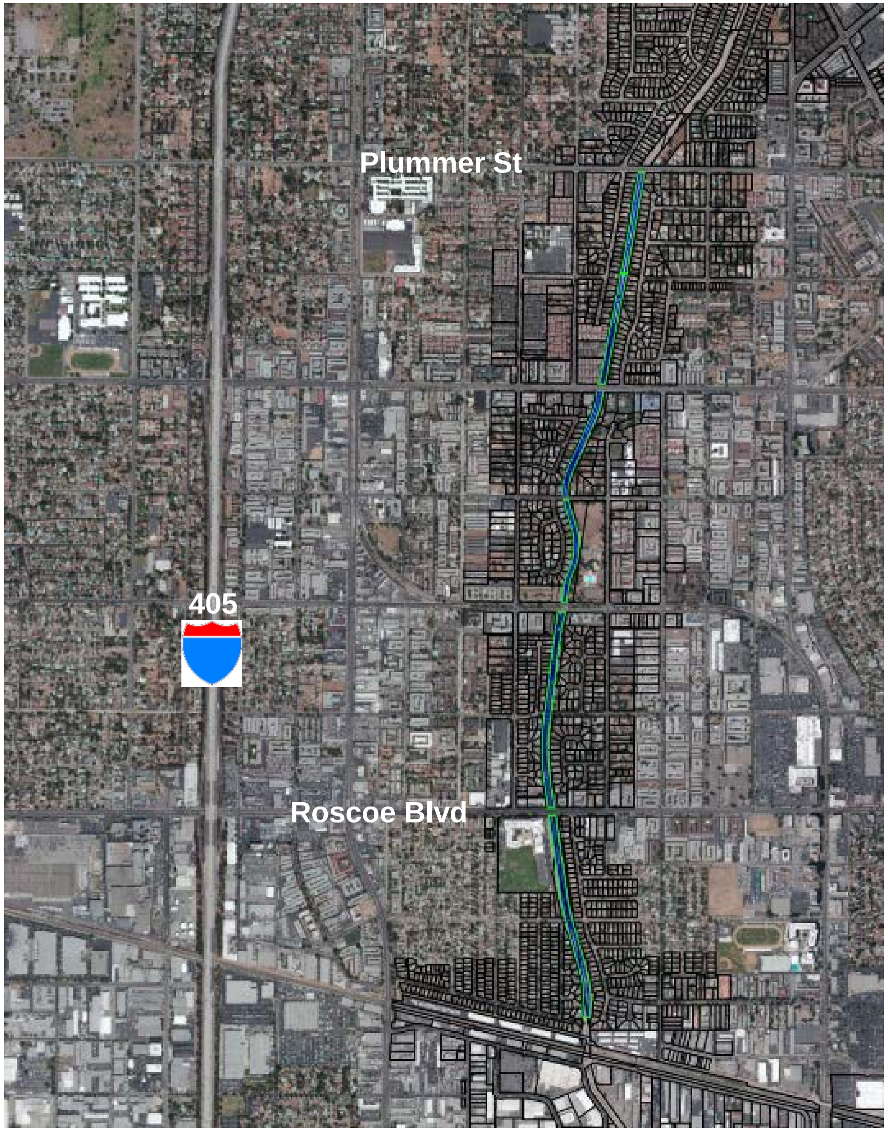


# Debris Basin Retrofits

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | Yes | Yes |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 5 | 25 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 3 | 18 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 4 | 12 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 3 | 9 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 3 | 9 |
| | | | | TOTAL | 73 |

# Old Pacoima Wash

The Old Pacoima Wash runs southwest from the Pacoima Spreading Grounds until it meets up with Tujunga Wash below the Tujunga Spreading Grounds. The channel acts as an overflow channel from the spreading ground if too much water is delivered. The channel also collects storm drain runoff as flows enter the system from tributary areas downstream from the spreading ground. The upstream portion of the channel from the spreading grounds to Parthenia Street is 8,600 feet-long and 40 feet wide at the bottom. It is concrete lined on the bed and banks. The downstream 4,700 foot-long portion of the Old Pacoima Wash, from Parthenia Street to Cabrito Road is rock bottomed, with concrete bank protection. There are drop structures for energy dissipation located throughout this reach. The Wash is owned by US Army Corp of Engineers and operated and maintained by the Los Angeles County Flood Control District. This concept intends to utilize the channel as an instream infiltration system by installing rubber dams on drop structures throughout the entire reach. These inflatable dams will be utilized after storm events to infiltrate captured storm water. With the length and an assumed depth of 5 feet, the expected storage capacity of the system is 12.2 acre-feet. Due to the storm flows and velocities, it is expected that the channel will require rock bottom as found in the unlined portion currently in the system. Removal of sediment to prevent plugging will be difficult, so use of the Pacoima Spreading Grounds as a settling basin prior to infiltration in Old Pacoima Wash will help keep infiltration rates high in the rocky bottom. Is it estimated that this project could provide between 1,000 and 1,500 AFY of recharge benefit. The preliminary project cost which was used for project rankings was between $20M and $49.9M.



# Old Pacoima Wash

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | YES | YES |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 2 | 10 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 3 | 18 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 4 | 12 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 5 | 15 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 4 | 12 |
| | | | | TOTAL | 67 |

# East Valley Baseball Park

The East Valley Baseball Park Infiltration System will divert water from a storm drain that runs along the SR-170 Freeway or from Tujunga Spreading Grounds. Two infiltration basins will be excavated with a surface area of approximately 9 acres and 5 to 10 feet deep. The expected storage volume for this system will be 50 to 80 acre-feet. Surface drainage from the nearby neighborhoods drains approximately 350 acres, which is only enough to deliver 20 acre feet during a 1” storm. Connecting the system to the Tujunga Spreading Grounds will allow the system to receive waters from releases at Big Tujunga and Hansen Dam, increasing supply to the park. The connection will also provide additional storage and infiltration down gradient from the retired landfill. Is it estimated that this project could provide between 500 and 1,000 AFY of recharge benefit. The preliminary project cost which was used for project rankings was between $10M and $19.9M.

# East Valley Baseball Park

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | Yes | Yes |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 3 | 15 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 2 | 12 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 5 | 15 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 5 | 15 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 3 | 9 |
| | | | | TOTAL | 66 |

# Storm drain mining

## Diversion, treatment and either injection or direct use

Storm drain mining is defined as diverting dry and wet weather flows out of storm drains and channels for treatment and beneficial use.  An example is a project being developed by the City of Los Angeles Bureau of Sanitation in the Ballona Creek Watershed called the North Outfall Treatment Facility (NOTF). The NOTF project proposes to retrofit a decommissioned sewage outfall treatment facility into urban runoff water quality improvement project to improve water quality in Ballona Creek, the Estuary, and downstream beaches while providing much needed reclaimed water for local irrigation and other non-potable uses in the area. Should sufficient demands not be identified, treated flows could be injected into the potable groundwater aquifer. NOTF project components include in-stream  flow diversion structure, pump station and wet wells, trash and fine screens, a disinfection facility, and discharge options such as a return conveyance to Ballona Creek, or a pump station for distribution and/or injection. This is a concept that could be replicated across the City where sufficient flow is available and where non-potable demands, or potable aquifers, exist. Estimated cost is < $3M.

# Storm drain mining

## Diversion, treatment and either injection or direct use

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | Yes | Yes |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 4 | 20 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 4 | 24 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 5 | 15 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 3 | 9 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 1 | 3 |
| | | | | TOTAL | 71 |

Sod Farm

# Whitsett Sports Fields Park Retrofit

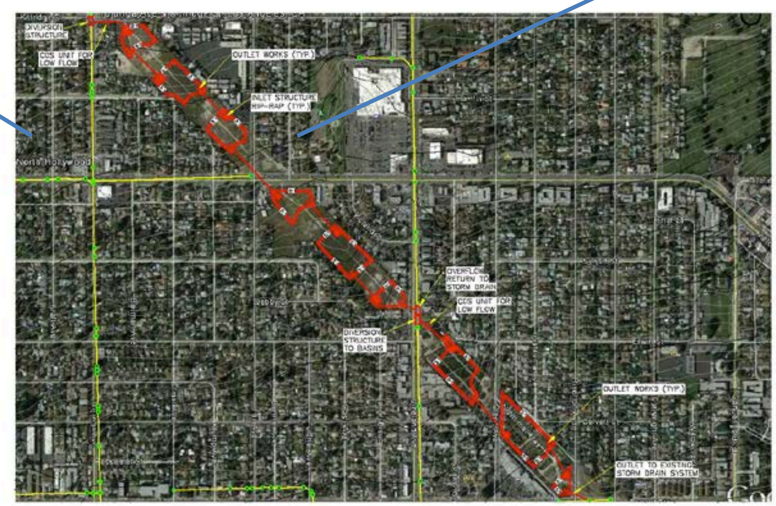
The Whitsett Sport Fields are located near the 170 Freeway at the intersection of Whitsett Avenue and Vanowen Street. Water will be routed from existing storm drains in the area. A hydrodynamic separator such as a CDS unit will be installed to remove trash from the inflowing water. The project concept for this project includes wetlands for treatment of low flows combined with infiltration basins. Subterrainian infiltration galleries are a potential option as well. Trails around the basins will be provided for walking/bike riding. The fields that are currently utilizing this piece of open space can be moved across the freeway to the other portion of the park. This project has a land area of approximately 22 acres and a 225 AF storage capacity. Is it estimated that this project could provide between 500 and 1,000 AFY of recharge benefit. Estimated cost is < $3M.

# Whitsett Sports Fields Park Retrofit

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | Yes | Yes |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 3 | 15 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 2 | 12 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 4 | 12 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 5 | 15 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 4 | 12 |
| | | | | TOTAL | 66 |

# North Hollywood Power Line Easement

Los Angeles Department of Water and Power (LADWP) transmission line easements are very pronounced within the San Fernando Valley. The proposed project would be to develop a project concept for infiltration basins along the easement to expand the Whitnall Highway corridor park project proposed by LADWP. The portion of the easement to be developed for this project runs between intersection of Tujunga Ave and Kitridge Street and follows the powerline easement down to Oxnard St. near Cahuenga Blvd. The basins within the easement must stay 100 ft from powerline towers. The project will consist of infiltration basins similar to those at Tujunga Spreading Grounds. Water will be diverted from storm drains in the area to provide water into the basins during storm events. A hydrodynamic separator such as a CDS unit will be installed to remove trash from the inflowing water. This project has a land area of approximately 14 acres and a 140 AF storage capacity. Is it estimated that this project could provide between 500 and 1,000 AFY of recharge benefit. Estimated cost is < $3M.

# North Hollywood Power Line Easement

| Criteria | Description | Scoring Guideline | Weight | Score | Total |
|---|---|---|---|---|---|
| Water Supply Project | The water supply criteria is an initial screening level that defines if a project is included in the SCMP or not. | YES: a) spreads water upgradient of and/or close to SFB well fields; b) anywhere (that is monitored) within the Central or West Coast Basins; c) directly offsets potable demands.<br>NO: does not meet above requirements | Pass/fail | Yes | Yes |
| Initial Cost: | The initial cost criterion accounts for the planning, engineering, acquisition, and construction of each project. The criterion will be evaluated using general price range categories. | 5 = <$3M<br>4 = $3M - $9.9M<br>3 = $10M - $19.9M<br>2 = $20M - $49.9M<br>1 = $50M - $100M<br>0 = >$100M | 5 | 4 | 20 |
| Expected Recharge/Direct Use Benefit: | The recharge/direct use benefit criterion accounts for the average annual amount of recharge/direct use the project is expected to help achieve, whether the recharge occurs locally or if it allows recharge downstream (i.e. through volume storage and release control). | 5 = >3,000 AF/YR<br>4 = 1,500 - 3,000 AF/YR<br>3 = 1,000 - 1,500 AF/YR<br>2 = 500 - 1,000 AF/YR<br>1 = 200 - 500 AF/YR<br>0 = <200 AF/YR | 6 | 2 | 12 |
| Ownership: | The ownership criterion addresses the ability and lawful right to modify the land and facilities included in the potential project. | 5 = owned by LADWP or landowner proposed<br>4 = owned by either the City or County of Los Angeles.<br>3 = owned by other public entities such as the Corps of Engineers.<br>2 = owned by private entities or individuals, land available.<br>0 = owned by private entities or individuals, land not available. | 3 | 5 | 15 |
| Compatible Uses/ Partnership Opportunities: | The compatible uses criterion accounts for the project's potential to include multiple uses on site. Use may include but are not limited to education, recreation, and wildlife enhancement. This is also related to the ability to combine resources with other local, City, County, Regional, State, Federal programs. Other benefits must be appropriately significant and will defined as "water quality improvements", "flood risk mitigation", "open space enhancements" (either habitat and/or recreation). | If a project has many other potential uses and hence several opportunities for partnerships it will be ranked a 5. If the project has one other use, it will be ranked a 3. If the project has no other uses, it will be ranked a 0. | 3 | 3 | 9 |
| Operating Cost: | The operating cost criterion accounts for the estimated annual operation and maintenance costs of each project. | A score of 5 will be given to the projects with the lowest operating costs and a 0 to the projects with the highest operating costs. Projects will be scored depending on how much they are expected to increase labor, maintenance, and other operating costs. A project will receive a reduced score by a point if it is a new site, if it requires pumping and/or more active monitoring, and for significant conservation volume (1 point for each conservation volume multiple of 2,000 AF). For example, a project at a new site, requiring pumping, with an expected increase in conservation of 4,000 AF would be given 1 point. | 3 | 3 | 9 |
| | | | | TOTAL | 65 |

# APPENDIX H. SOW DOCUMENTS AND CONCEPT DESIGNS FOR SELECTED CENTRALIZED PROJECTS

# Canterbury Avenue Power Line Easement

# Stormwater Capture Study

## CONCEPTUAL STUDY REPORT



December 2014

*Prepared By:*

Los Angeles Department of Water and Power
Water Resources Division
Watershed Management Group

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## Tables



## Figures

## I. Introduction

The Los Angeles Department of Water and Power (LADWP) and the Los Angeles County Flood Control District (District) are cooperatively working to complete various stormwater capture projects. These projects are designed to help alleviate localized flooding, recharge the groundwater basin, and improve downstream water quality in the San Fernando Valley. The 2011 *Tujunga Wash Watershed Groundwater Recharge Master Plan* details various projects and combinations of projects to help meet the objective of capturing and retaining stormwater from the Canterbury Avenue Power Line Easement (Easement). The easement is located in the upper Tujunga Wash Watershed within the San Fernando Valley Groundwater Basin, as presented in Figure 1, near the northern bounds of the City of Los Angeles (City).


**Figure 1 – Location of Canterbury Avenue Power Line Easement**

Groundwater storage levels in the San Fernando Valley Groundwater Basin have been in decline for several decades. Lack of precipitation and the increased demand for water within the Los Angeles Region, due to increase urbanization, have created a strain on the water supply. Declining reserves of groundwater and surface water show that new water supply sources are needed to sustain the long-term reliability and utility of the groundwater basin and decrease the region's dependence on imported water supplies. To minimize the regions dependence on imported water, the proposed

Project will capture stormwater overflow from Pacoima Spreading Grounds (PSG) to additionally recharge groundwater reserves within the San Fernando Valley Groundwater Basin.

Currently, the intake limit of the PSG is 600 cfs. Flow exceeding this limit will cause flooding on Arleta Street as percolation at Pacoima Spreading Ground is limited due to clay-rich lenses with low permeability that underlie the recharge area. To increase intake limits and storage volumes, the proposed Project will serve as an extension to the PSG.

## II. Project Site Background

The Easement is located in the Tujunga Wash Watershed in the San Fernando Valley, and runs parallel with Pacoima Diversion Channel between PSG and lower Tujunga Wash. The study area is owned by LADWP and is approximately 12,800 feet long by 150 feet wide. From the estimated 44-acre easement area, approximately 18.8-acres will be utilized for the construction of the recharge basins. The average annual rainfall for the area is 16 inches. The 50-year rainfall event is defined by the District is 6.26 inches in a 24-hour period.

Las Palmas Nursery currently occupies Canterbury Avenue Power Line Easement. The nursery is using the easement for agricultural purposes, growing a number of plants and crops. The surrounding area is predominately single-family residential homes with some multifamily residences.  Other uses surrounding the Project include open space, commercial, and education facilities. Figure 2 below presents an analysis comparing the land use composition surrounding the Project and confirms observations from the aerial imagery.

Existing facilities for the nursery and the easement include the following:

- A intermodal container between Garber Street and Terra Bella Street;
- Thirteen sheds of various sizes and one office trailer between Garber Street and Kagel Canyon Street;
- There are existing 34.5 kv and 4.8 kv distribution overhead systems (supported by either wood poles or metal towers) that cross or run parallel to the Canterbury Power Line Easement.
- Five 34.5 kv circuits, eight 4.8 kv circuits, and two communication cables run on the overhead system. The 34.5 kv circuits are major trunk circuits that connect receiving station to four Distribution Stations, which are all pole-top stations inside of or along the easement. The communication cables run overhead across the easement at Osborne Street and Van Nuys Boulevard, and connect receiving station to other Department stations and facilities within the surrounding areas.
- There is one underground 34.5 kv circuit crossing the easement at Pierce Street, which includes a large vault. This underground conduit system was built

in 1992, and consists of six 6-inch and two 4-inch plastic conduits encased in concrete.

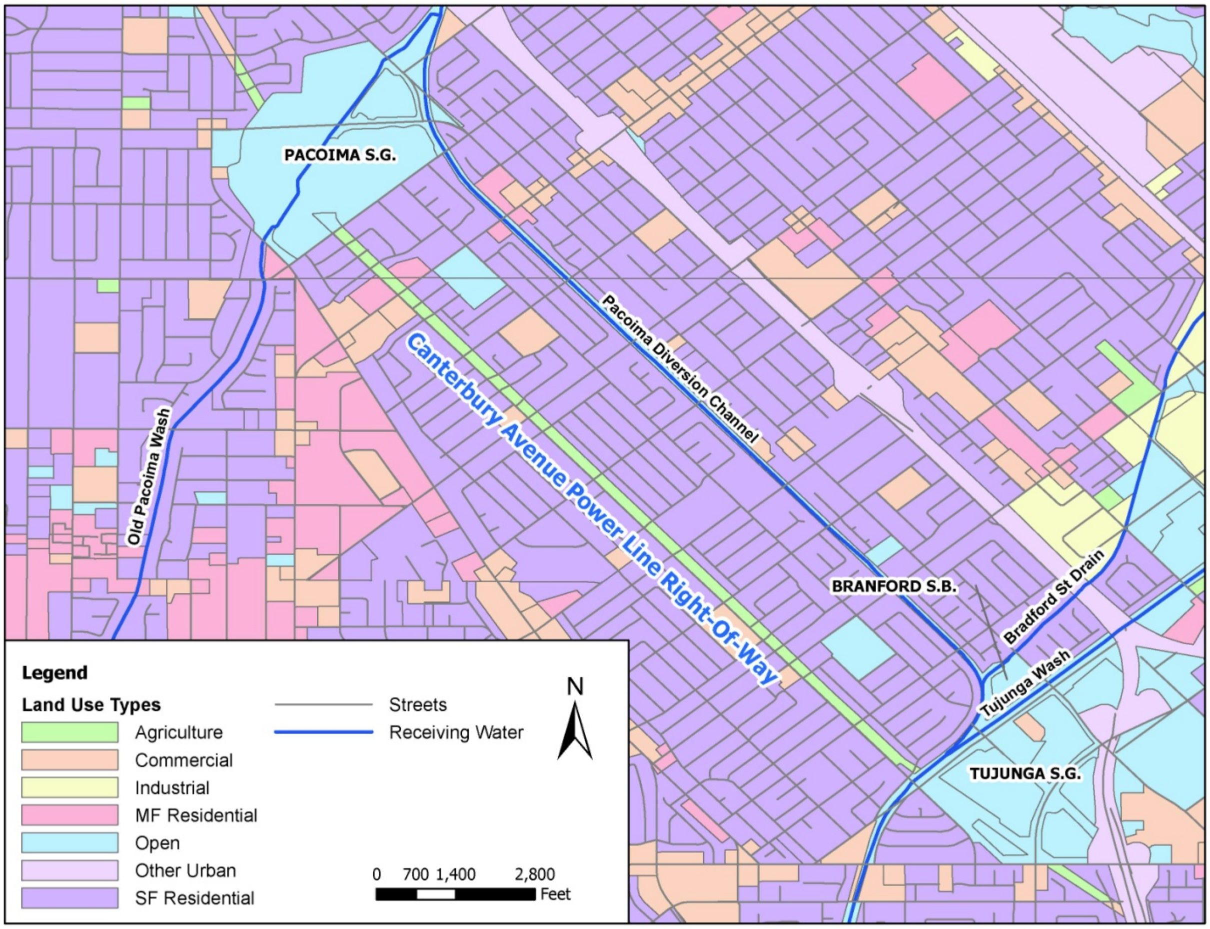


**Figure 2 – Land Use Surrounding Canterbury Avenue Power Line Easement**

The 2006 Los Angeles County Department of Public Works (LACDPW) Hydrology Manual provided the soil types and runoff coefficients for the study area. The soil types for the easement, as presented in Figure 3, consist predominately of Hanford Gravely Sandy Loam (HG), Hanford Fine Sandy Loam (HF), and Tujunga Fine Sandy Loam (TF). The HF soil is located near the north and south end of the project area, a small portion at the north end of the project area also contains TF. The HG soil is located in the center of the project area. The undeveloped runoff coefficients reported for 1 inch/hour rainfall intensity for these soil types range from 0.1 for TF to 0.46 for HF. Based on this finding, infiltration rates for TF soil would be the highest and HF would be the lowest. Table 1 shows the soil type numbers and runoff coefficients at 1 inch/hour rainfall intensity for the project area.

| Table 1: Canterbury Avenue Power Line Easement Area Soil Types | | | |
|---|---|---|---|
| Soil Type Number | Name | Original Name | Runoff Coefficient at 1"/hr |
| 005 | Hanford Fine Sandy Loam | HF | 0.46 |
| 007 | Hanford Gravely Sandy Loam | HG | 0.28 |
| 015 | Tujunga Fine Sandy Loam | TF | 0.1 |

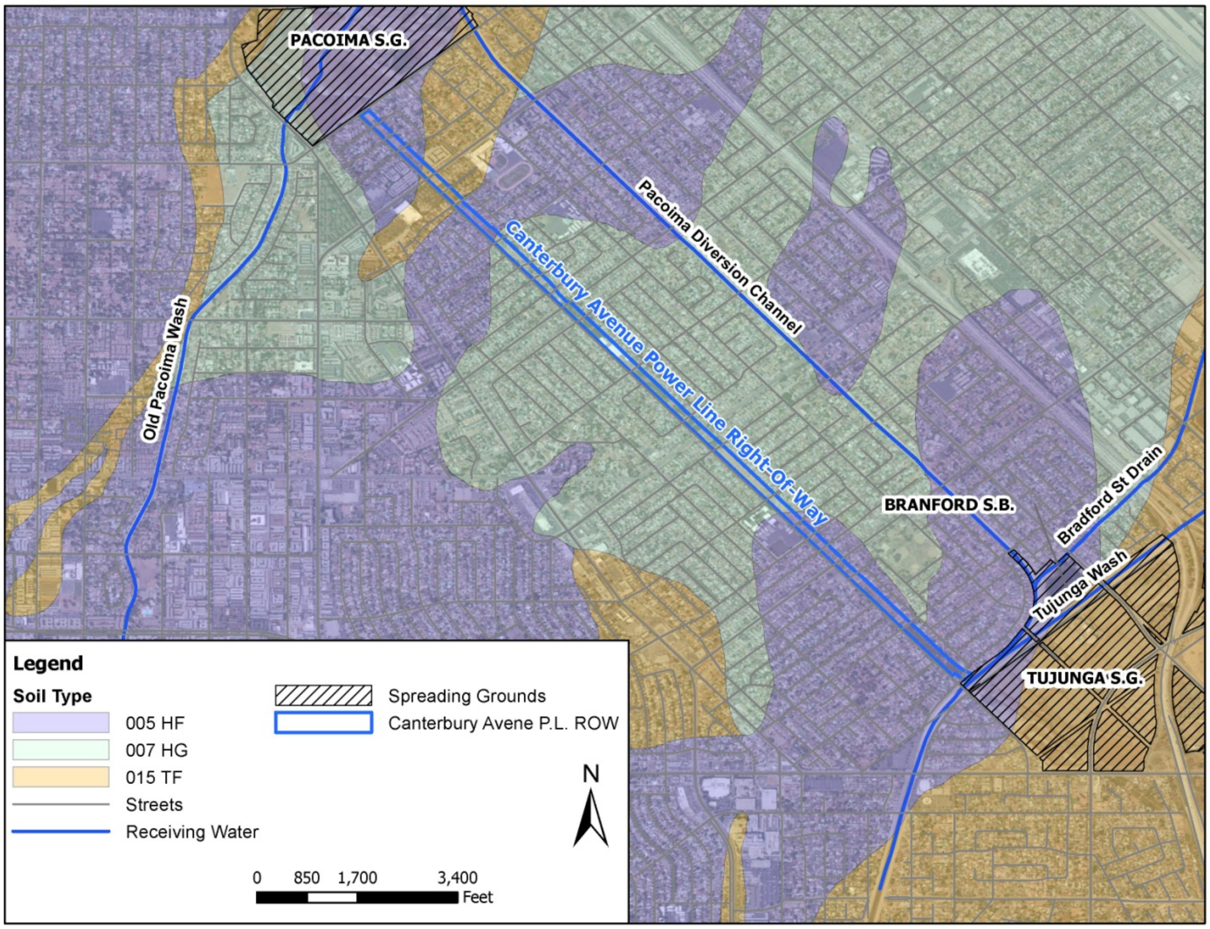


**Figure 3 – Soil Type Near Canterbury Avenue Power Line Easement**

## III. Goals & Objective

The objective of the Canterbury Avenue Power Line Easement Stormwater Capture Project is to determine the feasibility of capturing, retaining and infiltrating local stormwater runoff by constructing multiple recharge basins along the easement to meet the following goals:

- Help alleviate flooding in the area;
- Recharge the groundwater basin; and
- Improve stormwater quality at downstream water bodies.

These goals are designed to help meet the goals of the Tujunga Wash Groundwater Recharge Master Plan.

## IV. Project Summary

Removing areas required for easement construction requirements, parcels from private property, and, streets; the 18.8 available acres of the Canterbury Avenue Power Line Easement will be modified to construct 24 recharge basins. The recharge basins will receive and retain stormwater from the PSG Basin 5 and local flows from neighboring tributary area between the Pacoima Diversion Channel and the easement. Construction of the recharge basins in the easement will include the installation of inlets, weir box outlets, riprap aprons, reinforced concrete pipe (RCP), flow measuring devices, educational signage, access roads, and basins that vary in depth from 7 to 10 feet for optimal retention. Local flow capture will require modifications to the District's storm drain Bond Issue 666 and addition of 26 catch basins with screen inserts to divert, capture, and pre-treat tributary flows.

Although the basins will capture local runoff, the connection to PSG will require coordination with the District. Similar to the Tujunga Spreading Grounds, these proposed improvements can be managed where the facility is owned by LADWP and the District operates the facility for stormwater recharge. A maintenance plan and agreement with the District should be developed to define the each of the agency responsibilities. Stormwater diverted from PSG will enter the first recharge basin through an inlet structure and convey flows through RCP. Flows captured from the neighboring tributary area will be diverted from the streets to catch basins with screen inserts as a pretreatment of the urban flows. After the pretreatment, flows will go through 24 to 36 inch RCP connected to the inter-basin RCP supply lines.

To create inter-basin flow, the RCP size for Basins 1 though 24, varies as shown in Table 2. For scour protection, ½ ton riprap will be located at the downstream end of all inter-basin connections. Weir boxes with gates will be used at outlets to pond water in the basins for groundwater recharge. Figure 4 through Figure 6, show the conceptual layout of the proposed project. All pipes, inlets, riprap, and weir boxes will be sized based on storage volumes and infiltration capacity.

The proposed Project will include a bypass line constructed between PSG and Basin 12. The bypass line will carry 100 cfs and will provide flexibility in operating the basins as a set of recharge batteries. This allows the two sets of basins to be filled, drained, and dried independently. This flexibility is important for maintenance of the basins, as well as for emergency maintenance of the power lines.

| Table 2: Inter-basin Pipe Size and Flow Rate | | |
|---|---|---|
| **Basin** | **RCP Size (Inches)** | **Q (cfs)** |
| 1 | 48" | 51 |
| 2 | 60" | 55 |
| 3 | 48" | 52 |
| 4 | 24" | 45 |
| 5 | 24" | 52 |
| 6 | 60" | 57 |
| 7 | 36" | 60 |
| 8 | 48" | 49 |
| 9 | 48" | 53 |
| 10 | 36" | 74 |
| 11 | 18" | 44 |
| 12 | 48" | 126 |
| 13 | 60" | 99 |
| 14 | 84" | 92 |
| 15 | 60" | 109 |
| 16 | 36" | 90 |
| 17 | 36" | 87 |
| 18 | 36" | 134 |
| 19 | 60" | 123 |
| 20 | 84" | 114 |
| 21 | 84" | 114 |
| 22 | 36" | 86 |
| 23 | 48" | 116 |
| 24 | 60" | 105 |

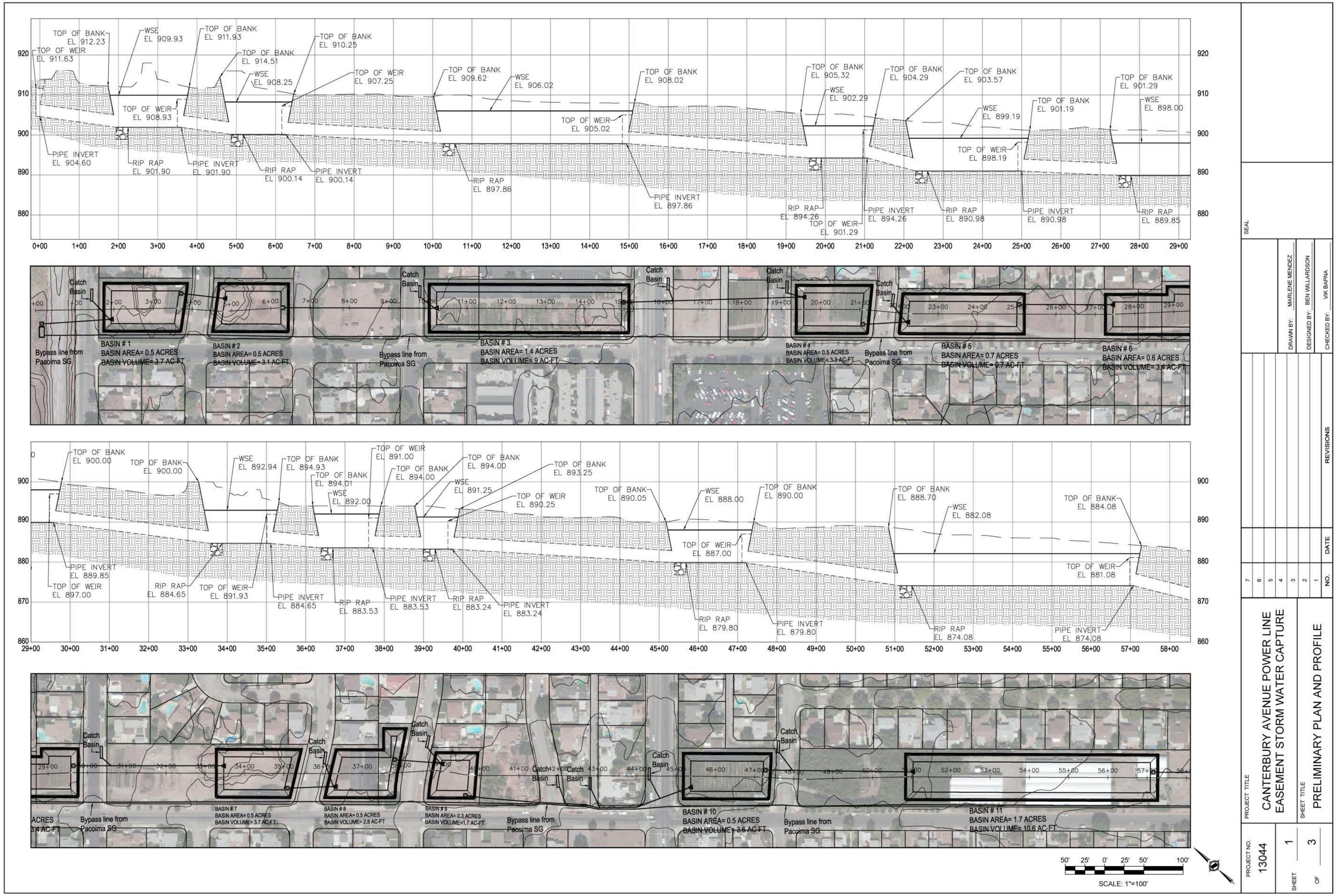


**Figure 4 - Conceptual Project Layout Page 1**

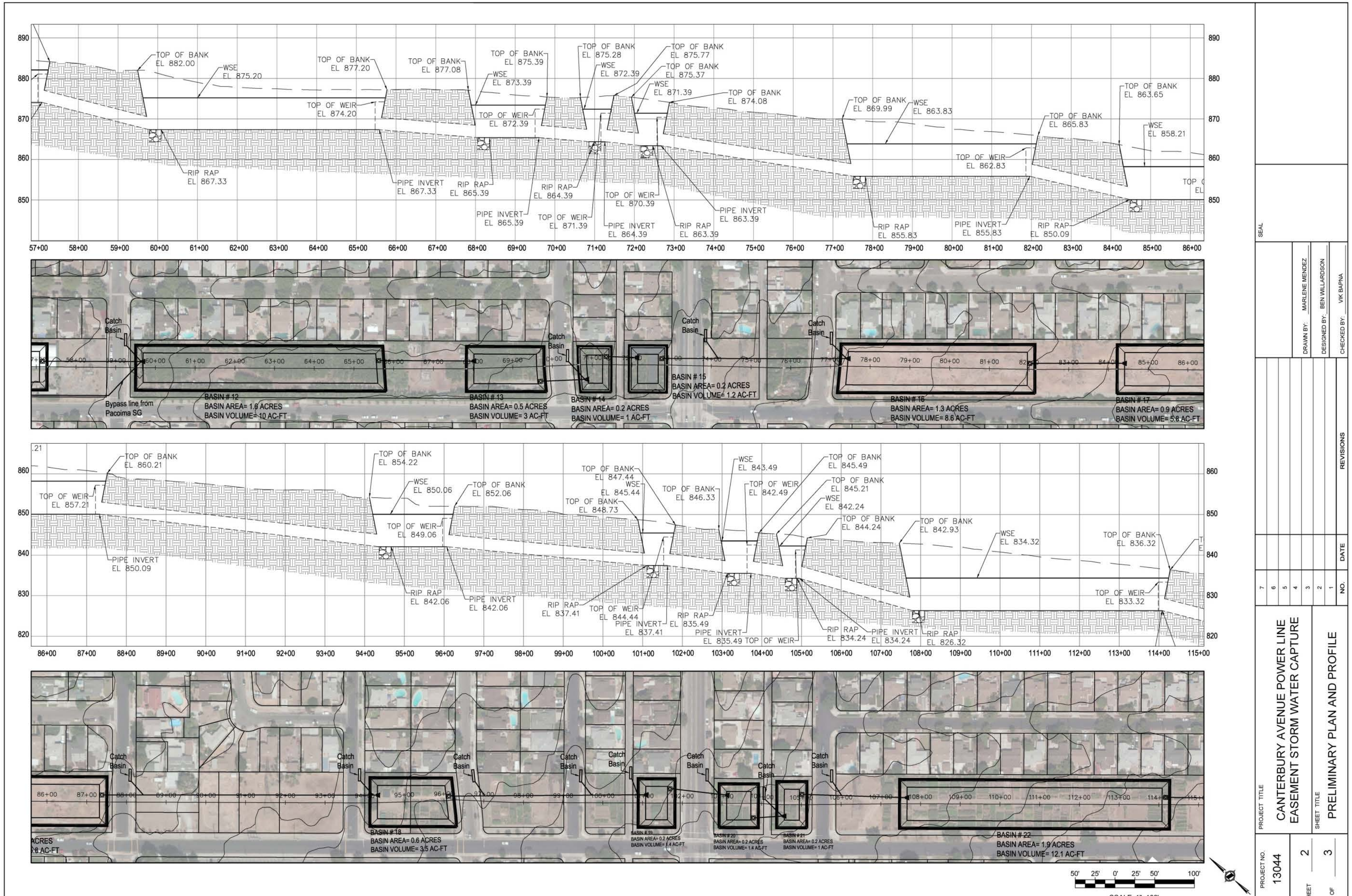


**Figure 5 - Conceptual Project Layout Page 2**

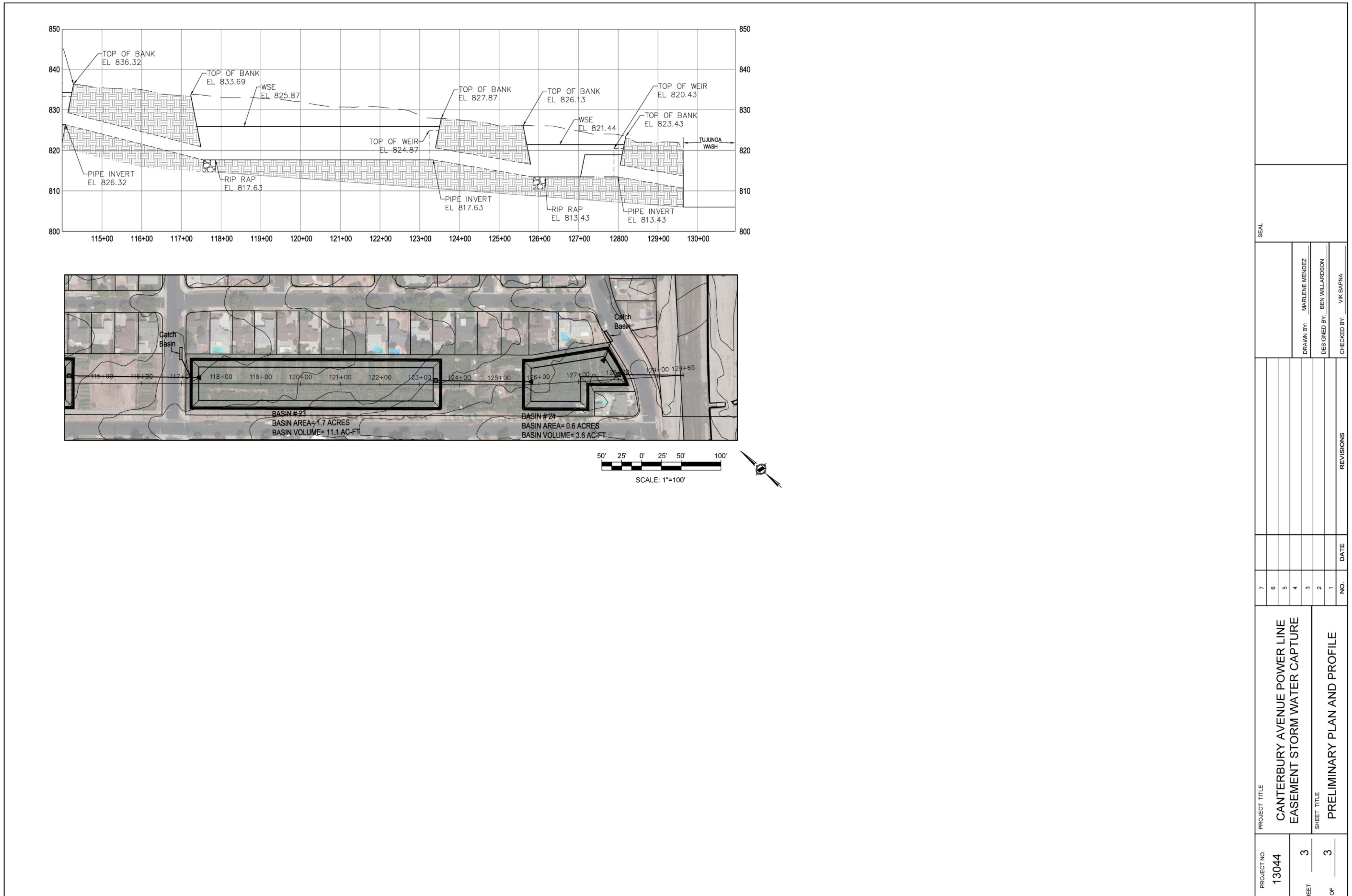


**Figure 6 - Conceptual Project Layout Page 3**

All recharge basins will be graded to control surface runoff. The grading will consist of surfaces with planned grades with smooth side slopes and corners. A vegetated buffer will surround the perimeter of the recharge basins to break up overland flows from the access roads and adjacent properties before entering the basin.

The average infiltration rate of the PSG, Hansen, and Tujunga Spreading Grounds is 1.3 inches/hour, or 2.5 feet/day. When completed, the Project will add a storage volume of 113 acre-feet, with an approximate total percolation rate of 24 cfs. Intake limit for Basins 1 though 12 is currently sized for 50 cfs and for Basins 12 through 24 is 100 cfs. Constructing the Canterbury Avenue Power Line Easement project will yield an estimated annual recharge benefit of 335 acre-feet annually from local runoff and the potential to capture another 1,000 acre-foot through the PSG. A summary of each recharge basins area and water storage volume is presented in Table 3.

**Table 3: Recharge Basin Area and Water Storage Volume**

| Basin | Basin Area (Acres) | Water Storage Volume (Acre-Feet) |
|---|---|---|
| 1 | 0.6 | 3.7 |
| 2 | 0.5 | 3.1 |
| 3 | 1.4 | 9.0 |
| 4 | 0.5 | 3.3 |
| 5 | 0.7 | 4.3 |
| 6 | 0.6 | 3.4 |
| 7 | 0.6 | 3.7 |
| 8 | 0.6 | 2.8 |
| 9 | 0.3 | 1.7 |
| 10 | 0.6 | 3.6 |
| 11 | 1.7 | 10.6 |
| 12 | 1.6 | 10.0 |
| 13 | 0.5 | 3.0 |
| 14 | 0.2 | 1.0 |
| 15 | 0.3 | 1.2 |
| 16 | 1.4 | 8.6 |
| 17 | 0.9 | 5.8 |
| 18 | 0.6 | 3.5 |
| 19 | 0.3 | 1.4 |
| 20 | 0.3 | 1.4 |
| 21 | 0.2 | 1.0 |
| 22 | 1.9 | 12.1 |
| 23 | 1.8 | 11.1 |
| 24 | 0.7 | 3.6 |
| **Project Total** | 18.8 | 112.9 |

While the easement appears to be in a viable location for groundwater recharge, several uncertainties exist. These uncertainties include percolation rates and potential impacts to adjacent residential properties due to groundwater mounding. Therefore, implementation of a pilot study utilizing two basins is recommended before full implementation of this option.

The proposed easement basins will require amendments to the current PSG operation and maintenance procedures. Operation and maintenance costs associated with sediment removal and additional basin facility maintenance will increase over the existing operation costs at the PSG, as this would be a new facility.

## V. Easement Construction Requirements

Construction on LADWP easements requires following the setback requirements listed below:

- Retain a 100-foot service radius around each tower.
- Retain a 10-foot service radius around each pole.
- Retain a 300-foot clearance around "dead-end" towers.

Pipe clearances to tower piers that are closer than outlined above for the service clearances shall be sleeved inside a pipe for a minimum distance of 60-feet from existing tower piers. New pipes shall be designed to allow for water loading.

Distribution System Clearance Requirements are the following:

- Retain a 10-foot service radius at existing ground level around each distribution pole.
- Provide a 20-foot service radius at existing ground level around each maintenance hole.
- Provide a 13-foot wide clear; unobstructed vehicle access to the overhead and underground systems for maintenance, repairs, upgrades, and cable pulling.
- Provide a 10-foot clear setback from the exterior of any underground distribution conduit or maintenance vault to the edge of any basin, swale, channel or other drainage feature.
- Maintain the existing cover between the top of the underground distribution conduit and the ground surface.

## VI. Environmental Considerations

Environmental studies for this project have not been conducted and will be required prior to the start of construction. A Mitigated Negative Declaration

(MND) or an Environmental Impact Report (EIR) may be required (upon approval of the Lead Agency) based on the findings of this study. LADWP Environmental Affairs Division will prepare the EIR as necessary. Potential environmental issues based on the Initial Study format for various environmental areas are summarized in Table 4 and Figure 7 illustrates areas of potential environmental constraints for this project site.

**Table 4: Canterbury Avenue Summary of Issues**

| Environmental Topic | Potential Issues | No Anticipated Issues | Comments |
|---|---|---|---|
| Land Use and Planning | | X | No issues are anticipated; however zoning regulations should be reviewed to confirm that the land use could be permitted. |
| Population and Housing | | X | No issues are anticipated. |
| Geology and Soils | X | | Additional studies for excavation would most likely be required. Use of excavated material by Vulcan should be considered. |
| Water | X | | Water quality measures (BMPs) will have to be employed during the excavation. |
| Air Quality | X | | Issues with air quality would be a concern primarily “during construction” activities (sediment removal, truck hauling). Post-construction air quality issues are not anticipated. |
| Transportation and Circulation | X | | Minor changes in transportation and circulation are anticipated during construction. The need for traffic studies would be triggered on an import or export due to associated truck trips. The project is adjacent to both a residential neighborhood and a school. Significant transportation issues are not anticipated upon the completion of construction. |
| Biological Resources | X | | The project site consists of disturbed areas or areas that contain ornamental vegetation in an urbanized area. The primary concern with biological issues is during construction. Mitigation may be identified in order to bring potential issues to a less than significant level. Vegetation removal may be limited to time periods outside of breeding season. |
| Energy and Mineral Resources [1] | X | | No mineral resource issues are associated with the proposed activities given the existing nature of the project site. However, the area is a major power line corridor, thus there are potential issues with energy resources. |

| Table 4: Canterbury Avenue Summary of Issues | | | |
|---|---|---|---|
| **Environmental Topic** | **Potential Issues** | **No Anticipated Issues** | **Comments** |
| Hazards | X | | Although significant issues are not anticipated, hazardous materials studies may be required to define on-site housekeeping practices and past land uses. Sampling may be required once soils are excavated and prior to transfer. The presence of pesticides within agricultural areas should also be defined. |
| Noise | X | | Noise is anticipated to be an issue during construction. Noise mitigation measures could be employed (i.e., hours of maintenance activities, buffers, etc.). It is anticipated that construction activities would occur during daytime hours. |
| Public Services | | X | Issues with existing public services are not anticipated. Increase in future public service activities would be required based on the proposed project. |
| Utilities and Service Systems | X | | Since the project is located within an existing power line corridor, it may include other utilities. Preliminary discussions with LADWP indicate these should be minor. |
| Aesthetics | | X | Given the existing conditions and land use, no issue with aesthetics is anticipated with the proposed project. |
| Cultural Resources | | X | Although no issues with cultural resources are anticipated, precautionary mitigation measures will be adopted in the event that cultural issues surface during construction. The primary concern with cultural resources is during excavation. A standard cultural resources report would identify any issues and potential mitigation measures to be employed. |
| Recreation | | X | No issues are anticipated, as the existing property does not offer recreation opportunities. |

[1] Existing Power Distribution Facilities.

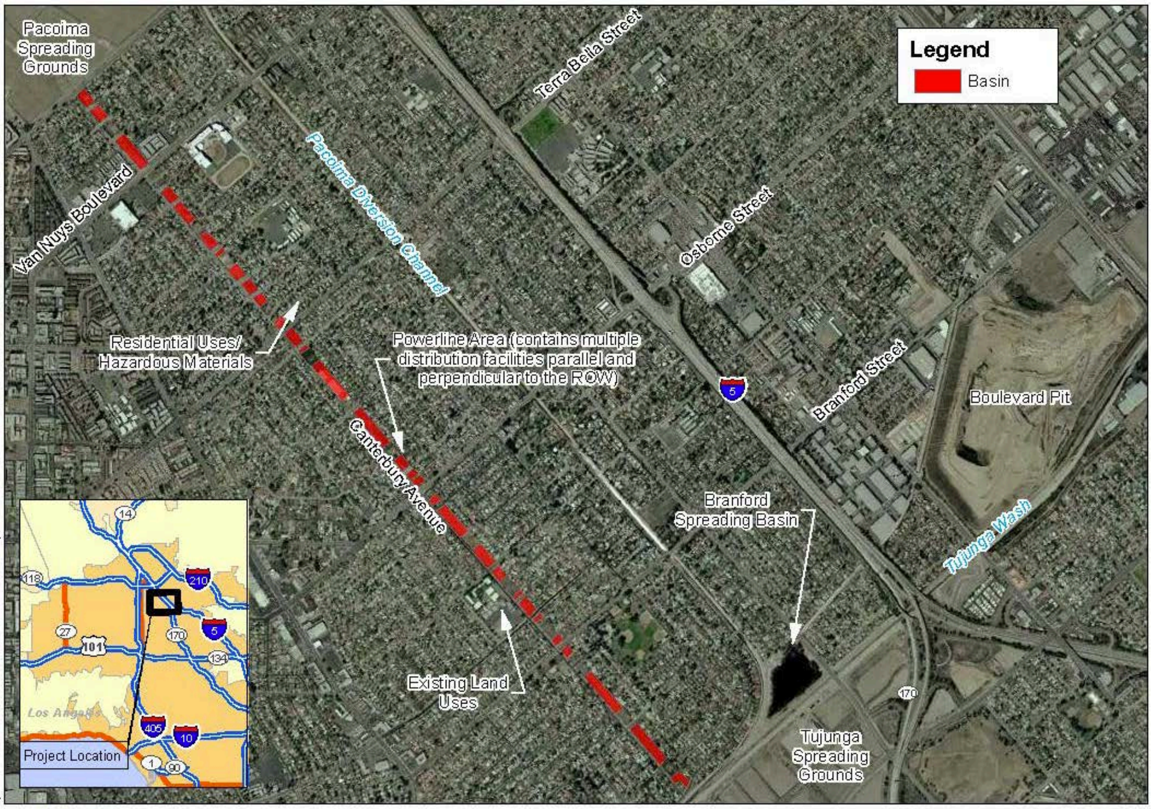


**Figure 7 - Potential Environmental Constraints**

## VII. Implementation Schedule

The Canterbury Avenue Power Line Easement Stormwater Capture Study is a new project, therefore, the planning and environmental phase includes all work completed before design studies and plans are produced (design phase). The construction phase begins with advertising of the project for bid and concludes with project completion. The assumed start date is early 2015. Table 5 summarizes the overall project schedule.

**Table 5: Canterbury Avenue Power Line Easement Summary Schedule**

| Phase | Start Date | End Date |
|---|---|---|
| Planning | Early 2015 | Early 2018 |
| Environmental | Late 2016 | Early 2018 |
| Engineering and Design | Early 2018 | Mid 2019 |
| Advertise | Early 2019 | Mid 2019 |
| Award | Mid 2019 | |
| Construction | Late 2019 | Mid 2021 |

## VIII. Cost Estimate

The preliminary cost estimate was developed using various sources of information. The construction cost entails various components of the Project that a contractor will construct. Standard engineering procedures were used to determine the preliminary cost estimate as presented in Table 6.

**Table 6: Preliminary Project Cost Estimate**

| ITEM NO. | ITEM | APPROX QTY | Unit | UNIT PRICE | Cost Total (2014 Dollars) |
|---|---|---|---|---|---|
| **MISCELLANEOUS** | | | | | |
| 1 | Mobilization (10% Max of Contract Bid) | 1 | LS | $4,918,000 | $4,918,000 |
| 2 | Contingency (30% Construction Cost) | 1 | LS | $1,640,000 | $1,640,000 |
| 3 | Inflation ( @ 3% per year for 5 years) | 1 | LS | $2,459,000 | $2,459,000 |
| **DEMOLITION** | | | | | |
| 4 | Demo of Existing Sidewalk | 21,000 | SF | $3 | $63,000 |
| 5 | Demo of Existing Curb and Gutter | 19,000 | LF | $10 | $190,000 |
| 6 | Clearing and Grubbing | 750,000 | SF | $5 | $3,750,000 |
| **CONSTRUCTION** | | | | | |
| 7 | Relocation of underground distribution line | 1 | LS | $525,000 | $525,000 |
| 8 | Catch Basin(s) w/screens | 26 | EA | $5,000 | $130,000 |
| 9 | Excavation | 247,000 | CY | $6 | $1,482,000 |
| 10 | Soil Export | 247,000 | CY | $25 | $6,175,000 |
| 11 | Inlet Structures | 25 | EA | $520 | $13,000 |
| 12 | 1/2 ton Riprap | 6,000 | CY | $110 | $660,000 |
| 13 | Reinforced Concrete Pipe | 13,000 | LF | $150 | $1,950,000 |
| 14 | Weir Box | 25 | EA | $15,000 | $375,000 |
| 15 | Curb and Gutter | 19,000 | LF | $25 | $475,000 |
| 16 | Passive recreation (walking paths) | 21,000 | SF | $4 | $84,000 |
| 17 | Educational signage | 96 | EA | $3,000 | $288,000 |
| 18 | Fencing | 20,000 | LF | $38 | $760,000 |
| **Cost Estimated Total (2014 Dollars)** | | | | | **$26,226,000** |

Annual operation and maintenance (O&M) costs were estimated using baseline data on a per acre-foot cost provided by LACDPW. LACDPW provided the recharge basins operational costs of $317 per acre-foot of facility capacity using 2007 data. With inflation operational costs for the recharge basins is calculated to be $364 per acre-foot of facility capacity. Catch Basin cleaning and maintenance is estimated at $18 each time per catch basin with the total anticipated O&M to be approximately $55,540 per year. Table 7 shows the cost estimate for the easement project, which includes the present value of cost for 50 years at a 5% inflation rate.

**Table 7: Canterbury Avenue Power Line Easement Total Estimated Costs**

| Description | Cost (2014 dollars) |
|---|---|
| Construction | $25,410,000 |
| Annual O&M for recharge | $42,000 |
| Annual Aquifer Extraction | $0 |
| Present Value of Costs (5%, 50-Years) | $35,033,000 |

The storage volume of the easement recharge basins is estimated to be 335 acre-feet annually for the recharge of local runoff. The basins can also be used for spreading of stormwater after rainfall events end to the connection to PSG, which receives water from Pacoima Dam and Reservoir. The District is also planning to connect Bull Creek to the northern side of the PSG. Based on these sources, it is expected that another 1,000 acre-feet can be conserved annually with the additional facilities.

Based on the estimated average of annual recharge from the easement, a cost benefit analysis was conducted for the Project. With the demands for domestic water continuing to increase, the Tier 1 untreated 2012 rate of $560 per acre-feet was used for the cost benefit analysis. Assuming a 7% increase per year and an economic life of 50 years the present estimated value of the 335 acre-feet is $87,316,000. With these costs estimates, the Project would produce a cost savings for the LADWP. Table 8 presented the benefit/cost ratio for the Canterbury Avenue Power Line Easement project.

**Table 8: Canterbury Avenue Power Line Easement Benefit/Cost Ratio**

| Description | Value (2014 dollars) |
|---|---|
| Present Value of Benefits | $87,316,000 |
| Present Value of Costs | $35,033,000 |
| Benefit/Cost Ratio | 2.49 |

In addition to cost saving and depending on several factors, the Project may incorporate open space attributes similar to those the PSG will undergo in order to keep the same continuous green space amenities for the neighboring community as well as reduce energy cost from decrease in water importation.

## IX. Funding Opportunities

To implement the project, funds will need to be allocated which will be difficult even during a good financial year. Funding knowledge and experience has been used to identify viable funding opportunities to assist LADWP in implementing the Project.

### 1. Partnership Opportunities

The project areas average annual rainfall, allows for a full capture of a 50-year rainfall event. This qualifies the project as a regional project for the Enhanced Watershed Management Plan (EWMP), which may be a potential funding source for the construction of the project. Partnership with local agencies who may benefit for the construction of the Project.

### 2. Grants and Loans

To implement the proposed Project, LADWP may need some financial assistance. To receive financial assistance an application must be completed and specific eligibility requirements must be met. All assistance programs also provide a set of conditions and limitations. Financial assistance programs are available in two common forms, grants and loans. It is important to fully understand the differences, benefits, and drawbacks of each in order to determine which form of financial assistance is best the project.

Grants are awards of financial assistance, meaning the grant awardee is not required to return the money, although they may need to follow specific requirements and produce specific products. On the other hand, loans are awarded as a benefit or assistance, but the awardee is required to pay back the loan, often with interest. Table 9 below outlines the major differences between grants and loans.

One of the major points outlined in Table 9 is the application and competition of grant programs versus loan programs. Grants often require extra work in addition to general work related to any project. Grants often require extra reports, and as mentioned, a more complex application process. Loans however have a relatively simple application process, less competition, and limited additional requirements that are often less complex. Grants will require extra work, but in return, “free” money is awarded. Both grant and loan financial assistance programs are outlined below.

| Table 9: Differences Between Grants and Loans | |
|---|---|
| **Grants** | **Loans** |
| • No payback required;<br>• Typically complex application process;<br>• Highly competitive;<br>• Extensive reporting and oversight needed;<br>• Matching funds generally required;<br>• May favor larger/more expensive projects;<br>• Some require participation with an IRWM;<br>• Funding limits vary;<br>• Generally limited application periods; and<br>• Operate under agency-specific guidelines. | • Payback required;<br>• Relatively simple application process;<br>• May require getting on priority list;<br>• Repayment terms vary;<br>• Threshold eligibility criteria must be met;<br>• Tie-in with job creation with some programs;<br>• Different agencies have different requirements;<br>• Maximum amount financed can be large; and<br>• Generally continuous application periods. |

**Proposition 84 (Chapter 2, §75026) Integrated Regional Water Management (IRWM) Grant Program**

| | |
|---|---|
| **Program Name:** | Proposition 84 (Chapter 2, §75026) IRWM |
| **Department:** | Department of Water Resources |
| **Type:** | Grant |
| **Purpose:** | Projects to assist local public agencies to meet long-term water management needs of the State, including the delivery of safe drinking water, flood risk reduction, and protection of water quality and the environment. |
| **Eligibility Requirements:** | Local public agencies or nonprofit representing an accepted IRWM Region |
| **Eligible Uses:** | Projects that implement IRWM Plans |
| **Ineligible Uses:** | Operation and maintenance activities |
| **Funding Limits:** | Bond funding allocation for entire program is $1 billion. Prop 84 allots grant funding to 11 funding areas. Each proposal solicitation package will have predetermined amount of funds available. |
| **Terms/Dates:** | 25% minimum cost share with waivers for DACs<br>Round 3 expected in Fall 2014 (approximately $130 million available for Los Angeles Funding Areas) |
| **Website:** | http://www.water.ca.gov/irwm/grants/guidelines.cfm |

IRWM is a collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries; involves multiple agencies, stakeholders, individuals, and groups; and attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions. A majority of projects funded through this grant program pertain to water supply, flood control, and habitat protection. Although some of these project types would not be applicable for the LADWP to implement in order to ensure stormwater compliance, there are some eligible project types that would coincide with LADWPs needs, including:

- Stormwater capture, storage, clean-up, treatment, and management;
- Non-point source pollution reduction, management, and monitoring;
- Groundwater recharge and management projects;
- Planning and implementation of multipurpose flood management programs; and
- Watershed protection and management.

**Clean Water State Revolving Fund Program**

| | |
|---|---|
| **Program Name:** | Clean Water State Revolving Fund Program |
| **Department:** | SWRCB |
| **Type:** | Financing (loan) |
| **Purpose:** | Provide funding for publically-owned facilities |
| **Eligibility Requirements:** | Public agencies and nonprofit organizations |
| **Eligible Uses:** | Stormwater treatment and diversions, sediment and erosion control, stream restoration, and land acquisitions |
| **Ineligible Uses:** | Operation and maintenance activities, legal fees |
| **Funding Limits:** | $50 million per agency per year |
| **Terms/Dates:** | Interest rate is one-half general obligation bond rate.<br>Repayment term of twenty years<br>Applications accepted continuously |
| **Website:** | http://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/index.shtml |

Various projects within California have utilized this funding program. Some projects considered through this program include the City of Anaheim Sewer Reconstruction Project and the Eastern Municipal Water District Recycled Water Pond Expansion and Optimization Project. Other project types that are considered under this financing program include:

- Construction of publicly-owned facilities:
  - Wastewater treatment

- Local sewers
- Sewer interceptors
- Water reclamation facilities
- Stormwater treatment

- Expanded Use projects include, but are not limited to:
  - Implementation of nonpoint source projects or programs
  - Development and implementation of estuary comprehensive conservation and management plan

**Infrastructure State Revolving Fund (ISRF) Program**

| | |
|---|---|
| **Program Name:** | ISRF Program |
| **Department:** | California Infrastructure and Economic Development Bank |
| **Type:** | Loan |
| **Purpose:** | Provide financing for public infrastructure projects |
| **Eligibility Requirements:** | Applicant must be a local municipal entity<br>Project must promote economic development and attract, create, and sustain long-term employment opportunities |
| **Eligible Uses:** | Construct or modify public infrastructure, purchase and install pollution control or noise abatement equipment, or acquire land. Project must meet tax-exempt financing criteria. |
| **Ineligible Uses:** | Privately owned facilities or debt refinancing |
| **Funding Limits:** | $2 million maximum per environmental mitigation project per fiscal year<br>$10 million maximum per project for all other purposes per fiscal year<br>$20 million per jurisdiction per fiscal year |
| **Terms/Dates:** | Maximum 30 year term and open application process<br>Preliminary application available at www.ibank.ca.gov |
| **Website:** | http://ibank.ca.gov/infrastructure_loans.htm |

This program provides low-cost, long-term financing to local governments for a variety of public infrastructure projects.

**Supplement Environmental Project (SEP) Funds**

**Program Name:** SEP Funds
**Department:** EPA
**Type:** Violation Reduction
**Purpose:** Provide a fine reduction as part of a settlement of an enforcement action
**Eligibility Requirements:** The project must improve, protect, or reduce risks to public health, or the environment at large. The project must also relate to the original violation.
**Eligible Uses:** Improvement to public health, pollution prevention through source reduction, environmental restoration and protection, environmental compliance promotion, and emergency planning and preparedness.
**Ineligible Uses:** Project not related to original violation
**Funding Limits:** The amount of penalty mitigation is based on the cost of the SEP and whether or how effectively the SEP:

- Benefited the public or environment;
- Was innovative;
- Considered input from affected community;
- Reduced emissions to more than one media (e.g. air, land, water);
- Factored in environmental justice issues; and
- Implemented pollution reduction through source reduction.

**Terms/Dates:** Continuously accept applications
**Website:** http://ibank.ca.gov/infrastructure_loans.htm

This program would benefit the City if any enforcement actions were taken against the City. This program assists with compliance and promotes action to fix current problems. One main goal of SEPs is to improve the environmental health of communities that have been put at risk due to the violation of an environmental law.

**2014 Water Bond**

**Program Name:** 2014 Water Bond (Proposition 1)
**Department:** State of California
**Type:** Grant
**Purpose:** Provide funding for projects that ensure reliable water supply for future generations.
**Eligibility Requirements:** Unknown at this time.
**Eligible Uses:** Provide funding for projects must address regional water reliability, water storage capacity, water recycling, groundwater sustainability, safe drinking

| | |
|---|---|
| | water, watershed projection, ecosystem restoration, state settlements, and flood management. |
| **Ineligible Uses:** | Unknown at this time. |
| **Funding Limits:** | $810 million on regional water reliability<br>$2.7 billion water storage capacity<br>$725 million water recycling<br>$900 million groundwater sustainability<br>$520 million safe drinking water<br>$1.5 billion watershed projection, ecosystem restoration, and state settlements<br>$395 million on flood management |
| **Terms/Dates:** | On the 2014 California ballot. |
| **Website:** | http://www.acwa.com/spotlight/2014-water-bond |

The 2014 Water Bond is the product of a comprehensive legislative package developed in 2009 by Governor Schwarzenegger and state lawmakers to meet California's growing water challenges. This package represented a major step toward ensuring reliable water supply for future generations as well as restoring the Sacramento-San Joaquin Delta and other ecologically sensitive areas.

## X. Study Recommendations

The Canterbury Avenue Power Line Easement Stormwater Capture study has lead to several findings as summarized below:

- To evaluate project site conditions, a geotechnical study will need to be conducted. The study will consist of a soil analysis of the site to determine soil classification, percolation rate, and determine whether contamination is present on site.
- Environmental studies for this project will need to be conducted prior to the start of construction to further evaluate the feasibility of the project.
- To further evaluate project outcomes, an initial pilot study will need to be conducted to evaluate percolation rates and potential impacts to adjacent residential properties due to groundwater mounding, prior to the full implementation of this proposed project.

Results from the implemented projects include:

- Reduced flooding during the capital storm event by as much as 24 cfs;
- Increased groundwater recharge by 335 acre-feet per year from local flows;
- Increased groundwater recharge by 1,000 acre-feet per year from flow through PSG;
- Cost savings to LADWP;
- Significant improvement to downstream water quality;

- Improved aesthetics and open space attributes surrounding Canterbury Avenue and local area; and
- The project can be used as a regional project for the area EWMP, which may be a potential funding source.

# CANTERBURY AVENUE POWER LINE EASEMENT

# STORMWATER CAPTURE PROJECT

## SCOPE OF WORK DOCUMENT



August 2015

*Prepared By:*

Los Angeles Department of Water and Power
Water Resources Division
Watershed Management Group

# TABLE OF CONTENTS

## I. Title

**CANTERBURY AVENUE POWER LINE EASEMENT STORMWATER CAPTURE PROJECT**

Functional Item: **24-318,** Job No. **56135**

## II. Project Objectives

To capture, retain, and infiltrate local stormwater runoff by constructing multiple recharge basins along the Canterbury Avenue Power Line Easement, between Pacoima Spreading Grounds and the lower Tujunga Wash.

## III. Project Team

| | |
|---|---|
| Project Management: | |
| Manager | TBD |
| | |
| Planning Phase: | |
| Manager | Andy A. Niknafs |
| | Eric M. Yoshida |
| | |
| Design Phase: | |
| Manager | Joseph J. Resong |
| Mechanical Design | John Otoshi |
| Electrical Design | Emmanuel Tan |
| Capital Improvement/Asset Management | Charles C. Ngo |
| Civil/Structural Design | Joseph J. Resong |
| Distribution Engineering | Alvin Z. Bautista |
| Geotechnical | Adam Perez |
| Geology | Clifford C. Plumb |
| Survey | Shereef Surur |
| Right-of-Way | Henry Bui |
| Property Management | Heidi K. Hiraoka |
| Water Transmission Operations | Linh T. Phan |
| Water Quality | Don Christie |
| Treatment Operations | Razmik O. Manoukian |
| Construction Specifications | David F. Neal |
| Environmental Assessment | Charles C. Holloway |
| Safety | Jaime F. Hernandez |
| Security Services | Eddy Allahverdian |
| Trunk Line | Craig A. Davis |

Construction Phase:

| | |
|---|---|
| Manager | Wayne A. Bamossy |
| Resident Engineer | TBD |
| Repair and Construction | Michael E. Grahek |
| Test Lab | Nancy A. Wigner |
| Plant Inspection | Vipin K. Wahi |
| Construction Support Team | TBD |

## IV. Approvals from Originating Organization

Senior Assistant General Manager – Water System Date
Martin L. Adams

Director of Water Operations Date
Richard F. Harasick

Director of Water Engineering & Technical Services Date
Susan R. Rowghani

Director of Water Quality Date
Albert G. Gastelum

Director of Water Distribution Date
Keith D. Session

Director of Water Resources Date
David R. Pettijohn

## V. Approvals

By signing this document, Power System approves the Scope of Work Document for the Canterbury Avenue Power Line Easement Stormwater Capture Project. Approval of this document is not to be construed as approval of design. Construction will not commence until Power System reviews and approves the design.



| | |
|---|---|
| Senior Assistant General Manager Power System<br>Randy S. Howard | Date |
| Director of Power Supply Operations<br>Kenneth A. Silver | Date |
| Director of Integrated Support Services<br>David B. Thrasher | Date |
| Director of Power System Engineering<br>Marvin D. Moon | Date |
| Manager of Real Estate<br>Reynan L. Ledesma | Date |

## VI. Project Background and Overview

Canterbury Avenue Power Line Easement (Easement) runs parallel with Pacoima Diversion Channel. The Easement extends between Pacoima Spreading Grounds and the lower Tujunga Wash, as presented in Figure 1. The Easement, owned by the LADWP, is approximately 12,800 feet long by 150 feet wide and does not include parcels from private property and streets. The project proposes to construct approximately 24 recharge basins within the Easement with depths ranging between 7 to 10 feet. The recharge basins would act as an extension of Pacoima Spreading Grounds, adding a storage volume of 113 acre-feet, with total percolation rate of 24 cfs. Constructing the Canterbury Avenue Power Line Easement project would yield an estimated annual recharge benefit of 335 acre-feet annually from local runoff and the potential to capture another 1,000 acre-feet through the Pacoima Spreading Ground (PSG), which receives upstream runoff and water captured at Pacoima Reservoir.


**Figure 1 - Project Location Overview**

Under the DWP easements, construction of the Canterbury Avenue Power line Easement will require following certain setback requirements to protect power infrastructure, which are as follows:

- Retain a 100-foot service radius around each tower.

- Retain a 10-foot service radius around each pole.
- Retain a 300-foot clearance around “dead-end” towers.

Pipe clearances from tower piers that are closer than those outlined will be sleeved inside of a pipe for a minimum distance of 60-ft from existing tower piers. New pipes will be designed to allow for H20 loading with the following distribution system clearance requirements:

- Retain a 10-foot service radius at existing ground level around each distribution pole.
- Provide a 20-foot service radius at existing ground level around each maintenance hole.
- Provide a 13-foot wide clear; unobstructed vehicle access to the overhead and underground systems for maintenance, repairs, upgrades, and cable pulling.
- Provide a 10-foot clear setback from the exterior of any underground distribution conduit or maintenance vault to the edge of any basin, swale, channel or other drainage feature.
- Maintain the existing cover between the top of the underground distribution conduit and the ground surface.

The recharge basins will receive flow from Pacoima Wash via the PSG Basin 5 and will outlet at Tujunga Wash adjacent to the Tujunga Spreading Grounds. In addition to receiving flows from PSG Basin 5, existing stormwater flow lines will be modified and additional catch basins will be installed to capture local stormwater runoff from the upstream tributary area between the Pacoima Wash Diversion Channel and the power line easement. The modified drains and installed catch basins will collect local stormwater flows that will pass through catch basin screens, before entering the recharge basins for groundwater recharge. The 24 basins will be internally linked to the pipes connecting the spreading basins, as presented in Figure 2, page 10. Reinforced Concrete Pipe (RCP) will be sized to maintain a flow rate approximately 50 cfs in Basin 1 through 12 and 100 cfs for Basin 12 through Basin 24. For scour protection, ½-ton riprap will be placed downstream of each outlet. A bypass line will connect PSG Basin 5 with the proposed Basin 13 in order to use the basins as two independent batteries. This will allow independent wetting and drying which improves the maintainability of both the grounds and the power line. In case of a power line emergency, or to access the recharge basins for maintenance, one set of basins can remain in operation while the other is drained for access.

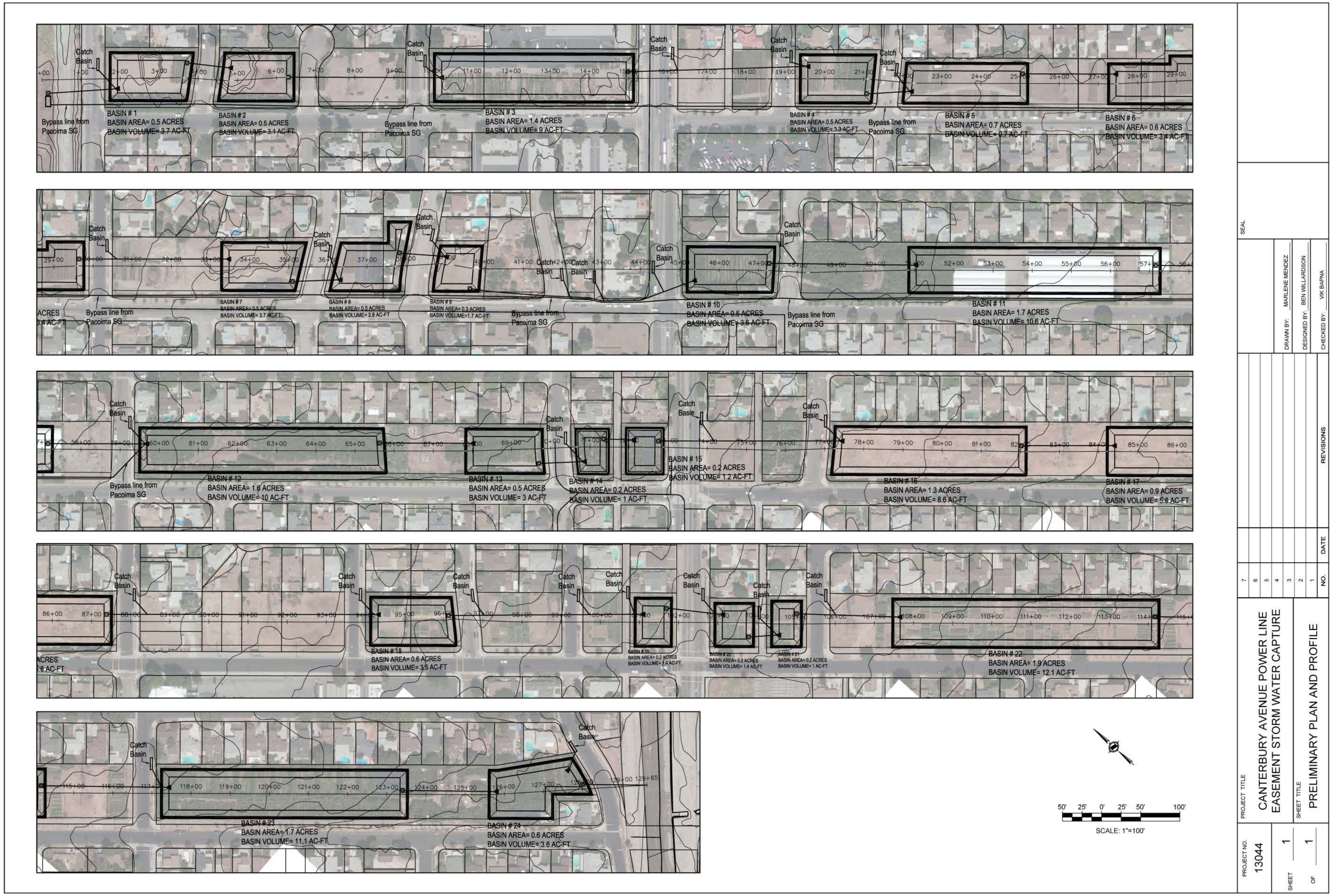


**Figure 2 - Project Basins**

## VII. Project Justification

The San Fernando Valley Groundwater Basin supplies approximately 10% of the City of Los Angeles' drinking water, and due to insufficient recharge, supply levels within the groundwater basin have been in decline for several decades. The Canterbury Avenue Power Line Easement is located in the San Fernando Valley Groundwater Basin and stormwater captured by the project will percolate into the ground and recharge the San Fernando Valley Groundwater Basin. This project will support LADWPs stormwater capture goals as adapted in the 2010 Urban Water Management Plan (UWMP).

## VIII. Project Description

### 1. Hydraulic Criteria

From the estimated 44-acre Easement area, approximately 18.8-acres will be utilized for the construction of the recharge basins. The Project's tributary area includes the approximate 18.8-acre project area, a local tributary area of 520 acres, and an upstream watershed of over 40 square miles tributary to PSG. Project components are sized based on site constraints such as current land use, clearance on the power line towers, and the estimated percolation rate of two and a half feet per day. The basins will have a 2-foot freeboard with a maximum 1-foot depth over the outflow weir. The system outflow capacity will equal the inflow capacity to prevent basin overtopping and flooding in the surrounding neighborhoods.

### 2. Project Location

The Canterbury Avenue Power Line Easement is located within the Tujunga Watershed, in the Arleta and Panorama City neighborhoods of the San Fernando Valley. The project area will be located along Canterbury Avenue Power Line Easement directly south of the Pacoima Spreading Ground and terminates at the Tujunga Wash, which is adjacent to the Tujunga Spreading Grounds. Figure 1 presents the project location.

### 3. Project Layout

Figures 3 through 5 shows a conceptual layout of the proposed project.

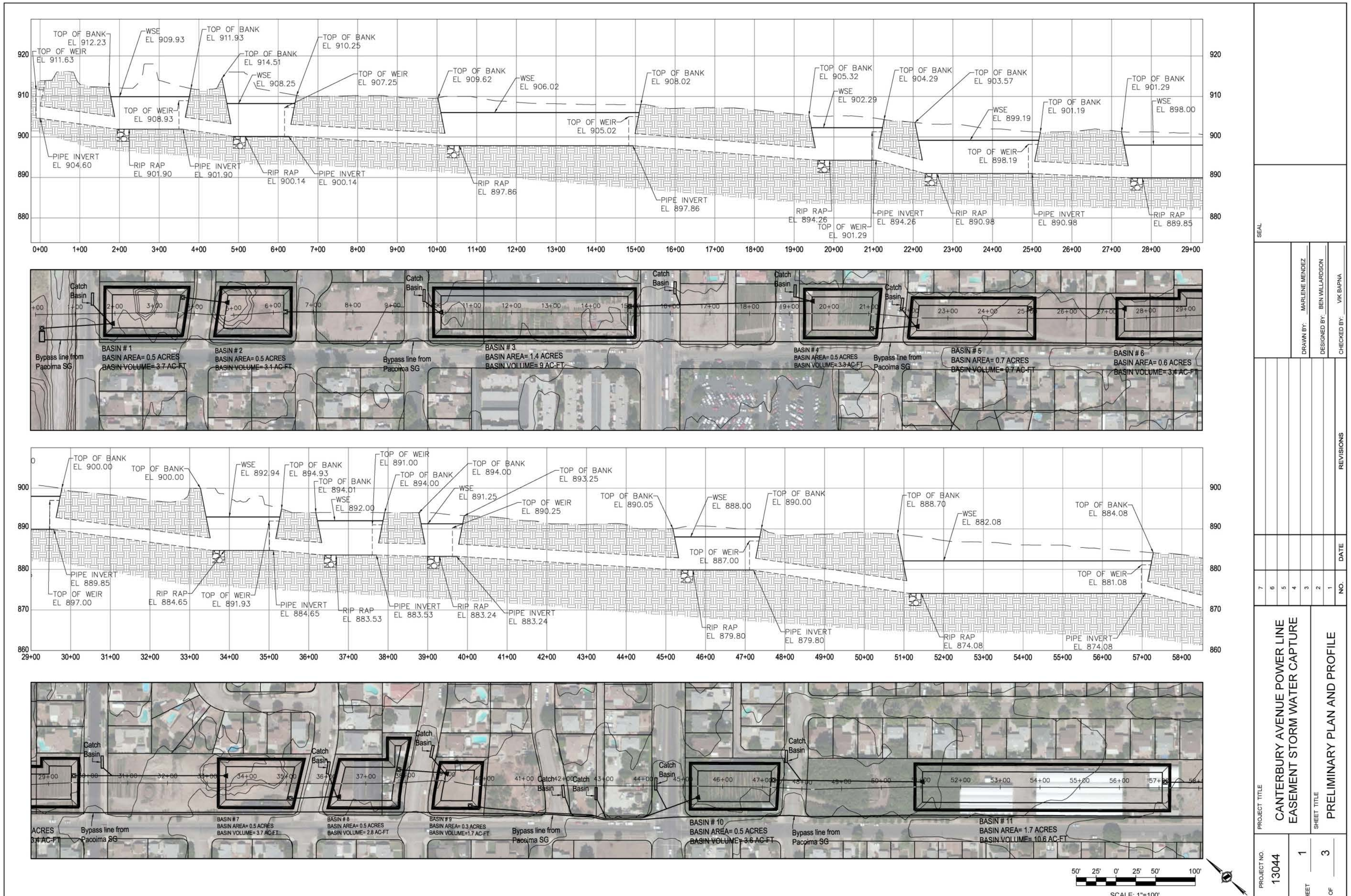


**Figure 3 - Conceptual Project Layout Page 1**

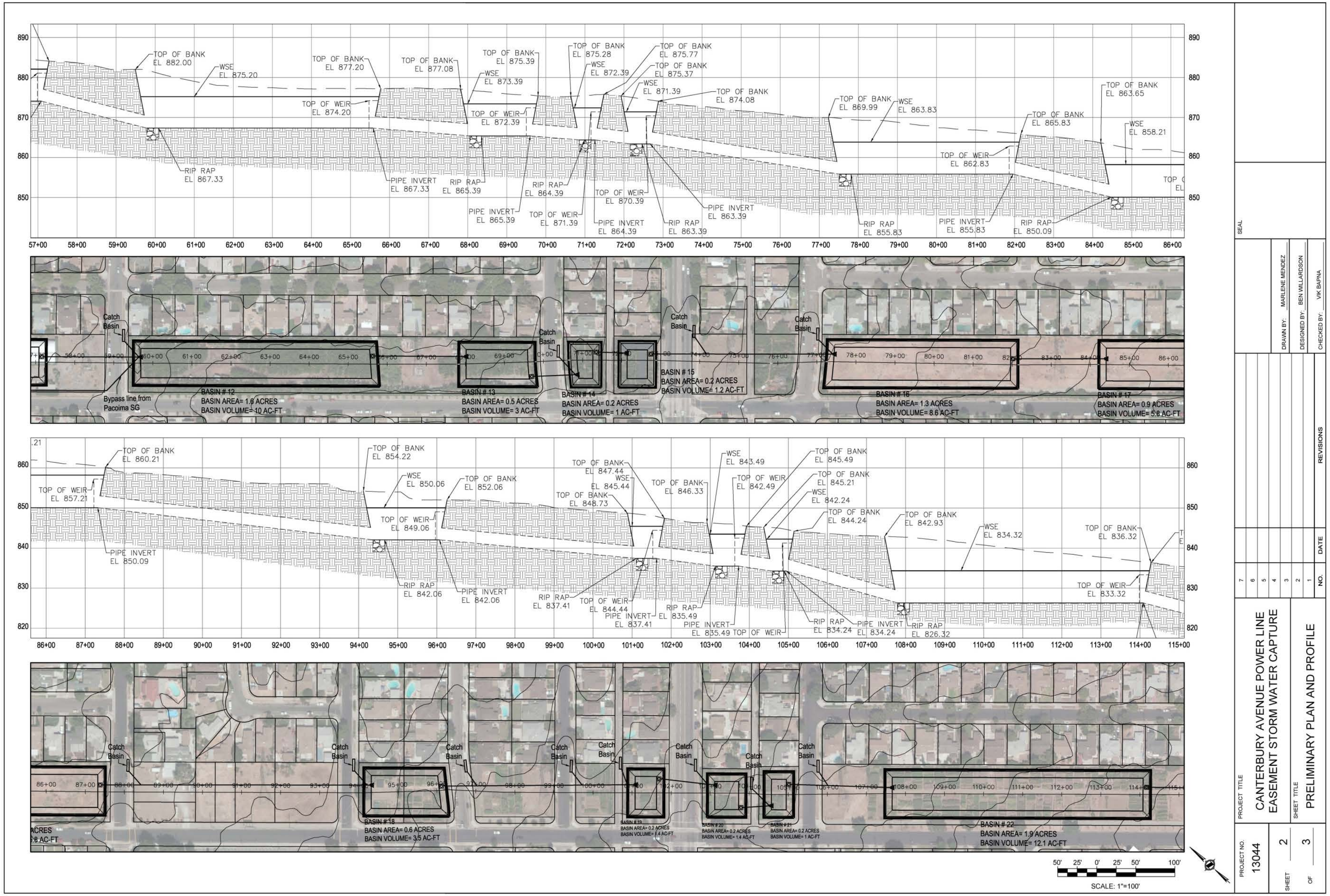


**Figure 4 - Conceptual Project Layout Page 2**

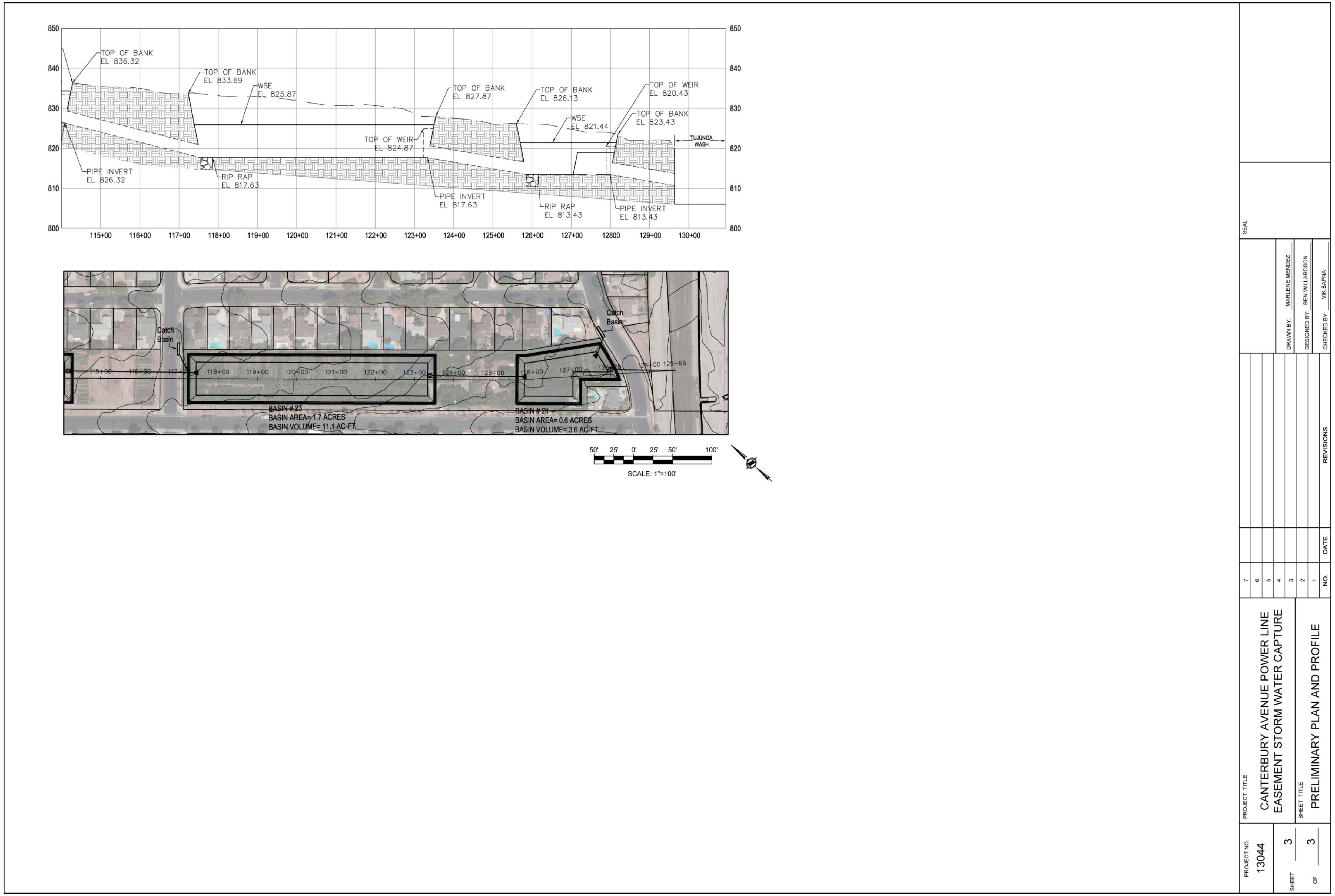


**Figure 5 - Conceptual Project Layout Page 3**

## 4. Project Details

Design and construction of all elements should adhere to all constraints detailed in the *Canterbury Avenue Power Line Easement Stormwater Capture Study Conceptual Study Report* (Attachment 1). Substructures located within the Easement will be designed to withstand a combined weight of 40,000 pounds in accordance with the American Association of State and Highway and Transportation Officials H20-44 (M18). All infiltration basins should be designed for full infiltration within 48-72 hours following a storm event and should be operated accordingly.

The Canterbury Avenue Power Line Easement will be modified through the construction of 24 recharge basins. The recharge basins will receive and retain stormwater from PSG Basin 5 and local flows from the neighboring tributary area. Construction of the recharge basins in the Easement will include the installation of inlets, weir box outlets, riprap aprons, reinforced concrete pipes (RCP), flow measuring devices, landscaping, educational signage, and will vary in depth from 7 to 10 feet. Modifications to storm drain line BI 666 and the addition of 26 catch basins with screen inserts will also be constructed to divert, capture and pre-treat tributary flows.

### a. Storm Drain and Catch Basin Modification

Stormwater flows from the local tributary area will be captured by modifying storm drain line BI 666. Portions of BI 666 line running from Van Nuys Boulevard to Canterbury Avenue will be modified to divert tributary flows from the streets to the recharge basins. In addition to the storm drain modifications, 26 catch basins with screens will be constructed on all streets that intersect Canterbury Avenue just upstream of the recharge basins. The systems will collect runoff from the 520-acre tributary area. The trash screen will act as a pretreatment system to capture sediment and/or debris, before it reaches the recharge basins.

### b. Recharge Basins

To construct the recharge basins along Canterbury Avenue Power Line Easement, the site will be graded to create 24 basins, requiring excavation of 247,000 cubic yards of material. The trapezoidal recharge basins will range between 7 to 10 feet deep, with 2:1 side slopes on all sides. Grading will consist of shaping the surfaces to planned grades and will smooth out side slopes and corners. A vegetated buffer will surround the perimeter of the recharge basins and will be used as pretreatment for any local flows before entering the basins and help prevent erosion and provide aesthetics.

Recharge Basin 1 and Basin 13 will receive stormwater overflow from PSG Basin 5. As the PSG is operated by the LACFCD, an operations and maintenance agreement with the LACFCD will be required. A summary of each recharge basins area and water storage volume is presented in Table 1.

**Table 1: Recharge Basin Area and Water Storage Volume**

| Basin | Basin Area (Acres) | Water Storage Volume (Acre-Feet) |
|---|---|---|
| 1 | 0.6 | 3.7 |
| 2 | 0.5 | 3.1 |
| 3 | 1.4 | 9.0 |
| 4 | 0.5 | 3.3 |
| 5 | 0.7 | 4.3 |
| 6 | 0.6 | 3.4 |
| 7 | 0.6 | 3.7 |
| 8 | 0.6 | 2.8 |
| 9 | 0.3 | 1.7 |
| 10 | 0.6 | 3.6 |
| 11 | 1.7 | 10.6 |
| 12 | 1.6 | 10.0 |
| 13 | 0.5 | 3.0 |
| 14 | 0.2 | 1.0 |
| 15 | 0.3 | 1.2 |
| 16 | 1.4 | 8.6 |
| 17 | 0.9 | 5.8 |
| 18 | 0.6 | 3.5 |
| 19 | 0.3 | 1.4 |
| 20 | 0.3 | 1.4 |
| 21 | 0.2 | 1.0 |
| 22 | 1.9 | 12.1 |
| 23 | 1.8 | 11.1 |
| 24 | 0.7 | 3.6 |
| **Project Total** | 18.8 | 112.9 |

c. Reinforced Concrete Pipes

Two supply lines will be constructed to deliver flows to the basins. The mainline will enter Basin 1 from PSG Basin 5. The bypass line will enter Basin 13 from PSG Basin 5. The two lines will be used to operate the linear system as two recharge batteries and will allow for flexible operations during scheduled or emergency basin and power line maintenance. Basins outlets will be connected to downstream basins via RCP that will vary in size as indicated in Table 2. The two lines will be jacked between basins to minimize cost. Water will enter through an inlet, which will be located at the northern end of each basin. Each inlet will be protected from scour using ½-ton riprap to prevent surface scouring.

| Table 2: Basins RCP Approximate Size | | |
|---|---|---|
| **Basin** | **RCP Size (Inches)** | **Q (cfs)** |
| 1 | 48" | 51 |
| 2 | 60" | 55 |
| 3 | 48" | 52 |
| 4 | 24" | 45 |
| 5 | 24" | 52 |
| 6 | 60" | 57 |
| 7 | 36" | 60 |
| 8 | 48" | 49 |
| 9 | 48" | 53 |
| 10 | 36" | 74 |
| 11 | 18" | 44 |
| 12 | 48" | 126 |
| 13 | 60" | 99 |
| 14 | 84" | 92 |
| 15 | 60" | 109 |
| 16 | 36" | 90 |
| 17 | 36" | 87 |
| 18 | 36" | 134 |
| 19 | 60" | 123 |
| 20 | 84" | 114 |
| 21 | 84" | 114 |
| 22 | 36" | 86 |
| 23 | 48" | 116 |
| 24 | 60" | 105 |

d. Weir Boxes

Weir boxes with drain gates will be installed at the southern end of each basin. The weir boxes will pond water for storage and infiltration and the gates will allow drainage for emergency maintenance or advanced basin operation. The weir boxes will be equipped with flow measuring devices to monitor flow. Weir boxes will have approximate dimensions of 7 feet high, 10 feet wide and 10 feet deep. The location of RCP, inlets, riprap, and weir box outlets will be determined based on the restrictions presented above in pages 8 and 9 and as shown in Figures 3 through 5.

While the Easement appears to be in a viable location for groundwater recharge, several uncertainties exist. These uncertainties include percolation rates and potential impacts to adjacent residential properties due to groundwater mounding. Therefore, before full implementation is considered, an initial pilot study constructing two basins is recommended.

## IX. Environmental Documentation

Preparation of a Mitigated Negative Declaration (MND) may be required for the Project. If required, the LADWP Environmental Affairs Divisions will prepare the MND once the scope of work is finalized. If the initial study presents substantial evidence that the Project will present significant environmental impacts after mitigation measures are exhausted, LADWP Environmental Affairs Division may prepare an Environmental Impact Report (EIR). A list of potential environmental issues based on various environmental considerations was provided the 2011 *Tujunga Wash Watershed Groundwater Recharge Master Plan*, as well as, Attachment 1.

## X. Geotechnical Study

A geotechnical study has not been conducted for the Project. The LADWP Geotechnical group will perform a soil analysis of the site to determine soil classification, percolation rates, and determine whether contamination is present. Once the study, has been conducted the results will be provided.

## XI. Related Projects

1. Pacoima Spreading Grounds Enhancement Project

The Pacoima Spreading Grounds comprise 169 acres and consist of a 12-basin shallow facility that can store 530 AF. LADWP, in conjunction with LACFCD, is proposing to upgrade the Pacoima Spreading Grounds by improving the intake and stormwater storage capacity. Annual average stormwater capture is expected to increase by approximately 10,500 Acre Feet/Year (AFY), from the current recharge capacity of 6,453 AFY, and will also improve flood protection, water quality, and passive recreation.

2. Old Pacoima Wash Stormwater Capture Project

The Old Pacoima Wash Stormwater Capture Project will utilize existing Los Angeles County Flood Control District property to capture and infiltrate local stormwater runoff to recharge SFB. Existing concrete inverts will be removed, exposing natural soils to allow infiltration of runoff generated locally and upstream of PSG. The Old Pacoima Wash Stormwater Capture Project will be designed as in stream infiltration system by installing rubber dams on drop structures throughout the entire reach. The proposed improvements have an expected storage capacity of 9.3 acre-feet.

3. Tujunga Spreading Grounds

Tujunga Spreading Grounds modifications include basin and intake improvements. The improvements have the potential to increase the estimated annual recharge up to 8,000 acre-feet. Modifications include the consolidation of 20 basins into nine deeper, larger basins and one bypass basin that would increase the storage capacity from 100 acre-feet to 790 acre-feet. Inter-basin flashboard structures will be replaced with concrete overflow structures, drains, and electric motor gates. The most significant improvement proposed is changing the existing intake into a low-flow intake and adding the following facilities:

- One located just downstream of the 5/170 freeway interchange on Tujunga Wash
- One downstream that would enable flows from Pacoima Diversion Channel to be diverted into the spreading grounds

Both intake facilities would require rubber dams and slide gates, increasing the maximum intake capacity from 250 cfs to 450 cfs.

## XII. Codes, Regulations, Permits and Approvals

The new facilities shall meet the requirements of all applicable regulations, codes, permits and approvals. The permits required for this project will be determined during design. Permits could potentially include, but are not limited to the following:

**1. City of Los Angeles, Department of Building and Safety Permits**

- o Grading
- o Plumbing
- o Demolition

**2. City of Los Angeles Fire Department**

- o Risk Management Plan

**3. City of Los Angeles, Department of Public Works, Bureau of Engineering**

- o Excavation and Class ‘A’ Permanent Resurfacing Permit

**4. City of Los Angeles, Bureau of Sanitation**

- o Industrial Waste Permit

**5. City of Angeles, Department of Transportation**

- o Traffic Control Plan or WATCH Manual

**6. City of Los Angeles, Planning Department**

- o Conditional Use Permit
- o Cultural Affairs

7. **State of California, Regional Water Quality Control Board**

8. **County of Los Angeles, Department of Public Works, Flood Control**

## XIII. Elected Officials

Honorable Eric Garcetti, Mayor of the City of Los Angeles
Mr. Felipe Fuentes, Councilmember 7th Council District
Sheila Kuehl, Los Angeles County Supervisor 3rd District

## XIV. Public Access/Community Outreach

Open communication with key community groups and neighborhood councils should continue throughout the entire life of the project and should include regular updates as to the status of the project as well as key milestones.

Sun Valley Watershed Stakeholders:

- City of Los Angeles – Bureau of Sanitation
- City of Los Angeles – Bureau of Street Services
- City of Los Angeles – Recreation and Parks
- Los Angeles County Flood Control District
- LADWP
- US Army Corps of Engineers
- TreePeople
- LA Trails Project
- The River Project
- East Valley Coalition
- Sun Valley Area Neighborhood Council
- Arleta Neighborhood Council
- Mission Hills Neighborhood Council
- Council for Watershed Health
- County of Los Angeles Supervisor District 3
- City of LA Council District 6
- Area Residents

## XV. Baseline Division of Responsibilities

Project Management will determine division responsibilities and prepare a work breakdown structure, which will include the following work groups.

1. **Water Engineering and Technical Services Division**

   The Water Engineering and Technical Services Division will be responsible for Project Management to oversee and coordinate all phases of design and construction including obtaining the proper permits, Project Design which includes generating a set of plans for 30, 60 and 90 percent review and approvals, and Construction Management to administer all negotiations with chosen contractor. Construction will be completed either in house by the Integrated Support Services Division or contracted out, this still needs to be determined.

**2. Water Operations Division**

The Water Operations Division will be responsible for operation and maintenance of the basins. Debris removal in the basins, pretreatment devices, culverts and swales will be necessary prior to the beginning of storm season and after each storm event to ensure effectiveness of the project. See Section XVII for estimated operation and maintenance costs and labor required. It is expected that an operations agreement will be needed with the Los Angeles County Flood Control District to have water diverted from Pacoima Spreading Grounds into the Canterbury Basins.

**3. Watershed Management Group of Water Resource Division**

The Watershed Management Group will be responsible for the planning phase, which focuses on the development of the project's concept. It will involve outlining the tasks and responsible groups who will perform the work, obtain management approvals, risk management and legal approvals and ensure the project follows deliverables to completion.

**4. Power System Engineering Division**

The Water Engineering and Technical Services Division will coordinate with the Power System Engineering Division during the design phase to ensure design constraints of all elements related to overhead and underground distribution and transmissions lines are met. The constraints include, but are not limited to, the details in the Canterbury Avenue Power Line Easement Stormwater Capture Report (Conceptual Study Report, Attachment 1).

**5. Power System Transmission and Distribution Division**

The Water Engineering and Technical Services Division will coordinate with the Power System Transmission and Distribution Division during the construction phase to ensure construction of all elements related to overhead and underground distribution and transmissions lines are met. The constraints include, but are not limited to, the details in the Conceptual Study Report, Attachment 1.

**6. Integrated Support Services Division**

The Integrated Support Services Division will be responsible for the construction of the project, if construction is determined to be completed in house by the Water Engineering and Technical Services Division.

**7. Real Estate Group of Operations Support Services Division**

The Real Estate Group will be responsible for vacating the portions of the property that are presently occupied by nurseries through relocation or termination of nursery leases.

## XVI. Project Schedule

| | |
|---|---|
| Planning | Early 2015 |
| Environmental | Late 2016 |
| Engineering and Design | Early 2018 |
| Advertise (Out to Bid) | Mid 2019 |
| Award | Mid 2019 |
| Construction | Late 2019 |
| Completion | Mid 2021 |

## XVII. Project Budget, Cost Estimates, and Fund Opportunities

Construction of the project will begin when construction funds are secured later. The project budget, preliminary cost estimates and potential funding opportunities are summarized below.

### 1. Work Order Information

Title: Canterbury Avenue Power Line Easement Stormwater Capture Project

| | |
|---|---|
| Functional Item | 24-318 |
| Job Number | 56135 |
| Parent Work Order | UCE80 |
| Planning | UCE01 |
| Design | TBD |
| Construction | TBD |

## 2. Preliminary Cost Estimate

| Table 3: Preliminary Project Cost Estimate | | | | | |
|---|---|---|---|---|---|
| **ITEM NO.** | **ITEM** | **APPROX QTY** | **Unit** | **UNIT PRICE** | **Cost Total (2014 Dollars)** |
| | | **MISCELLANEOUS** | | | |
| 1 | Mobilization (10% Max of Contract Bid) | 1 | LS | $4,918,000 | $4,918,000 |
| 2 | Contingency (30% Construction Cost) | 1 | LS | $1,640,000 | $1,640,000 |
| 3 | Inflation ( @ 3% per year for 5 years) | 1 | LS | $2,459,000 | $2,459,000 |
| | | **DEMOLITION** | | | |
| 4 | Demo of Existing Sidewalk | 21,000 | SF | $3 | $63,000 |
| 5 | Demo of Existing Curb and Gutter | 19,000 | LF | $10 | $190,000 |
| 6 | Clearing and Grubbing | 750,000 | SF | $5 | $3,750,000 |
| | | **CONSTRUCTION** | | | |
| 7 | Relocation of underground distribution line | 1 | LS | $525,000 | $525,000 |
| 8 | Catch Basin(s) w/screens | 26 | EA | $5,000 | $130,000 |
| 9 | Excavation | 247,000 | CY | $6 | $1,482,000 |
| 10 | Soil Export | 247,000 | CY | $25 | $6,175,000 |
| 11 | Inlet Structures | 25 | EA | $520 | $13,000 |
| 12 | 1/2 ton Riprap | 6,000 | CY | $110 | $660,000 |
| 13 | Reinforced Concrete Pipe | 13,000 | LF | $150 | $1,950,000 |
| 14 | Weir Box | 25 | EA | $15,000 | $375,000 |
| 15 | Curb and Gutter | 19,000 | LF | $25 | $475,000 |
| 16 | Passive recreation (walking paths) | 21,000 | SF | $4 | $84,000 |
| 17 | Educational signage | 96 | EA | $3,000 | $288,000 |
| 18 | Fencing | 20,000 | LF | $38 | $760,000 |
| | | | | **Cost Estimated Total (2014 Dollars)** | **$26,226,000** |

DRAFT

## 3. Estimated Operation and Maintenance Costs

Annual operation and maintenance (O&M) costs were estimated using baseline data on a per acre-foot cost provided by LACDPW. LACDPW provided the recharge basins operational costs of $317 per acre-foot of facility capacity using 2007 data. With inflation operational costs for the recharge basins is calculated to be $364 per acre-foot of facility capacity. Catch basin cleaning and maintenance is estimated at $18 each time per catch basin with the total anticipated O&M to be approximately $55,540 per year.

### 4. Funding Opportunities

To secure funds for the project, a number of funding opportunities exists. These opportunities exists from partnership opportunities with local agencies to help share project cost, to submitting application for grants and loans to provide the needed financial assistance to initiate the project. Additional information regarding funding opportunities is provided in the Canterbury Avenue Power Line Easement Stormwater Capture Conceptual Study Report found in Attachment 1.

## XVIII. Risk Assessment

Potential risk factors that may influence design and construction schedules include: community involvement, coordination with other projects (in-house or otherwise), permit processing, environmental considerations regarding the wash, geotechnical investigations, changed field conditions, unknown impacts to adjacent residential properties due to potential groundwater mounding, unknown infiltration rates, close proximity to existing electrical towers and power distribution facilities within the Power Line Easement, and etc.

## XIX. Safety

The Canterbury Avenue Power Line Easement Stormwater Capture Project including planning, design, installation, and in-service phases, shall conform to safety regulations, especially those from the Division of Occupational Safety and Health, State of California (formerly CAL OSHA). In addition, during the design process, the Corporate Safety Group will be included in plan reviews and discussions to ensure safety is considered and incorporated in the design of the project.

ATTACHMENT 1
Canterbury Avenue Power Line Easement Stormwater Capture
Conceptual Study Report
November 2014

# East Valley Baseball Park Infiltration System

# Stormwater Capture Study

## CONCEPTUAL STUDY REPORT

November 2014



*Prepared By:*

Los Angeles Department of Water and Power

Water Resources Division
Watershed Management Group

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## TABLES



## Figures

## I. Introduction

The Los Angeles City Department of Water and Power (LADWP) and the Los Angeles County Flood Control District (District) are cooperatively working to complete various stormwater capture projects. These projects are designed to help alleviate localized flooding, recharge the groundwater basin, and improve downstream water quality in the San Fernando Valley. The infiltration system is located in the upper Tujunga Wash Watershed within the San Fernando Valley Groundwater Basin, as presented in Figure 1, near the northern bounds of the City of Los Angeles (City).


**Figure 1 - Location of East Valley Baseball Park System**

Groundwater storage levels in the San Fernando Valley Groundwater Basin have been in decline for several decades. Lack of precipitation and the increased demand for water within the Los Angeles Region have created a strain on the water supply. Declining reserves of groundwater and surface water show that new water supply sources are vital to sustain the long-term reliability and utility of the groundwater basin and decrease the region's dependence on imported water supplies. To minimize the region's dependence on imported water, the proposed project will capture stormwater overflow from the Tujunga Spreading Grounds (TSG) and from a local storm drain, MTD 117, to supply additional recharge to groundwater reserves within the San Fernando Valley Groundwater Basin.

Currently, surface drainage from the nearby neighborhoods drains approximately 350 acres, which will deliver 20 acre-feet during a 1” storm. The East Valley Baseball Park System will serve as an extension of the TSG to increase water capture capacities within the watershed.

## II. Project Site Background

The project is located in the Tujunga Wash Watershed in the San Fernando Valley, and runs parallel with the SR-170 Freeway. The Infiltration System is approximately 4,000 feet long by 100 feet wide. It is surrounded by residential property and streets, and covers approximately 9.09 acres. The average annual rainfall for the area is 16 inches. The 50-year rainfall event is defined by the District is 6.26 inches in a 24-hour period.

Basin 1 of the Infiltration Facility will be located in a portion of the LADWP right-of-way (ROW) currently occupied by Roscoe Nursery Wholesale. The nursery is using the ROW for agricultural purposes, growing a number of plants and crops.

Basin 2 of the system will be located within the LADWP ROW and a portion of Strathern Park North. Basin 3 will be located in Jamie Beth Slaven Park located directly south of Strathern Street. The surrounding area is predominately single-family residential homes with some multifamily residences. Other uses surrounding the project include open space, commercial, and education facilities. Figure 2 below presents an analysis comparing the land use composition surrounding the project and confirms observations from the aerial imagery.

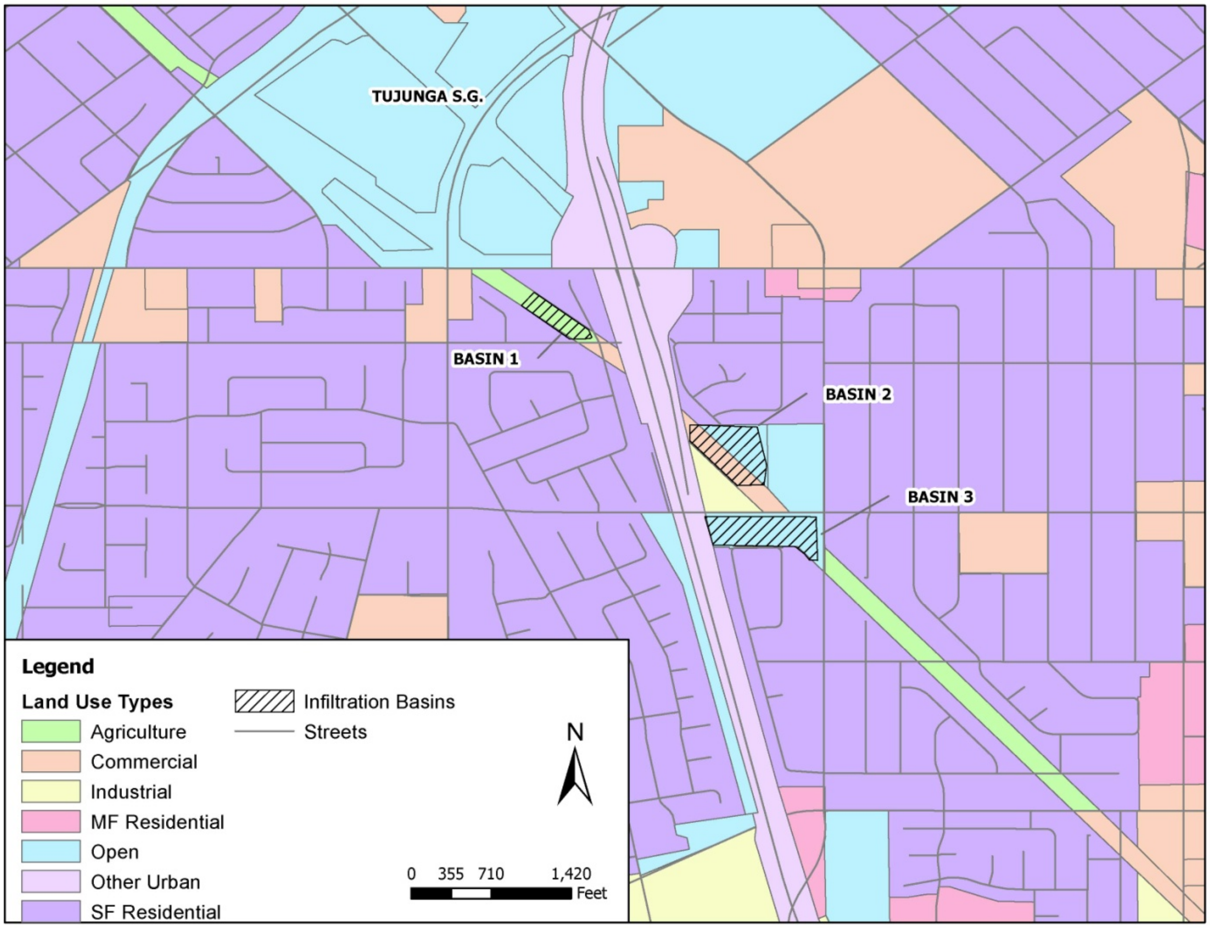



**Figure 2 - Land Use Surrounding East Valley Baseball Park System**

The 2006 Los Angeles County Department of Public Works (LACDPW) Hydrology Manual provided the soil types and runoff coefficients for the study area. The soil types for the easement, as presented in Figure 3, consist of Hanford Fine Sandy Loam (HF) and Tujunga Fine Sandy Loam (TF). The project area is predominantly TF soil. The runoff coefficients reported at 1 inch/hour for these soils types range from 0.1 for TF to 0.46 for HF. Based on this finding, infiltration rates for TF soil would be the highest and HF would be the lowest. Table 1 shows the soil type numbers and runoff coefficients at 1 inch/hour for the project area.

**Table 1: East Valley Baseball Park System Area Soil Types**

| Soil Type Number | Name | Original Name | Runoff Coefficient at 1"/hr |
|---|---|---|---|
| 005 | Hanford Fine Sandy Loam | HF | 0.46 |
| 015 | Tujunga Fine Sandy Loam | TF | 0.1 |

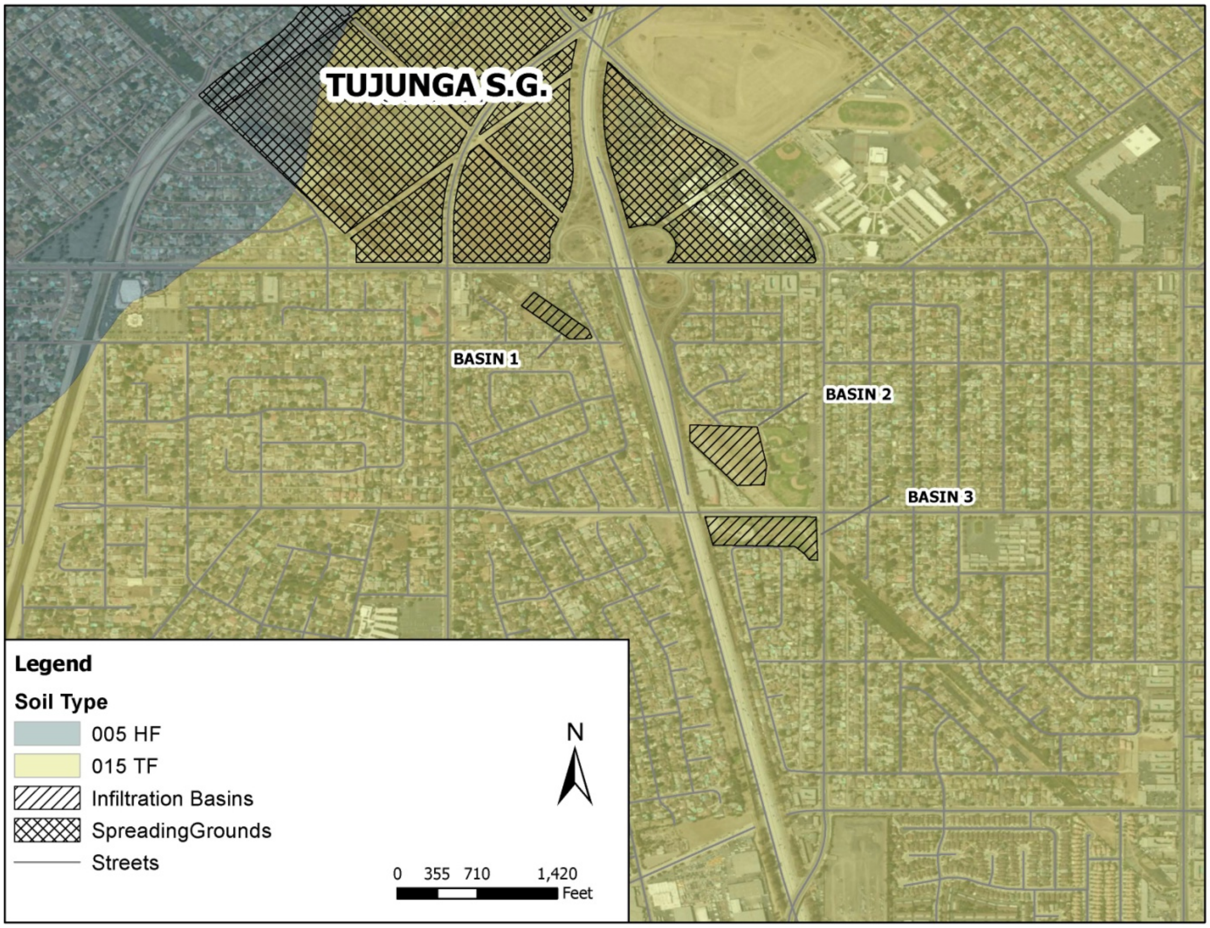



**Figure 3 - Soil Types Surrounding East Valley Baseball Park System**

## III. Goals & Objective

The objective of the East Valley Baseball Park System Stormwater Capture Project is to determine the feasibility of capturing and retaining all local stormwater runoff by constructing multiple infiltration basins along the ROW and within the parks to meet the following goals:

- Increase water supply to the park;
- Help mitigate flooding in the area;
- Improve stormwater quality at downstream water bodies; and
- Recharge the groundwater basin.

These goals are designed to help meet the goals of the Tujunga Wash Groundwater Recharge Master Plan.

## IV. Project Summary

The 9.09 available acres of the East Valley Baseball Park System will be modified to construct three infiltration basins. The infiltration basins will receive and retain stormwater from the TSG Basin 17 and flows from the neighboring storm drain, MTD 117. Construction of the infiltration basins in the Infiltration System will include the installation of diversion structures, inlets, weir box outlets, riprap aprons, reinforced concrete pipe (RCP), Continuous Deflection System Unit (CDS Unit), flow measuring devices, educational signage, access roads, and basins that vary in depth from 7 to 10 feet for optimal retention. Local flow capture will require modifications to storm drain MTD 117.

Although the facilities will be owned by LADWP, it is expected that the District will operate the facility for stormwater recharge due to the connection to the TSG (TSG). It is also expected that the District will require a maintenance plan and agreement. Stormwater diverted from TSG will enter the first infiltration basin through an inlet structure and convey flows through RCP. Flows captured from the local tributary area will be diverted from MTD 117, which will be connected to a hydrodynamic separator to provide pretreatment for the urban flows. The flows will then go through RCP with varying diameters connected to the inter-basin RCP supply lines.

To create inter-basin flow, the RCP size for Basins 1 though three, varies as shown in Table 2. For scour protection, ½-ton riprap will be located at the downstream end of all inter-basin connections. Weir boxes with gates will be used as outlets to pond water in the basins for groundwater recharge. Figure 4 through Figure 6, show the conceptual layout of the proposed project. All pipes, inlets, riprap, and weir boxes will be sized based on storage volumes and infiltration capacity.

**Table 2: Inter-basin Pipe Size and Flow Rate**

| Basin | RCP Size (Inches) | Q (cfs) |
|---|---|---|
| 1 | 45” | 30 |
| 2 | 45” | 60 |
| 3 | 60” | 60 |
| 3 to MTD 117 | 36” | 60 |

**Figure 4 - Conceptual Project Layout Page 1**

**Figure 5 - Conceptual Project Layout Page 2**

**Figure 6 - Conceptual Project Layout Page 3**

All infiltration basins will be graded to control surface runoff. The grading will consist of surfaces with planned grades with smooth side slopes and corners. A vegetated buffer will surround the perimeter of the infiltration basins to break up overland flows from the access roads and adjacent properties before entering the basin. The infiltration rate of the TSG is 1.89 inches/hour, or 3.78 feet/day. When completed, the Project will add a storage volume of 58 acre-feet, with an approximate total percolation rate of 17 cfs. The intake limit for the three infiltration basins is currently sized for 49 cfs through 60cfs. Constructing the East Valley Baseball Park System project will yield an estimated annual recharge benefit of 174 acre-feet annually from local runoff and the potential to capture another 575 acre-feet through the TSG. A summary of each infiltration basin area and water storage volume is presented in Table 3.

**Table 3: Infiltration Basin Area and Water Storage Volume**

| Basin | Basin Area (Acres) | Water Storage Volume (Acre-Feet) |
|---|---|---|
| 1 | 1.0 | 5.7 |
| 2 | 4.6 | 30.9 |
| 3 | 3.5 | 20.9 |
| **Project Total** | 9.1 | 57.5 |

While the ROW and parks appear to be in a viable location for groundwater recharge, several uncertainties exist. These uncertainties include percolation rates and potential impacts to adjacent residential properties due to groundwater mounding.

The proposed ROW basins will require amendments to the current TSG operation and maintenance procedures. Since this would be a new facility, operation and maintenance costs associated with sediment removal and additional basin facility maintenance will increase over the existing operation costs at the TSG.

## V. Easement Construction Requirements

Construction on LADWP easements requires following the setback requirements listed below.

- Retain a 100-foot service radius around each tower.
- Retain a 10-foot service radius around each pole.
- Retain a 300-foot clearance around “dead-end” towers.

Pipe clearances to tower piers that are closer than outlined above for the service clearances shall be sleeved inside of a pipe for a minimum distance of 60-ft from existing tower piers. New pipes shall be designed to allow for an H20 loading. Distribution System Clearance Requirements are the following:

- Retain a 10-foot service radius at existing ground level around each distribution pole.
- Provide a 20-foot service radius at existing ground level around each maintenance hole.
- Provide a 13-foot wide clear; unobstructed vehicle access to the overhead and underground systems for maintenance, repairs, upgrades, and cable pulling.
- Provide a 10-foot clear setback from the exterior of any underground distribution conduit or maintenance vault to the edge of any basin, swale, channel or other drainage feature.
- Maintain the existing cover between the top of the underground distribution conduit and the ground surface.

## VI. Environmental Considerations

Environmental studies for this project have not been conducted and will be required prior to the start of construction. A Mitigated Negative Declaration (MND) or an Environmental Impact Report (EIR) may be required (upon approval of the Lead Agency) based on the findings of this study. LADWP Environmental Affairs Division will prepare the EIR as necessary. Potential environmental issues based on the Initial Study format for various environmental areas are summarized in Table 4 and Figure 7 illustrates a few of the locations surrounding the project that may cause potential environmental constraints for this project site.

**Table 4: Strathern Park Summary of Issues**

| Environmental Topic | Potential Issues | No Anticipated Issues | Comments |
|---|---|---|---|
| Land Use and Planning | X | | Issues with the removal of the parks would be a concern as local neighborhood opposition can arise. Zoning regulations should be reviewed to confirm that the land use could be permitted and recreational aspects should be incorporated into the design. |
| Population and Housing | | X | No issues are anticipated. |
| Geology and Soils | X | | Additional studies for excavation would most likely be required. Use of excavated material by Vulcan should be considered. |
| Water | X | | Water quality measures (BMPs) will have to be employed during the excavation. |
| Air Quality | X | | Issues with air quality would be a concern primarily “during construction” activities (sediment removal, truck hauling). Post-construction air quality issues are not anticipated. |

**Table 4: Strathern Park Summary of Issues**

| Environmental Topic | Potential Issues | No Anticipated Issues | Comments |
|---|---|---|---|
| Transportation and Circulation | X | | Minor changes in transportation and circulation are anticipated. The need for traffic studies would be triggered on an import or export due to associated truck trips. The project is adjacent to both a residential neighborhood and a school. Transportation issues are not anticipated upon the completion of construction since the site maintenance will generally not be increasing trips. |
| Biological Resources | X | | The project site consists of disturbed areas or areas that contain ornamental vegetation in an urbanized area. The primary concern with biological issues is during construction. Mitigation may be identified in order to bring potential issues to a less than significant level. Vegetation removal may be limited to time periods outside of the spring breeding season. |
| Energy and Mineral Resources [1] | X | | No mineral resource issues are associated with the proposed activities given the existing nature of the project site. However, the area is a major power line corridor, thus there are potential issues with energy resources. |
| Hazards | X | | Although significant issues are not anticipated, hazardous materials studies may be required to define on-site housekeeping practices and past land uses. Sampling may be required once soils are excavated and prior to transfer. The presence of pesticides within agricultural areas should also be defined. |
| Noise | X | | Noise is anticipated to be an issue during construction. Noise mitigation measures could be employed (i.e., hours of maintenance activities, buffers, etc.). It is anticipated that construction activities would occur during the daytime hours due to the close proximity of residential units and a school. |
| Public Services | X | | Conflicts are anticipated as health and environmental benefits provided by the park will be eliminated unless recreational aspects are incorporated in the final design. |
| Utilities and Service Systems | X | | Since the project is located within an existing power line corridor, it may include other utilities. Preliminary discussions with LADWP indicate these should be minor. |
| Aesthetics | X | | Issues are anticipated, as the current aesthetics provided by the parks will be eliminated. These will need to be mitigated in the final design plans based on input from stakeholders. |

| Table 4: Strathern Park Summary of Issues | | | |
|---|---|---|---|
| **Environmental Topic** | **Potential Issues** | **No Anticipated Issues** | **Comments** |
| Cultural Resources | | X | Although no issues with cultural resources are anticipated, precautionary mitigation measures will be adopted in the event that cultural issues surface during construction. The primary concern with cultural resources is during excavation. A standard cultural resources report would identify any issues and potential mitigation measures to be employed. |
| Recreation | X | | Issues are anticipated, as recreation currently provided by the parks will be eliminated. Incorporation of low-lying ball fields and walking paths will address many of these issues. |

[1] Existing Power Distribution Facilities.


**Figure 7 - Potential Environmental Constraints**

## VII. Implementation Schedule

The East Valley Baseball Park System Stormwater Capture Study is a new project, therefore, the planning and environmental phase includes all work done before design studies and plans are produced (design phase). The construction phase begins with advertising of the project for bid and concludes with project completion. The assumed start date is early 2015. Table 5 summarizes the overall project schedule.

**Table 5: East Valley Baseball Park System Summary Schedule**

| Phase | Start Date | End Date |
|---|---|---|
| Planning | Early 2015 | Early 2018 |
| Environmental | Late 2016 | Early 2018 |
| Engineering and Design | Early 2018 | Mid 2019 |
| Advertise | Early 2019 | Mid 2019 |
| Award | Mid 2019 | |
| Construction | Late 2019 | Mid 2021 |

## VIII. Cost Estimate

The preliminary cost estimate was developed using various sources of information. The construction cost entails various components of the Project that a contractor will construct. Standard engineering procedures were used to determine the preliminary cost estimate as presented in Table 6.

| Table 6: Preliminary Project Cost Estimate | | | | | |
|---|---|---|---|---|---|
| **ITEM NO.** | **ITEM** | **APPROX.QTY** | **Unit** | **UNIT PRICE** | **Total** |
| | **MISCELLANEOUS** | | | | |
| 1 | Mobilization (10% Max of Contract Bid) | 1 | LS | $2,413,000 | $2,413,000 |
| 2 | Contingency (30% Construction Cost) | 1 | LS | $804,000 | $804,000 |
| 3 | Inflation ( @ 3% per year for 5 years) | 1 | LS | $1,207,000 | $1,207,000 |
| | **DEMOLITION** | | | | |
| 4 | Demo of Existing Sidewalk | 40,000 | SF | $3 | $120,000 |
| 6 | Clearing and Grubbing | 396,000 | SF | $5 | $1,980,000 |
| | **CONSTRUCTION** | | | | |
| 7 | Diversion Structure | 1 | EA | $23,000 | $23,000 |
| 8 | Excavation | 129,000 | CY | $6 | $774,000 |
| 9 | Soil Export | 129,000 | CY | $25 | $3,225,000 |
| 10 | Inlet Structures | 3 | EA | $500 | $1,500 |
| 11 | 1/2 ton Riprap | 4,000 | CY | $110 | $440,000 |
| 12 | Reinforced Concrete Pipe | 6,000 | LF | $150 | $900,000 |
| 13 | CDS Unit | 1 | EA | $100,000 | $100,000 |
| 14 | Weir Box | 4 | EA | $15,000 | $60,000 |
| 15 | Passive recreation (walking paths) | 127,000 | SF | $4 | $508,000 |
| 16 | Educational signage | 16 | EA | $3,000 | $48,000 |
| | | | | **Cost Estimated Total** | **$12,603,500** |



Annual operation and maintenance (O&M) costs were estimated using baseline data on a per acre-foot cost provided by LACDPW. LACDPW provided the recharge basins operational costs of $317 per acre-foot of facility capacity using 2007 data. With inflation operational costs for the recharge basins is calculated to be $364 per acre-foot of facility capacity. The total anticipated O&M is approximately $20,384 per year. Table 7 shows the cost estimate for the Easement project, which includes the present value of cost for 50 years at a 5% inflation rate.

| Table 6: East Valley Baseball Park System Total Estimated Costs | |
|---|---|
| **Description** | **Cost (2014 dollars)** |
| Construction | $12,451,000 |
| Annual O&M for recharge | $20,000 |
| Annual Aquifer Extraction | $0 |
| Present Value of Costs (5%, 50-Years) | $16,712,000 |

The storage volume of local water conserved in the infiltration basins is estimated to be 174 acre-feet annually based on average local rainfall patterns and the proposed storage capacity.

Based on the estimated average of annual recharge from the ROW, a cost benefit analysis was conducted for the Project. With the demands for domestic water continuing to increase, the Tier -1 untreated 2012 rate of $560 per acre-feet was used for the cost benefit analysis. Assuming a 7% increase per year and an economic life of 50 years the present estimated value of the 174 acre-feet is $45,553,684. With these costs estimates, the Project would produce a cost savings for the LADWP. Table 8 presents the benefit/cost ratio for the Strathern Park Stormwater Capture project.

| Table 7: Strathern Park Stormwater Capture Benefit/Cost Ratio | |
|---|---|
| **Description** | **Value (2014 dollars)** |
| Present Value of Benefits | $45,553,684 |
| Present Value of Costs | $16,712,000 |
| Benefit/Cost Ratio | 2.73 |

In addition to cost saving and depending on several factors, the Project may incorporate open space attributes similar to those the TSG will undergo in order to keep the same continuous green space amenities for the neighboring community as well as reduce energy cost from decrease in water importation.

## IX. Funding Opportunities

To implement the project, funds will need to be allocated which will be difficult even during a good financial year. Funding knowledge and experience has been used to identify viable funding opportunities to assist LADWP in implementing the Project.

### 1. Partnership Opportunities

The project areas average annual rainfall, allows for a full capture of a 50-year rainfall event. This qualifies the project as a regional project for the Enhanced Watershed Management Plan (EWMP), which may be a potential funding source for the construction of the project. Partnership with local agencies that may benefit for the construction of the Project

## 2. Grants and Loans

To implement the proposed Project, LADWP will need some financial assistance. To receive financial assistance an application must be completed and specific eligibility requirements must be met. All assistance programs also provide a set of conditions and limitations. Financial assistance programs are available in two common forms, grants and loans. It is important to fully understand the differences, benefits, and drawbacks of each in order to determine which form of financial assistance is best the project.

Grants are awards of financial assistance, meaning the grant awardee is not required to return the money, although they may need to follow specific requirements and produce specific products. On the other hand, loans are awarded as a benefit or assistance, but the awardee is required to pay back the loan, often with interest. Table 9 below outlines the major differences between grants and loans.

One of the major points outlined in Table 9 is the application and competition of grant programs versus loan programs. Grants often require extra work in addition to general work related to any project. Grants often require extra reports, and as mentioned, a more complex application process. Loans however have a relatively simple application process, less competition, and limited additional requirements that are often less complex. Grants will require extra work, but in return, “free” money is awarded. Both grant and loan financial assistance programs are outlined below.

**Table 8: Differences Between Grants and Loans**

| Grants | Loans |
|---|---|
| • No payback required;<br>• Typically complex application process;<br>• Highly competitive;<br>• Extensive reporting and oversight needed;<br>• Matching funds generally required;<br>• May favor larger/more expensive projects;<br>• Some require participation with an IRWM;<br>• Funding limits vary;<br>• Generally limited application periods; and<br>• Operate under agency-specific guidelines. | • Payback required;<br>• Relatively simple application process;<br>• May require getting on priority list;<br>• Repayment terms vary;<br>• Threshold eligibility criteria must be met;<br>• Tie-in with job creation with some programs;<br>• Different agencies have different requirements;<br>• Maximum amount financed can be large; and<br>• Generally continuous application periods. |

**Proposition 84 (Chapter 2, §75026) Integrated Regional Water Management (IRWM) Grant Program**

| | |
|---|---|
| **Program Name:** | Proposition 84 (Chapter 2, §75026) IRWM |
| **Department:** | Department of Water Resources |
| **Type:** | Grant |
| **Purpose:** | Projects to assist local public agencies to meet long-term water management needs of the State, including the delivery of safe drinking water, flood risk reduction, and protection of water quality and the environment. |
| **Eligibility Requirements:** | Local public agencies or nonprofit representing an accepted IRWM Region |
| **Eligible Uses:** | Projects that implement IRWM Plans |
| **Ineligible Uses:** | Operation and maintenance activities |
| **Funding Limits:** | Bond funding allocation for entire program is $1 billion.<br>Prop 84 allots grant funding to 11 funding areas.<br>Each proposal solicitation package will have predetermined amount of funds available. |
| **Terms/Dates:** | 25% minimum cost share with waivers for DACs<br>Round 3 expected in Fall 2014 (approximately $130 million available for Los Angeles Funding Areas) |
| **Website:** | http://www.water.ca.gov/irwm/grants/guidelines.cfm |

IRWM is a collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries; involves multiple agencies, stakeholders, individuals, and groups; and attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions. A majority of projects funded through this grant program pertain to water supply, flood control, and habitat protection. Although some of these project types would not be applicable for the LADWP to implement in order to ensure stormwater compliance, there are some eligible project types that would coincide with LADWPs needs, including:

- Stormwater capture, storage, clean-up, treatment, and management;
- Non-point source pollution reduction, management, and monitoring;
- Groundwater recharge and management projects;
- Planning and implementation of multipurpose flood management programs; and
- Watershed protection and management.

**Clean Water State Revolving Fund Program**

| | |
|---|---|
| **Program Name:** | Clean Water State Revolving Fund Program |
| **Department:** | SWRCB |

**Type:** Financing (loan)
**Purpose:** Provide funding for publically-owned facilities
**Eligibility Requirements:** Public agencies and nonprofit organizations
**Eligible Uses:** Stormwater treatment and diversions, sediment and erosion control, stream restoration, and land acquisitions
**Ineligible Uses:** Operation and maintenance activities, legal fees
**Funding Limits:** $50 million per agency per year
**Terms/Dates:** Interest rate is one-half general obligation bond rate.
Repayment term of twenty years
Applications accepted continuously

**Website:** http://www.waterboards.ca.gov/water_issues/programs/grants_loans/srf/index.shtml

Various projects within California have utilized this funding program. Some projects considered through this program include the City of Anaheim Sewer Reconstruction Project and the Eastern Municipal Water District Recycled Water Pond Expansion and Optimization Project. Other project types that are considered under this financing program include:

- Construction of publicly-owned facilities:
  - Wastewater treatment
  - Local sewers
  - Sewer interceptors
  - Water reclamation facilities
  - Stormwater treatment

- Expanded Use projects include, but are not limited to:
  - Implementation of nonpoint source projects or programs
  - Development and implementation of estuary comprehensive conservation and management plan

**Infrastructure State Revolving Fund (ISRF) Program**

**Program Name:** ISRF Program
**Department:** California Infrastructure and Economic Development Bank
**Type:** Loan
**Purpose:** Provide financing for public infrastructure projects
**Eligibility Requirements:** Applicant must be a local municipal entity
Project must promote economic development and attract, create, and sustain long-term employment opportunities
**Eligible Uses:** Construct or modify public infrastructure, purchase and

| | |
|---|---|
| | install pollution control or noise abatement equipment, or acquire land. Project must meet tax-exempt financing criteria. |
| **Ineligible Uses:** | Privately owned facilities or debt refinancing |
| **Funding Limits:** | $2 million maximum per environmental mitigation project per fiscal year<br>$10 million maximum per project for all other purposes per fiscal year<br>$20 million per jurisdiction per fiscal year |
| **Terms/Dates:** | Maximum 30 year term and open application process<br>Preliminary application available at www.ibank.ca.gov |
| **Website:** | http://ibank.ca.gov/infrastructure_loans.htm |

This program provides low-cost, long-term financing to local governments for a variety of public infrastructure projects.

**Supplement Environmental Project (SEP) Funds**

| | |
|---|---|
| **Program Name:** | SEP Funds |
| **Department:** | EPA |
| **Type:** | Violation Reduction |
| **Purpose:** | Provide a fine reduction as part of a settlement of an enforcement action |
| **Eligibility Requirements:** | The project must improve, protect, or reduce risks to public health, or the environment at large. The project must also relate to the original violation. |
| **Eligible Uses:** | Improvement to public health, pollution prevention through source reduction, environmental restoration and protection, environmental compliance promotion, and emergency planning and preparedness. |
| **Ineligible Uses:** | Project not related to original violation |
| **Funding Limits:** | The amount of penalty mitigation is based on the cost of the SEP and whether or how effectively the SEP:<br>• Benefited the public or environment;<br>• Was innovative;<br>• Considered input from affected community;<br>• Reduced emissions to more than one media (e.g. air, land, water);<br>• Factored in environmental justice issues; and<br>• Implemented pollution reduction through source reduction. |
| **Terms/Dates:** | Continuously accept applications |
| **Website:** | http://ibank.ca.gov/infrastructure_loans.htm |

This program would benefit the City if any enforcement actions were taken against the City. This program assists with compliance and promotes action to fix current problems. One main goal of SEPs is to improve the environmental health of communities that have been put at risk due to the violation of an environmental law.

**2014 Water Bond**

| | |
|---|---|
| **Program Name:** | 2014 Water Bond (Proposition 1) |
| **Department:** | State of California |
| **Type:** | Grant |
| **Purpose:** | Provide funding for projects that ensure reliable water supply for future generations. |
| **Eligibility Requirements:** | Unknown at this time. |
| **Eligible Uses:** | Provide funding for projects must address regional water reliability, water storage capacity, water recycling, groundwater sustainability, safe drinking water, watershed projection, ecosystem restoration, state settlements, and flood management. |
| **Ineligible Uses:** | Unknown at this time. |
| **Funding Limits:** | $810 million on regional water reliability<br>$2.7 billion water storage capacity<br>$725 million water recycling<br>$900 million groundwater sustainability<br>$520 million safe drinking water<br>$1.5 billion watershed projection, ecosystem restoration, and state settlements<br>$395 million on flood management |
| **Terms/Dates:** | On the 2014 California ballot. |
| **Website:** | http://www.acwa.com/spotlight/2014-water-bond |

The 2014 Water Bond is the product of a comprehensive legislative package developed in 2009 by Governor Schwarzenegger and state lawmakers to meet California's growing water challenges. This package represented a major step toward ensuring reliable water supply for future generations as well as restoring the Sacramento-San Joaquin Delta and other ecologically sensitive areas.

## X. Study Recommendations

The East Valley Baseball Park System Stormwater Capture study has lead to several findings, which are summarized below:

- To evaluate project site conditions, a geotechnical study will need to be conducted. The study will consist of a soil analysis of the site to determine soil classification, percolation rate, and determine whether contamination is present on site.

- Environmental studies for this project will need to be conducted prior to the start of construction to further evaluate the feasibility of the project.
- To further evaluate project outcomes, an initial pilot study will need to be conducted to evaluate percolation rates and potential impacts to adjacent residential properties due to groundwater mounding, prior to the full implementation of this proposed project.

Results from the implemented projects include:

- Reduced flooding during the capital storm event;
- Increased groundwater recharge by 174 acre-feet per year from local flows;
- Increased groundwater recharge by 575 acre-feet per year from flow through TSG;
- Cost savings to LADWP;
- Significant improvement to downstream water quality;
- Improved aesthetics and open space attributes surrounding Strathern Park and local area; and
- The project can be used as a regional project for the area EWMP, which may be a potential funding source.

# EAST VALLEY BASEBALL PARK INFILTRATION SYSTEM

# STORMWATER CAPTURE PROJECT

## SCOPE OF WORK DOCUMENT



August 2015

*Prepared By:*

Los Angeles Department of Water and Power
Water Resources Division
Watershed Management Group

# TABLE OF CONTENTS

## I. Title

**EAST VALLEY BASEBALL PARK INFILTRATION SYSTEM STORMWATER CAPTURE PROJECT**

Functional Item: **TBD,** Job No. **TBD**

## II. Project Objectives

To capture, infiltrate and retain local stormwater runoff facilitated by the construction of multiple infiltration basins located near the I-170, between the TSG and Blythe Street. The basins will help mitigate flooding, improve downstream water quality, and increase water supply to the park.

## III. Project Team

| | |
|---|---|
| Project Management: | |
| Manager | TBD |
| | |
| Planning Phase: | |
| Manager | Andy A. Niknafs |
| | Eric M. Yoshida |
| | |
| Design Phase: | |
| Manager | Joseph J. Resong |
| Mechanical Design | John Otoshi |
| Electrical Design | Emmanuel Tan |
| Capital Improvement/Asset Management | Charles C. Ngo |
| Civil/Structural Design | Joseph J. Resong |
| Distribution Engineering | Alvin Z. Bautista |
| Geotechnical | Adam Perez |
| Geology | Clifford C. Plumb |
| Survey | Shereef Surur |
| Right-of-Way | Henry Bui |
| Property Management | Heidi K. Hiraoka |
| Water Transmission Operations | Linh T. Phan |
| Water Quality | Don Christie |
| Treatment Operations | Razmik O. Manoukian |
| Construction Specifications | David F. Neal |
| Environmental Assessment | Charles C. Holloway |
| Safety | Jaime F. Hernandez |
| Security Services | Eddy Allahverdian |
| Trunk Line | Craig A. Davis |

| | |
|---|---|
| Construction Phase: | |
| Manager | Wayne A. Bamossy |
| Resident Engineer | TBD |
| Repair and Construction | Michael E. Grahek |
| Test Lab | Nancy A. Wigner |
| Plant Inspection | Vipin K. Wahi |
| Construction Support Team | TBD |

## IV. Approvals from Originating Organization

Senior Assistant General Manager – Water System Date
Martin L. Adams

Director of Water Operations Date
Richard F. Harasick

Director of Water Engineering & Technical Services Date
Susan R. Rowghani

Director of Water Quality Date
Albert G. Gastelum

Director of Water Distribution Date
Keith D. Session

Director of Water Resources Date
David R. Pettijohn

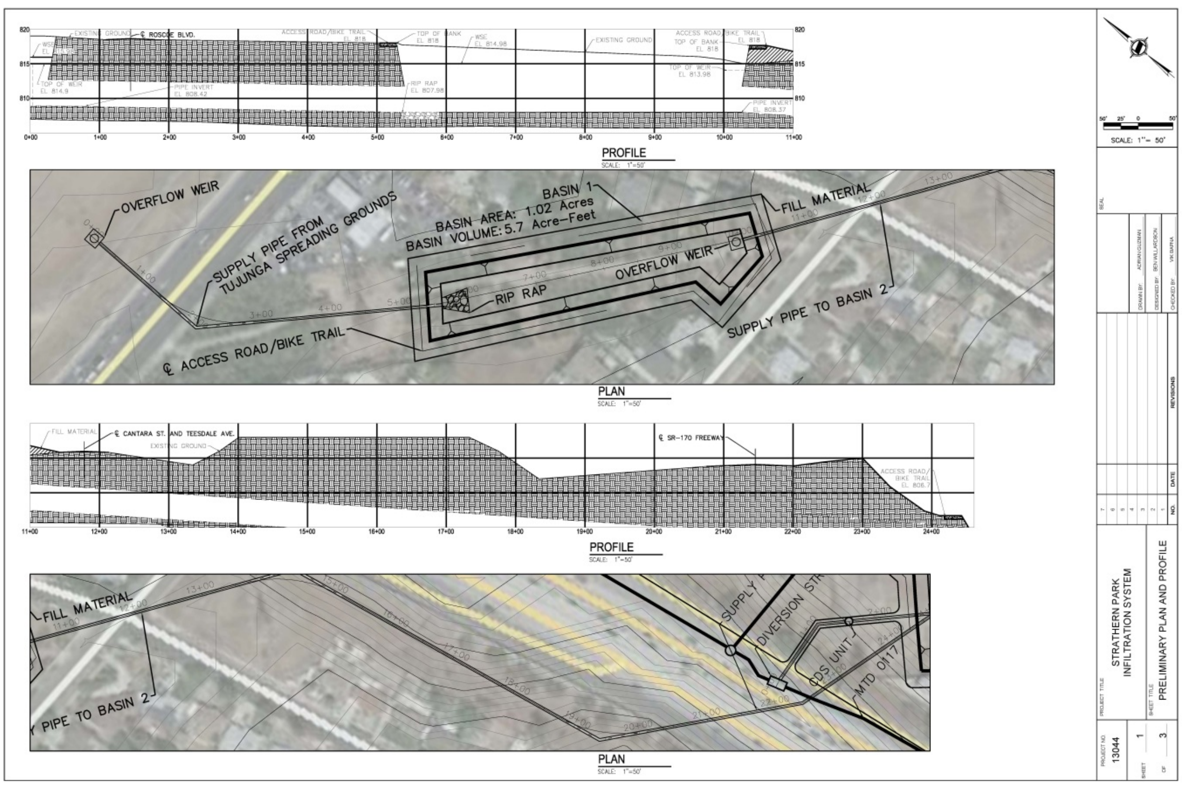
## V. Approvals

By signing this document, Power System approves the Scope of Work Document for the East Valley Baseball Park Infiltration System Stormwater Capture Project. Approval of this document is not to be construed as approval of design. Construction will not commence until Power System reviews and approves the design.

| | |
|---|---|
| Senior Assistant General Manager Power System<br>Randy S. Howard | Date |
| Director of Power Supply Operations<br>Kenneth A. Silver | Date |
| Director of Integrated Support Services<br>David B. Thrasher | Date |
| Director of Power System Engineering<br>Marvin D. Moon | Date |
| Manager of Real Estate<br>Reynan L. Ledesma | Date |

## VI. Project Background and Overview

The East Valley Baseball Park Infiltration System will infiltrate and retain water from local storm drain, MTD 117, and from the Tujunga Spreading Grounds (TSG) to mitigate flooding, improve downstream water quality, and increase water supply in the region. The infiltration system is approximately 4,000 feet long by 100 feet wide. The expected storage volume for this infiltration system will be approximately 60 acre-feet with total percolation rate of 17 cfs. Constructing the East Valley Baseball Park Infiltration System project would yield an estimated annual recharge benefit of 174 acre-feet annually from local runoff and the potential to capture another 575 acre-feet through the TSG. Stormwater from the local storm drain will be diverted through a diversion structure located in the north-west section of Strathern Park North. It will then travel through a hydrodynamic separator




as pretreatment before entering into the infiltration basins for groundwater recharge. The overflow will pass under Strathern Street located south of Strathern Park to Jamie Beth Slaven Park. If the system capacity is reached, the overflow will be diverted into the outlet box and back into MTD 117.


**Figure 1 – Project Location Overview**

Under the LADWP easements, construction of the Strathern Park Infiltration System must follow certain setback requirements to protect power infrastructure, which are as follows:

- Retain a 100-foot service radius around each tower.
- Retain a 10-foot service radius around each pole.
- Retain a 300-foot clearance around “dead-end” towers.

Pipe clearances from tower piers that are closer than those outlined will be sleeved inside of a pipe for a minimum distance of 60-ft from existing tower piers. New pipes will be designed to allow for H20 loading with the following distribution system clearance requirements:

- Retain a 10-foot service radius at existing ground level around each distribution pole.
- Provide a 20-foot service radius at existing ground level around each maintenance hole.

- Provide a 13-foot wide clear; unobstructed vehicle access to the overhead and underground systems for maintenance, repairs, upgrades, and cable pulling.
- Provide a 10-foot clear setback from the exterior of any underground distribution conduit or maintenance vault to the edge of any basin, swale, channel or other drainage feature.
- Maintain the existing cover between the top of the underground distribution conduit and the ground surface.

Three infiltration basins will be excavated with a surface area of approximately 9 acres and 10 feet deep with 2:1 side slopes. Surface drainage from the nearby neighborhoods drains approximately 320 acres, which delivers 20 acre-feet during a 1" storm. The infiltration basins will receive flow from the storm drain MTD 117 and from the TSG. Inflows from TSG will need to be controlled during storms to prevent overfilling. Any flows that exceed the storage capacity will flow back into MTD 117. The three basins will be internally linked with pipes connecting each adjacent basin. These reinforced concrete pipes (RCP) will have various diameters.

Connecting the system to TSG will allow the system to receive water from releases at Big Tujunga and Hansen Dams, increasing supply to the proposed system. The connection provides additional storage and infiltration down gradient from the retired landfill. High groundwater levels in this area cause gas intrusion at Francis Polytechnic Senior High on Roscoe Boulevard.

## VII. Project Justification

The San Fernando Valley Groundwater Basin supplies approximately 10% of the City of Los Angeles' drinking water. Supply levels in the groundwater basin have been in decline for several decades due to insufficient recharge. Strathern Park Infiltration System is located within the San Fernando Valley Groundwater Basin and stormwater captured from MTD 117 and TSG will help mitigate downstream flooding and aid in groundwater recharge. This project will support LADWP's stormwater capture goals adopted in the 2010 Urban Water Management Plan (UWMP).

## VIII. Project Description

### 1. Hydraulic Criteria

Approximately 9.1 acres will be utilized for the construction of the infiltration basins. The Project's tributary area includes the approximate 9.1-acre project area, a local tributary area of 320 acres, and an upstream watershed of over 150 square miles tributary to TSG. Project components are sized based on site constraints such as current land use, clearance on the power line towers, and the estimated percolation rate of two and a half feet per day. The basins will have a 2-foot freeboard, and will be operated with a maximum depth over the outflow weir of 1 foot. The system outflow capacity will equal the inflow capacity to prevent basin overtopping and flooding in the surrounding neighborhoods.

## 2. Project Location

The East Valley Baseball Park Infiltration System is located within the Tujunga Watershed, in the North Hollywood neighborhood of the Sun Valley. The project area will be parallel to the SR-170 freeway, south of the TSG and north of Blythe Street. Refer to Figure 1 to view the project location.

## 3. Project Layout

Figures 2 through 4 demonstrate the conceptual layout of the proposed project.

**Figure 2 - Conceptual Project Layout Page 1**

**Figure 3 – Conceptual Project Layout Page 2**

**Figure 4 – Conceptual Project Layout Page 3**

## 4. Project Details

Design and construction of all elements should adhere to all constraints detailed in the *East Valley Baseball Park Infiltration System Stormwater Capture Study Conceptual Study Report* (Attachment 1). Substructures located within the system are to be designed to withstand a combined weight of 40,000 pounds in accordance with the American Association of State and Highway and Transportation Officials H20-44 (M18). All infiltration basins are to be designed to completely infiltrate within 48-72 hours following a storm event and should be sized accordingly.

The East Valley Baseball Park Infiltration System will consist of the construction of three infiltration basins. The infiltration basins will receive and retain stormwater from TSG Basin 17 and local flows from the neighboring tributary area. Construction of the infiltration basins in the Easement will include the installation of a diversion box, inlets, weir box outlets, riprap aprons, reinforced concrete pipes (RCP), hydrodynamic separator unit, flow measuring devices, landscaping, educational signage, and will be 10 feet deep. Modifications to storm drain MTD 117 will divert and pre-treat tributary flows from the local drainage area.

### a. Storm Drain and Catch Basin Modification

Stormwater flows from the local tributary area will be captured by modifying storm drain line MTD 117. Portions of MTD 117 line running from Cantara Street to Blythe Street will be modified to divert tributary flows from the streets to the recharge basins. The systems will collect runoff from the 320-acre tributary area. The hydrodynamic separator unit will act as a pretreatment system to capture sediment and/or debris, before it reaches the recharge basins.

### b. Infiltration Basins

To construct the infiltration basins, the site will be graded to create three basins, requiring excavation of 130,000 cubic yards of material. The trapezoidal recharge basins will be 10 feet deep, with 2:1 side slopes on all sides. Grading will consist of shaping the surfaces to planned grades and will smooth out side slopes and corners. A vegetated buffer will surround the perimeter of the recharge basins and will be used as pretreatment for any local flows before entering the basins, help prevent erosion, and provide aesthetics.

Recharge Basin 1 will receive stormwater overflow from TSG Basin 17. The Los Angeles County Flood Control District (LACFCD) operates the TSG under an operations and maintenance agreement with LADWP. The agreement may require changes based on addition of the system. A summary of the infiltration basin area and water storage volume is presented in Table 1.

| Table 1: Infiltration Basin Area and Water Storage Volume | | |
|---|---|---|
| **Basin** | **Basin Area (Acres)** | **Water Storage Volume (Acre-Feet)** |
| 1 | 1.0 | 5.7 |
| 2 | 4.6 | 30.9 |
| 3 | 3.5 | 20.9 |
| **Project Total** | 9.1 | 57.5 |

c. Reinforced Concrete Pipes

Basins outlets will be connected to downstream basins via RCP that will vary in size as indicated in Table 2. Two lines will be jacked between basins to minimize cost. Water will enter through an inlet, which will be located at the northern end of each basin. Each inlet will be protected from scour using ½ ton riprap to prevent surface scouring.

| Table 2: Basins RCP Approximate Size | | |
|---|---|---|
| **Basin** | **RCP Size (Inches)** | **Q (cfs)** |
| 1 | 45" | 30 |
| 2 | 45" | 60 |
| 3 | 60” | 60 |
| 3 to MTD 117 | 36” | 220 |

d. Weir Boxes

Weir boxes with gates for drainage will be installed at the southern end of each basin. The weir boxes will pond water for storage and infiltration, while the gates allow drainage for emergency maintenance or advanced basin operation. The weir boxes will be equipped with water flow measuring devices to monitor flow. Weir boxes will have approximate dimensions of 7 feet high, 10 feet wide and 10 feet deep. The location of RCP, inlets, riprap, and weir box outlets will be determined based on the restrictions presented in pages 8 and 9 and as shown in Figures 3 through 5.

While the system appears to be in a viable location for groundwater recharge, several uncertainties exist. These uncertainties include percolation rates and potential impacts to adjacent residential properties due to groundwater mounding.

## IX. Environmental Documentation

Preparation of a Mitigated Negative Declaration (MND) may be required for the Project. If required, the LADWP Environmental Affairs Divisions will prepare the MND once the scope of work is finalized. If the initial study presents substantial evidence that the Project will present significant environmental impacts after mitigation measures are exhausted, LADWP Environmental Affairs Division may prepare an Environmental Impact Report (EIR).

## X. Geotechnical Study

A geotechnical study has not been conducted for the project. The LADWP Geotechnical group will perform a soil analysis of the site to determine soil classification, percolation rates, and determine whether contamination is present and the results will be provided in a geotechnical report.

## XI. Related Projects

Tujunga Spreading Grounds

TSG modifications include basin and intake improvements. The improvements have the potential to increase the estimated annual recharge up to 8,000 acre-feet. Modifications include the consolidation of 20 basins into nine deeper, larger basins and one bypass basin that would increase the storage capacity from 100-acre-feet to 790 acre-feet. Inter-basin flashboard structures will be replaced with concrete overflow structures, drains, and electric motor gates. The most significant improvement proposed is changing the existing intake into a low-flow intake and adding the following facilities:

- One located just downstream of the 5/170 freeway interchange on Tujunga Wash
- One downstream that would enable flows from Pacoima Diversion Channel to be diverted into the spreading grounds

Both intake facilities would require rubber dams and slide gates, increasing the maximum intake capacity from 250 cfs to 450 cfs.

## XII. Codes, Regulations, Permits and Approvals

The new facilities shall meet the requirements of all applicable regulations, codes, permits and approvals. The permits required for this project will be determined during design. Permits could potentially include, but are not limited to the following:

**1. City of Los Angeles, Department of Building and Safety Permits**

- o Grading
- o Plumbing
- o Demolition

**2. City of Los Angeles Fire Department**

- o Risk Management Plan

3. **City of Los Angeles, Department of Public Works, Bureau of Engineering**
    - Excavation and Class ‘A’ Permanent Resurfacing Permit

4. **City of Los Angeles, Bureau of Sanitation**
    - Industrial Waste Permit

5. **City of Angeles, Department of Transportation**
    - Traffic Control Plan or WATCH Manual

6. **City of Los Angeles, Planning Department**
    - Conditional Use Permit
    - Cultural Affairs

7. **State of California, Regional Water Quality Control Board**

8. **County of Los Angeles, Department of Public Works, Flood Control**

## XIII. Elected Officials

Honorable Eric Garcetti, Mayor of the City of Los Angeles
Mr. Felipe Fuentes, Councilmember 7$^{th}$ Council District
Sheila Kuehl, Los Angeles County Supervisor 3$^{rd}$ District

## XIV. Public Access/Community Outreach

Open communication with key community groups and neighborhood councils should continue throughout the entire life of the project and should include regular updates as to the status of the project as well as key milestones.

Sun Valley Watershed Stakeholders:

- City of Los Angeles – Bureau of Sanitation,
- City of Los Angeles – Bureau of Street Services
- City of Los Angeles – Recreation and Parks
- Los Angeles County Flood Control District
- LADWP
- US Army Corps of Engineers
- TreePeople
- LA Trails Project
- The River Project
- East Valley Coalition
- Sun Valley Area Neighborhood Council
- Arleta Neighborhood Council
- Mission Hills Neighborhood Council
- Council for Watershed Health

- County of Los Angeles Supervisor District 3
- City of LA Council District 6
- Area Residents

## XV. Baseline Division of Responsibilities

Project Management will determine division responsibilities and prepare a work breakdown structure, which will include the following work groups.

### 1. Water Engineering and Technical Services Division

The Water Engineering and Technical Services Division will be responsible for Project Management to oversee and coordinate all phases of design and construction including obtaining the proper permits, Project Design which includes generating a set of plans for 30, 60 and 90 percent review and approvals, and Construction Management to administer all negotiations with chosen contractor. Construction will be completed either in house by the Integrated Support Services Division or contracted out, this still needs to be determined.

### 2. Water Operations Division

The Water Operations Division will be responsible for operation and maintenance of the basins. Debris removal in the basins, pretreatment devices, culverts and swales will be necessary prior to the beginning of storm season and after each storm event to ensure effectiveness of the project. See Section XVII for estimated operation and maintenance costs and labor required. It is expected that an operations agreement will be needed with the Los Angeles County Flood Control District to have water diverted from TSG into the Strathern Basins.

### 3. Watershed Management Group of Water Resources Division

The Watershed Management Group will be responsible for the planning phase, which focuses on the development of the project's concept. It will involve outlining the tasks and responsible groups who will perform the work, obtain management approvals, risk management and legal approvals and ensure the project follows deliverables to completion.

### 4. Power System Engineering Division

The Water Engineering and Technical Services Division will coordinate with the Power System Engineering Division during the design phase to ensure design constraints of all elements related to overhead and underground distribution and transmissions lines are met. The constraints include, but are not limited to, the details in the East Valley Baseball Park Infiltration System Stormwater Capture Report (Conceptual Study Report, Attachment 1).

### 5. Power System Transmission and Distribution Division

The Water Engineering and Technical Services Division will coordinate with the Power System Transmission and Distribution Division during the construction phase to ensure construction of all elements related to overhead and underground distribution and transmissions lines are met. The constraints include, but are not limited to, the details in the Conceptual Study Report, Attachment 1.

### 6. Integrated Support Services Division

The Integrated Support Services Division will be responsible for the construction of the project, if construction is determined to be completed in house by the Water Engineering and Technical Services Division.

### 7. Real Estate Group of Operations Support Services Division

The Real Estate Group will be responsible for vacating the portions of the property that are presently occupied by nurseries through relocation or termination of nursery leases.

## XVI. Project Schedule

| | |
|---|---|
| Planning | Early 2015 |
| Environmental | Late 2016 |
| Engineering and Design | Early 2018 |
| Advertise (Out to Bid) | Mid 2019 |
| Award | Mid 2019 |
| Construction | Late 2019 |
| Completion | Mid 2021 |

## XVII. Project Budget, Cost Estimates, and Fund Opportunities

Construction of the project will begin when construction funds are secured at a later time. The project budget, preliminary cost estimates and potential funding opportunities are summarized below.

### 1. Work Order Information

Title: East Valley Baseball Park Infiltration System Stormwater Capture Project

| | |
|---|---|
| Functional Item | TBD |
| Job Number | TBD |
| Parent Work Order | TBD |
| Planning | TBD |
| Design | TBD |
| Construction | TBD |

## 2. Preliminary Cost Estimate

| Table 3: Preliminary Project Cost Estimate | | | | | |
|---|---|---|---|---|---|
| ITEM NO. | ITEM | APPROX.QTY | Unit | UNIT PRICE | Total |
| **MISCELLANEOUS** | | | | | |
| 1 | Mobilization (10% Max of Contract Bid) | 1 | LS | $2,413,000 | $2,413,000 |
| 2 | Contingency (30% Construction Cost) | 1 | LS | $804,000 | $804,000 |
| 3 | Inflation ( @ 3% per year for 5 years) | 1 | LS | $1,207,000 | $1,207,000 |
| **DEMOLITION** | | | | | |
| 4 | Demo of Existing Sidewalk | 40,000 | SF | $3 | $120,000 |
| 6 | Clearing and Grubbing | 396,000 | SF | $5 | $1,980,000 |
| **CONSTRUCTION** | | | | | |
| 7 | Diversion Structure | 1 | EA | $23,000 | $23,000 |
| 8 | Excavation | 129,000 | CY | $6 | $774,000 |
| 9 | Soil Export | 129,000 | CY | $25 | $3,225,000 |
| 10 | Inlet Structures | 3 | EA | $500 | $1,500 |
| 11 | 1/2 ton Riprap | 4,000 | CY | $110 | $440,000 |
| 12 | Reinforced Concrete Pipe | 6,000 | LF | $150 | $900,000 |
| 13 | CDS Unit | 1 | EA | $100,000 | $100,000 |
| 14 | Weir Box | 4 | EA | $15,000 | $60,000 |
| 15 | Passive recreation (walking paths) | 127,000 | SF | $4 | $508,000 |
| 16 | Educational signage | 16 | EA | $3,000 | $48,000 |
| | | | | **Cost Estimated Total** | **$12,603,500** |

## 3. Estimated Operation and Maintenance Costs

Annual operation and maintenance (O&M) costs were estimated using baseline data on a per acre-foot cost provided by LACDPW. LACDPW provided the recharge basins operational costs of $317 per acre-foot of facility capacity using 2007 data. With inflation operational costs for the recharge basins is calculated to be $364 per acre-foot of facility capacity. The total anticipated O&M is approximately $20,384 per year.

### 4. Funding Opportunities

To secure funds for the project, a number of funding opportunities exists. These opportunities exists from partnership opportunities with local agencies to help share project cost, to submitting application for grants and loans to provide the needed financial assistance to initiate the project. Additional information regarding funding opportunities is provided in the East Valley Baseball Park Infiltration System Stormwater Capture Conceptual Study Report found in Attachment 1.

## XVIII. Risk Assessment

Potential risk factors that may influence design and construction schedules include: community involvement, coordination with other projects (in-house or otherwise), permit processing, environmental considerations regarding the wash, geotechnical investigations, changed field conditions, unknown impacts to adjacent residential properties due to potential groundwater mounding, unknown infiltration rates, close proximity to existing electrical towers and power distribution facilities within the Easement, and etc.

## XIX. Safety

The East Valley Baseball Park Infiltration System Stormwater Capture Project including planning, design, installation, and in-service phases, shall conform to safety regulations, especially those from the Division of Occupational Safety and Health, State of California (formerly CAL OSHA). In addition, during the design process, the Corporate Safety Group will be included in plan reviews and discussions to ensure safety is considered and incorporated in the design of the project.

ATTACHMENT 1
East Valley Baseball Park Infiltration System Stormwater Capture Project
Conceptual Study Report

# Old Pacoima Wash
# Stormwater Capture Study

## CONCEPTUAL STUDY REPORT



December 2014

*Prepared By:*

Los Angeles Department of Water and Power
Water Resources Division
Watershed Management Group

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## Tables



## Figures

## I. Introduction

The Los Angeles City Department of Water and Power (LADWP) and the Los Angeles County Flood Control District (District) are cooperatively working to complete various stormwater capture projects. These projects are designed to help alleviate localized flooding, recharge the groundwater basin, and improve downstream water quality in the San Fernando Valley. As part of the cooperative efforts of the City of Los Angeles Integrated Resource Plan, LADWP Urban Water Management Plan, and Water Quality Compliance Master Plan for Urban Runoff, the proposed Old Pacoima Wash Stormwater Capture project (Project) will help meet the objective of capturing and retaining stormwater for the region. The Old Pacoima Wash is located in the upper Tujunga Wash Watershed within the San Fernando Valley Groundwater Basin, as presented in Figure 1, near the northern bounds of the City of Los Angeles (City).

The Project will capture local stormwater runoff and flows from Pacoima Spreading Grounds (PSG) to supply additional recharge to groundwater reserves within the San Fernando Valley Groundwater Basin. Groundwater storage levels in the San Fernando Valley Groundwater Basin have been in decline for several decades. Lack of precipitation, combined with increased demand for water within the Los Angeles Region has created a strain on the water supply. The dwindling reserves of both groundwater and surface water stores are evidence that new water supply sources are needed to sustain the long-term reliability and utility of the groundwater basin and decrease the region's dependence on imported water supplies.

Currently, the intake limit of the PSG is 600 cfs. Flow exceeding this limit will cause flooding on Arleta Street as percolation at PSG is limited due to clay-rich lenses with low permeability that underlie the recharge area. The Project will serve as an extension to the PSG, increasing intake potential and stormwater storage volumes.

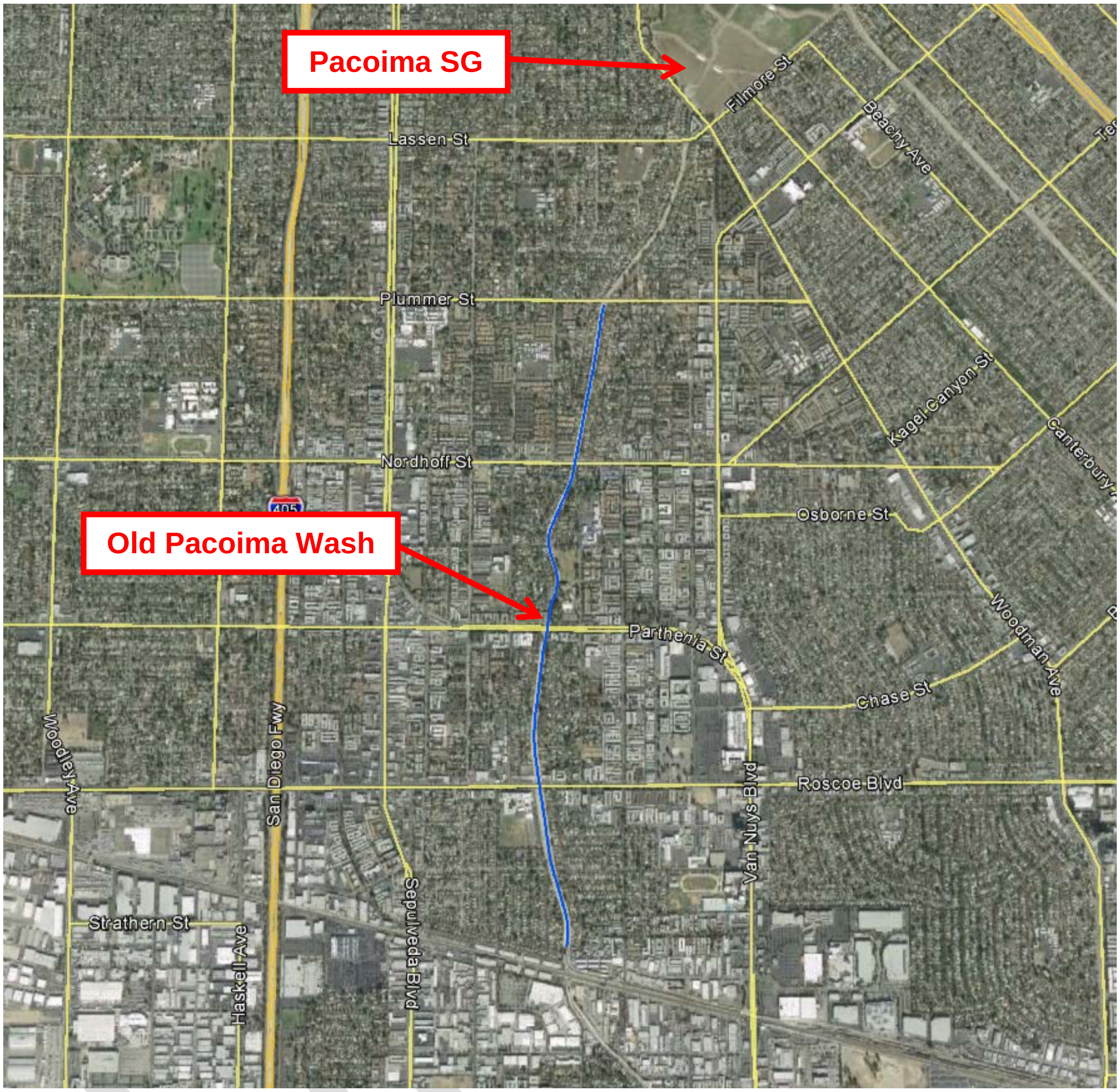


**Figure 1 – Location of Proposed Old Pacoima Wash Project Area**

## II. Project Site Background

Pacoima Wash is a 33-mile long tributary of the Tujunga Wash, which is a tributary of the Los Angeles River. The wash is located in the San Fernando Valley of Los Angeles County. The stream begins upstream from Pacoima Dam and Reservoir in the western San Gabriel Mountains of the Angeles National Forest. Once past the dam, it proceeds south in a free-flowing stream alongside Pacoima Trail Road. From there, it joins several other streams that drain the nearby mountains, collecting at Lopez Dam. South of Lopez Dam, Pacoima Wash is a concrete flood control channel that travels south from Kagel Canyon in Sylmar though San Fernando, Pacoima, Mission Hills, Panorama City, and Van Nuys. Just after the junction of the Interstate 5 and 118 Freeways, the stream flows to the Pacoima Spreading Grounds with a diversion towards Tujunga Wash known as the Pacoima Diversion Channel.

Prior to the construction of the Pacoima Diversion Channel and the Pacoima Spreading Grounds, the Old Pacoima Wash was the natural waterway for stormwater flows emanating from the upper Tujunga Watershed. The proposed Project will be approximately 2 miles long and will be situated along the existing Old Pacoima Wash; bordering Plummer Street to the north and right before the wash divergence at Marson Street to the south, as depicted in Figure 1.

From the spreading grounds to Plummer Street, the channel is buried as an 81" reinforced concrete pipe (RCP) that transitions to an 84" RCP. From Plummer to Parthenia Street, the 5,700 feet-long portion of the channel is a trapezoidal concrete lined channel varying in width from 28 feet to 47 feet. From Parthenia Street to Cabrito Road, the 4,700 foot-long portion of the channel becomes rip-rap bottom trapezoidal channel varying in width from 48 to 75 feet with concrete lined banks. There are drop structures for energy dissipation located throughout this reach. This portion of the channel is owned by US Army Corp of Engineers, and operated and maintained by the District. Old Pacoima Wash continues to Van Nuys Boulevard and is carried through a storm drain to join Tujunga Wash further south. The average annual rainfall for the area is 16 inches. The 50-year rainfall event is defined by the District to be 6.26 inches in a 24-hour period.

Existing facilities along the proposed project area include the concrete channel, access roads, invert access ramps, local storm drain system outlets, and drop structures along Old Pacoima Wash. Land use for the surrounding area is predominately single-family residential homes with a mix of multifamily residences. Other uses surrounding the wash include open space, and commercial facilities. At the end of the project area of the wash, industrial facilities were observed. Figure 2 below presents an analysis comparing the land use composition surrounding Old Pacoima Wash.

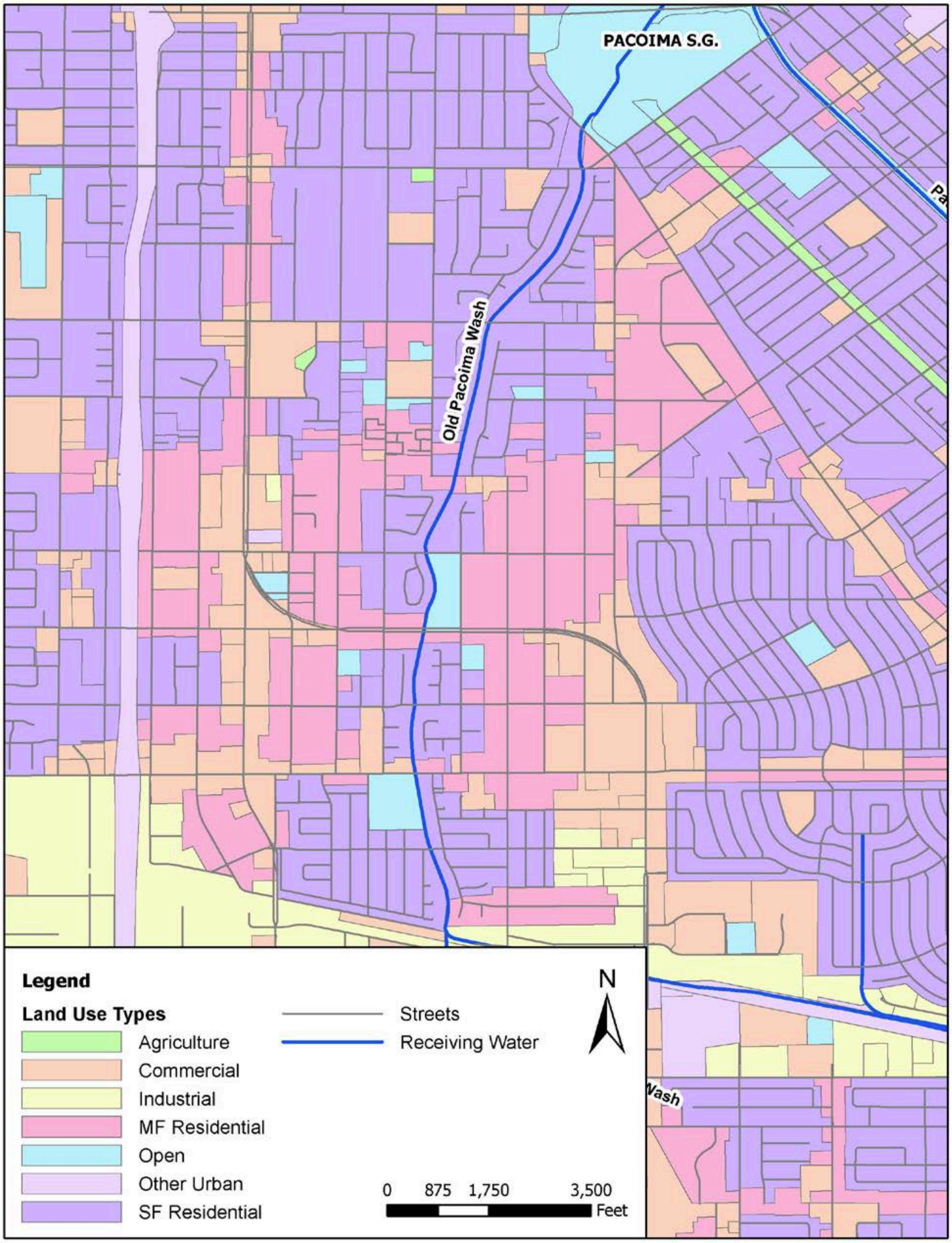


**Figure 2 – Land Use Surrounding Old Pacoima Wash**

The 2006 Los Angeles County Department of Public Works (LACDPW) Hydrology Manual provided the soil types and runoff coefficients for the study area. The soil types for Old Pacoima Wash, as presented in Figure 3, consist predominately of Hanford Fine Sandy Loan (HF) throughout the wash with a small concentration of Hanford Gravely Sandy Loam (HG) near the upstream portion of the wash. The runoff coefficients reported at 1 inch/hour for these soil types are 0.46 for HF and 0.28 for HG. Based on these runoff coefficients, infiltration rates for HG soil would be the highest and HF would be the lowest along the wash. The soil type numbers and runoff coefficients for the Project area are presented in Table 1.

**Table 1: Old Pacoima Wash Project Area Soil Types**

| Soil Type Number | Name | Original Name | Runoff Coefficient at 1"/hr |
|---|---|---|---|
| 005 | Hanford Fine Sandy Loam | HF | 0.46 |
| 007 | Hanford Gravely Sandy Loam | HG | 0.28 |

The average infiltration rate of the PSG, Hansen Spreading Grounds, and Tujunga Spreading Grounds is 1.3 inches/hour, or 2.5 feet/day. When completed, the Old Pacoima Wash infiltration basins would add an approximate water storage volume of 67 acre-feet, with total percolation rate of 9 cfs.

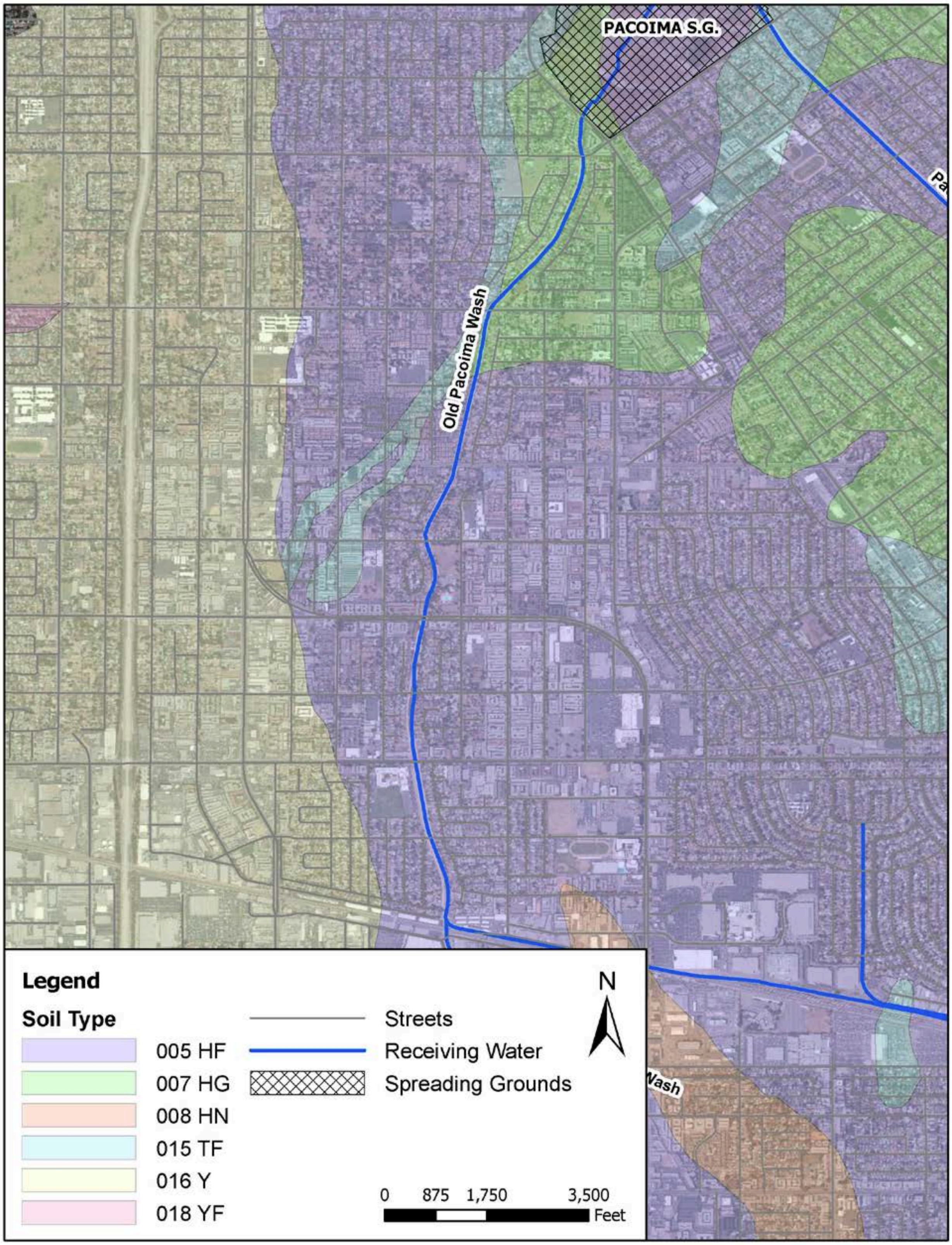


**Figure 3 – Soil Type Surrounding Old Pacoima Wash**

## III. Goals & Objective

The objective of the Old Pacoima Wash stormwater capture project is to determine the feasibility of capturing, retaining and infiltrating local stormwater runoff by constructing multiple in-channel recharge basins to meet the following goals:

- Help alleviate flooding in the area;
- Recharge the groundwater basin;
- Improve stormwater quality at downstream water bodies; and
- Incorporate green space amenities for the neighboring community.

These goals are designed to increase groundwater recharge within Tujunga Wash Watershed while maintaining or enhancing flood protection.

## IV. Project Summary

Approximately two miles of Old Pacoima Wash will be modified for the construction of multiple infiltration basins. Each infiltration basin will receive and retain stormwater from upstream PSG, and will act as an extension of the spreading grounds. Local flows will also be captured and will require modifications to storm drain lines and approximately 600 catch basins will need to be retrofitted with trash screens, if these modifications have not been completed under the *City of Los Angeles Trash TMDL Compliance Method: Structural Measures, Bureau of Sanitation Watershed Projection Division, September 2011*. Modification to Old Pacoima Wash will include the removal of the bottom concrete invert section of the wash for infiltration, installation of the rubber dams situated on a concrete pad for retention, cutoff walls, and stilling basins downstream of each rubber dam to provide scour protection.

The PSG is owned and operated by the District. Old Pacoima Wash is owned by the US Army Corps of Engineers and maintained by the District. It is expected that funding arrangements will be required for construction and potentially for maintenance. Stormwater exiting from PSG and local runoff will enter the wash through inlet structures and into the infiltration basins formed by the rubber dams. Stormwater received from the spreading ground will be from Basin 5 or 12. Flows captured from the neighboring tributary area will be diverted from the streets to catch basins with trash screens.

Stormwater infiltration will be determined by the District. For small storms, it is expected that the basins will either be filled from the downstream to the upstream end by raising dam sequentially as downstream basins fill. In order to dry some basins for maintenance or vector issues, a filling pattern from upstream to downstream can be completed with water from PSG. Having the system automated and on telemetry will improve stormwater capture and operations. Figure 4 through Figure 5, show the conceptual layout of the proposed project. All rubber dams and stilling basins will be sized to pass the design flows for the channel with the dams in the deflated position.

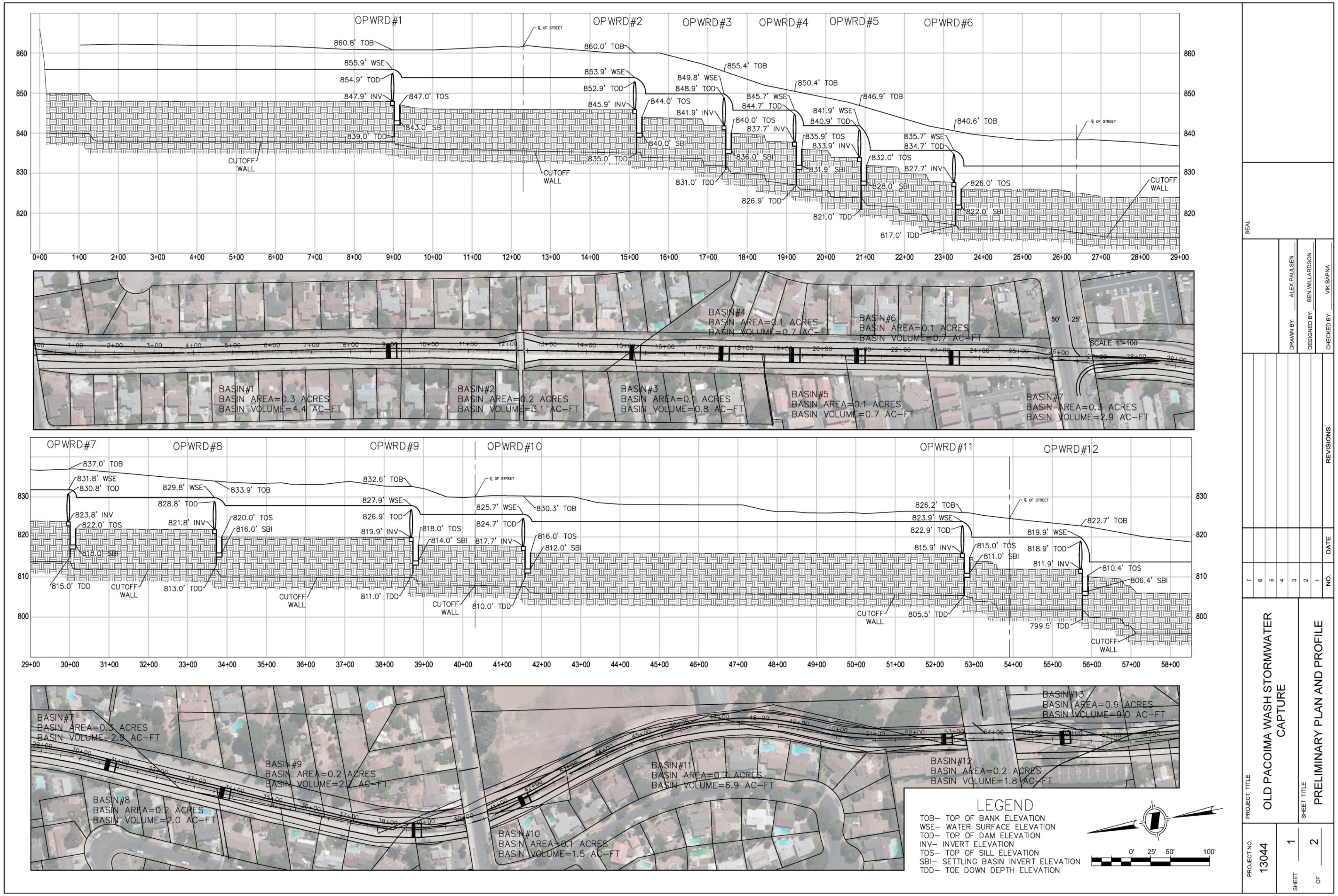


**Figure 4 - Conceptual Project Layout Page 1**

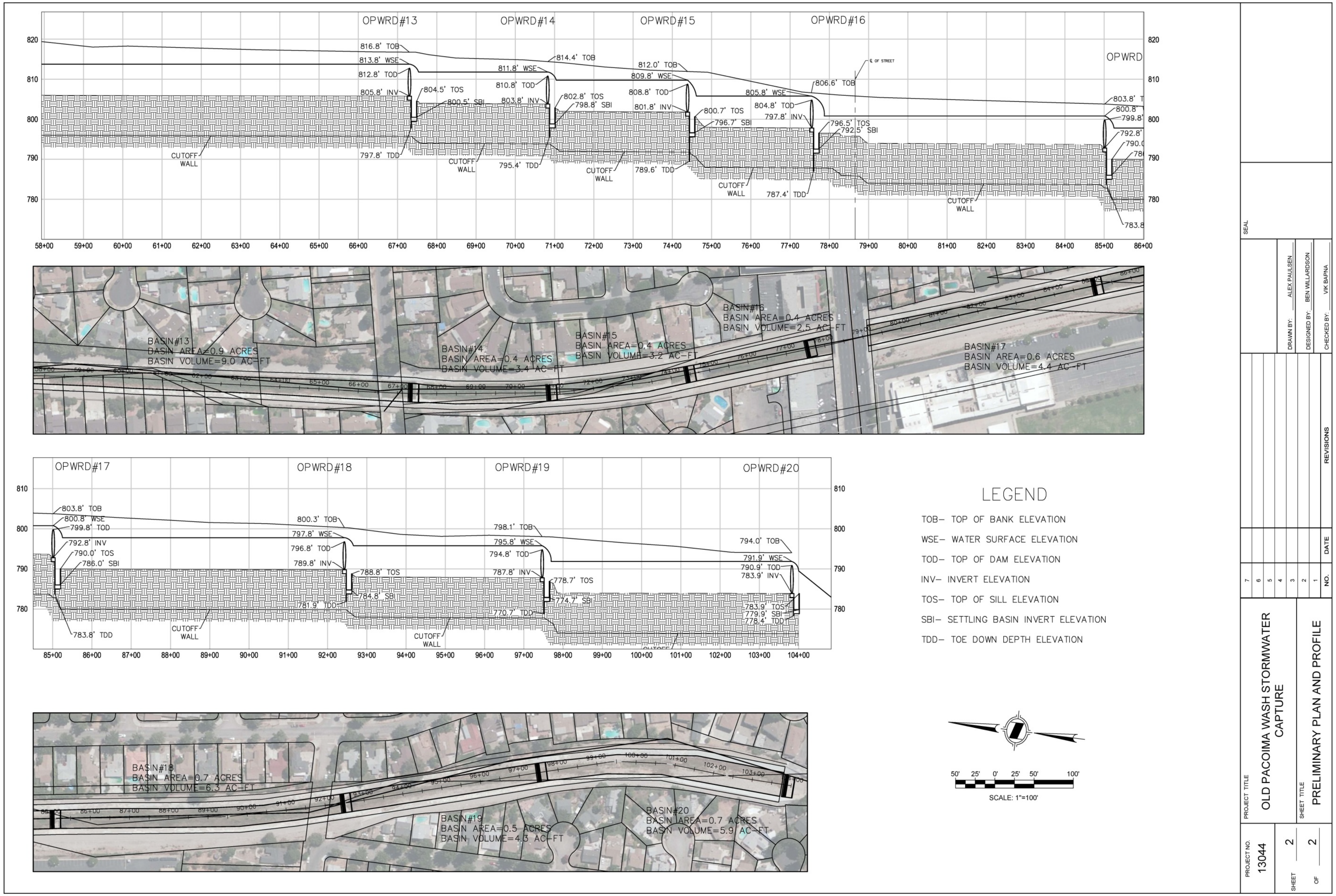


**Figure 5 - Conceptual Project Layout Page 2**

Constructing the Old Pacoima Wash infiltration basins project would yield an estimated annual recharge benefit of 350 acre-feet annually from local runoff and the potential to capture another 1,000 acre-foot through the PSG. A summary of each recharge basins area and water storage volume is presented in Table 2.

**Table 2: Infiltration Basin Area and Water Storage Volume**

| Basin | Basin Area (Acres) | Water Storage Volume (Acre-Feet) |
|---|---|---|
| 1 | 0.3 | 4.4 |
| 2 | 0.2 | 3.1 |
| 3 | 0.1 | 0.8 |
| 4 | 0.1 | 0.7 |
| 5 | 0.1 | 0.7 |
| 6 | 0.1 | 0.7 |
| 7 | 0.3 | 2.9 |
| 8 | 0.2 | 2.0 |
| 9 | 0.2 | 2.7 |
| 10 | 0.1 | 1.5 |
| 11 | 0.7 | 6.9 |
| 12 | 0.2 | 1.8 |
| 13 | 0.9 | 9.0 |
| 14 | 0.4 | 3.4 |
| 15 | 0.4 | 3.2 |
| 16 | 0.4 | 2.5 |
| 17 | 0.6 | 4.4 |
| 18 | 0.7 | 6.3 |
| 19 | 0.5 | 4.3 |
| 20 | 0.7 | 5.9 |
| Project Total | 7.2 | 67.2 |

The proposed infiltration basins will likely require amendments to the current PSG operation and maintenance procedures. Since this would be a new facility, operation and maintenance costs associated with sediment removal and additional surface area are expected to increase as compared to the existing operation costs at the PSG. All infiltration basins should be designed to completely infiltrate within 48-72 hours following a storm event and should be sized accordingly.

## V. Environmental Considerations

Environmental studies for this project have not been conducted and will be required prior to the start of construction. A Mitigated Negative Declaration (MND) or an Environmental Impact Report (EIR) may be required (upon approval of the Lead Agency) based on the findings of this study. LADWP Environmental Affairs Division will prepare the EIR as necessary. Potential environmental issues based on various environmental considerations are summarized in Table 3 and Figure 6 illustrates areas of potential environmental constraints for this project site.

**Table 3: Old Pacoima Wash Summary of Issues**

| Environmental Topic | Potential Issues | No Anticipated Issues | Comments |
|---|---|---|---|
| Land Use and Planning | | X | No issues are anticipated; however zoning regulations should be reviewed to confirm that the land use could be permitted. |
| Population and Housing | | X | No issues are anticipated. |
| Geology and Soils | X | | Additional studies for percolation rates would most likely be required. |
| Water | X | | Water quality measures (BMPs) will have to be employed during the excavation. |
| Air Quality | X | | Issues with air quality would be a concern primarily “during construction” activities (sediment removal, truck hauling). Post-construction air quality issues are not anticipated. |
| Transportation and Circulation | X | | Minor changes in transportation and circulation are anticipated. The need for traffic studies would be triggered on an import or export due to associated truck trips. The project is adjacent to residential neighborhood. Transportation issues are not anticipated upon the completion of construction since the site maintenance will generally not be increasing trips. |
| Biological Resources | | X | No biological resources are associated with the proposed activities given the existing nature of the project site. |
| Energy and Mineral Resources [1] | | X | No mineral resource issues are associated with the proposed activities given the existing nature of the project site. |
| Hazards | X | | Significant issues are not anticipated. Hazardous materials studies may be required to define on-site housekeeping practices. Sampling may be required once soils are excavated and prior to transfer. |
| Noise | X | | Noise is anticipated to be an issue during construction. Noise mitigation measures could be employed (i.e., hours of maintenance activities, buffers, etc.). It is anticipated that construction activities would occur during the daytime hours due to the close proximity of residential units. |
| Public Services | | X | Issues with existing public services are not anticipated. Increases in future public service activities would be required based on the proposed project. |

| Table 3: Old Pacoima Wash Summary of Issues | | | |
|---|---|---|---|
| **Environmental Topic** | **Potential Issues** | **No Anticipated Issues** | **Comments** |
| Utilities and Service Systems | X | | Since the project is located within an existing wash, it is unlikely that many utilities will be located within the area. |
| Aesthetics | | X | Given the existing conditions and land use, no issue with aesthetics is anticipated with the proposed project. |
| Cultural Resources | | X | Although no issues with cultural resources are anticipated, precautionary mitigation measures will be adopted in the event that cultural issues surface during construction. The primary concern with cultural resources is during excavation. A standard cultural resources report would identify any issues and potential mitigation measures to be employed. |
| Recreation | | X | The existing wash does not offer recreation opportunities, recreational uses are not anticipated given the nature of the wash. |

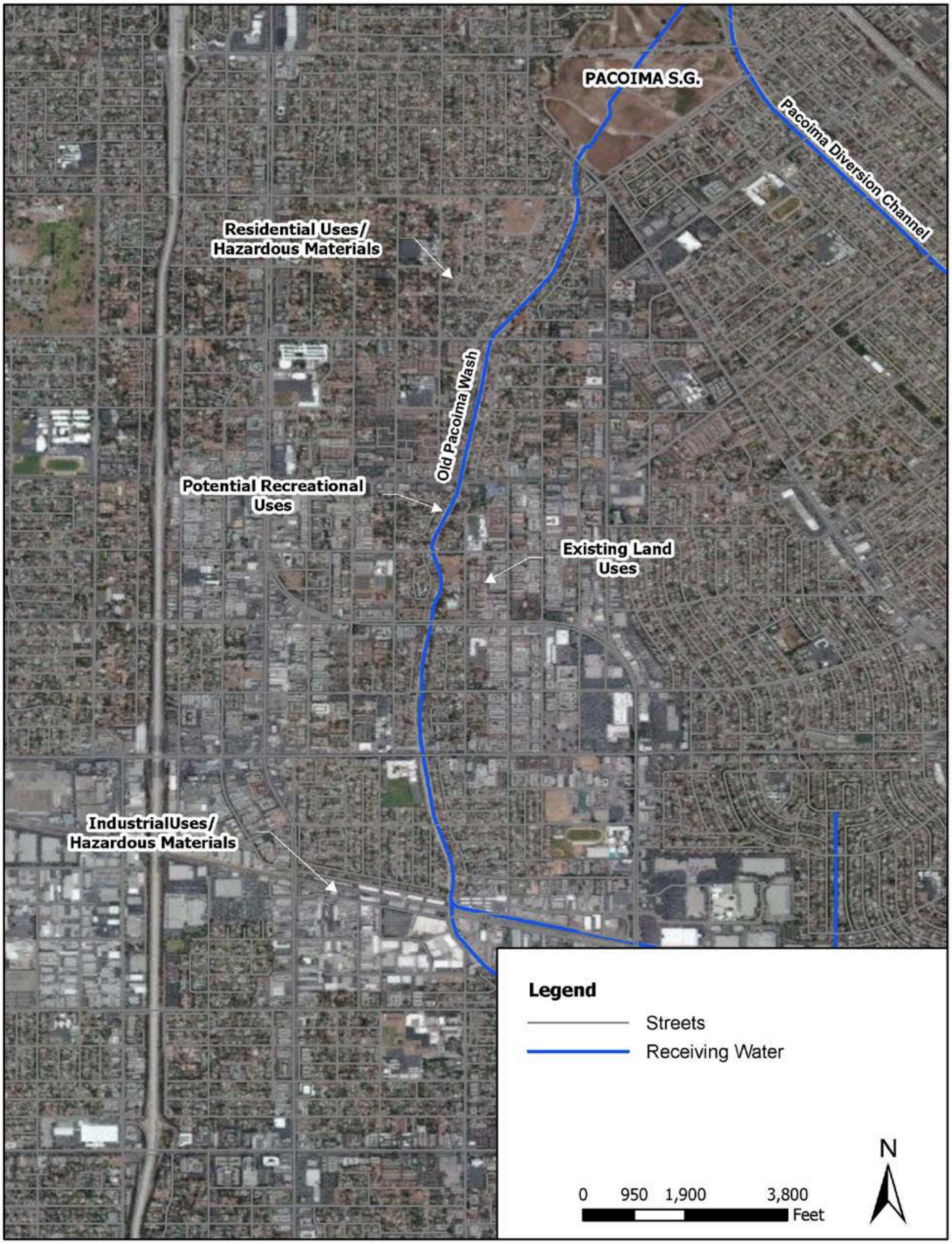


**Figure 6 - Potential Environmental Constraints**

## VI. Implementation Schedule

Construction of the Old Pacoima Wash infiltration basins is a new project, therefore, the planning and environmental phase includes all work done before design studies and plans are produced (design phase). The construction phase begins with advertising of the project for bid and concludes with project completion. The assumed start date is early 2017. Table 4 summarizes the overall project schedule.

**Table 4: Old Pacoima Wash Infiltration Basin Summary Schedule**

| Phase | Start Date | End Date |
|---|---|---|
| Planning/Environmental | Early 2015 | Early 2018 |
| Environmental | Early 2017 | Early 2019 |
| Engineering and Design | Early 2018 | Mid 2020 |
| Advertise (Out to Bid) | Mid 2019 | Late 2019 |
| Award | Late 2019 | |
| Construction | Early 2020 | Mid 2022 |

## VII. Cost Estimate

Various sources of information were used in the development of the preliminary cost estimate. The construction cost entails various components of the project that a contractor will construct. Standard engineering procedures were used to determine the preliminary cost estimate as presented in Table 5.

| ITEM NO. | ITEM | APPROX.QTY | Unit | UNIT PRICE | Total (2014 Dollars) |
|---|---|---|---|---|---|
| **MISCELLANEOUS** | | | | | |
| 1 | Mobilization (10% Max of Contract Bid) | 1 | LS | $8,559,000 | $8,558,600 |
| 2 | Contingency (30% Construction Cost) | 1 | LS | $2,853,000 | $2,852,900 |
| 3 | Inflation ( @ 3% per year for 5 years) | 1 | LS | $4,280,000 | $4,279,300 |
| **DEMOLITION** | | | | | |
| 4 | Demo of Existing Concrete Lined Wash Bottom | 11,630 | CY | $25 | $290,700 |
| **CONSTRUCTION** | | | | | |
| 5 | Excavation | 116,200 | CY | $6 | $698,000 |
| 6 | Cutoff Walls | 7,700 | CY | $520 | $4,004,000 |
| 7 | Concrete pads | 2,100 | CY | $520 | $1,092,000 |
| 8 | Rubber Dams | 20 | EA | $1,000,000 | $20,000,000 |
| 9 | Stilling Basins | 1,300 | CY | $520 | $676,000 |
| 10 | Passive recreation (walking paths) | 312,000 | SF | $4 | $1,248,000 |
| 11 | Educational signage | 40 | EA | $3,000 | $120,000 |
| 12 | Fencing | 10,510 | LF | $38 | $400,000 |
| | | | | **Cost Estimated Total** | **$44,219,500** |

Annual operation and maintenance (O&M) costs were estimated using baseline data on a per acre-foot cost provided by LACDPW. LACDPW provided the recharge basins operational costs of $317 per acre-foot of facility capacity using 2007 data. With inflation operational costs for the recharge basins is calculated to be $364 per acre-foot of facility capacity. Table 6 shows the cost estimate for the ROW project, which includes the present value of cost for 50 years at a 5% inflation rate.

**Table 5: Old Pacoima Wash Costs**

| Description | Cost (2014 dollars) |
|---|---|
| Construction | $44,219,500 |
| Annual O&M for recharge | $24,400 |
| Annual Aquifer Extraction | $0 |
| Present Value of Costs (5%, 50-years) | $49,326,000 |

The average annual infiltration volume of the Old Pacoima Wash infiltration basins for local runoff was estimated to average 350 acre-feet. The basins can also be used for spreading of stormwater after rainfall events end through the connection to PSG which receives water from Pacoima Dam and Reservoir. The District is planning to connect Bull Creek to the northern side of the PSG. Based on these sources, it is expected that another 1,000 acre-feet can be conserved annually with the additional facilities.

Based on the estimated average of annual recharge in the basins, a cost benefit analysis was conducted for the Project. With the demands for domestic water continuing to increase, the Tier 1 untreated 2012 rate of $560 per acre-foot was used for the cost benefit analysis. Assuming a 7% increase per year and an economic life of 50 years, the present estimated value of the 350 acre-feet is $91,226,000. With these costs estimates, the Project would produce a cost savings for the region.  Table 7 presented the benefit/cost ratio for the Old Pacoima Wash Stormwater Capture project.

**Table 6: Old Pacoima Wash Stormwater Capture Benefit/Cost Ratio**

| Description | Value (2014 dollars) |
|---|---|
| Present Value of Benefits | $91,226,000 |
| Present Value of Costs | $49,326,000 |
| Benefit/Cost Ratio | 1.85 |

In addition to cost savings and depending on several factors, the Old Pacoima Wash Project may incorporate open space attributes for the neighboring community such as a walking/biking trail. The project will also reduce energy costs related to water importation.

## VIII. Funding Opportunities

In order to implement the project, funds will need to be allocated which will be difficult even during a good financial year. Funding knowledge and experience has been used to identify viable funding opportunities to assist LADWP in implementing the Project.

### 1. Partnership Opportunities

The project areas average annual rainfall, allows for a full capture of a 50-year rainfall event. This qualifies the project as a regional project for the Enhanced Watershed Management Plan (EWMP), which may be a potential funding source for the construction of the project. Partnership with local agencies who may benefit for the construction of the Project

### 2. Grants and Loans

In order to implement the Project, LADWP will need some financial assistance. To receive financial assistance an application must be completed and specific eligibility requirements must be met. All assistance programs also provide a set of conditions and limitations. Financial assistance programs are available in two common forms, grants and loans. It is important to fully understand the differences, benefits, and drawbacks of each in order to determine which form of financial assistance is best the project.

Grants are awards of financial assistance, meaning the grant awardee is not required to return the money, although they may need to follow specific requirements and produce specific products. On the other hand, loans are awarded as a benefit or assistance, but the awardee is required to pay back the loan, often with interest. Table 8 below outlines the major differences between grants and loans.

**Table 7: Differences Between Grants and Loans**

| Grants | Loans |
|---|---|
| • No payback required;<br>• Typically complex application process;<br>• Highly competitive;<br>• Extensive reporting and oversight needed;<br>• Matching funds generally required;<br>• May favor larger/more expensive projects;<br>• Some require participation with an IRWM;<br>• Funding limits vary;<br>• Generally limited application periods; and<br>• Operate under agency-specific guidelines. | • Payback required;<br>• Relatively simple application process;<br>• May require getting on priority list;<br>• Repayment terms vary;<br>• Threshold eligibility criteria must be met;<br>• Tie-in with job creation with some programs;<br>• Different agencies have different requirements;<br>• Maximum amount financed can be large; and<br>• Generally continuous application periods. |

One of the major points outlined in Table 8 is the application and competition of grant programs versus loan programs. Grants often require extra work in addition to general work related to any project. Grants often require extra reports, and as mentioned, a more complex application process. Loans however have a relatively simple application process, less competition, and limited additional requirements that are often less complex. Grants will require extra work, but in return, free money is awarded. Both grant and loan financial assistance programs are outlined below.

**Proposition 84 (Chapter 2, §75026) Integrated Regional Water Management (IRWM) Grant Program**

| | |
|---|---|
| **Program Name:** | Proposition 84 (Chapter 2, §75026) IRWM |
| **Department:** | Department of Water Resources |
| **Type:** | Grant |
| **Purpose:** | Projects to assist local public agencies to meet long-term water management needs of the State, including the delivery of safe drinking water, flood risk reduction, and protection of water quality and the environment. |
| **Eligibility Requirements:** | Local public agencies or nonprofit representing an accepted IRWM Region |
| **Eligible Uses:** | Projects that implement IRWM Plans |
| **Ineligible Uses:** | Operation and maintenance activities |
| **Funding Limits:** | Bond funding allocation for entire program is $1 billion. Prop 84 allots grant funding to 11 funding areas. Each proposal solicitation package will have predetermined amount of funds available. |
| **Terms/Dates:** | 25% minimum cost share with waivers for DACs<br>Round 3 expected in Fall 2014 (approximately $130 million available for Los Angeles Funding Areas) |
| **Website:** | http://www.water.ca.gov/irwm/grants/guidelines.cfm |

IRWM is a collaborative effort to manage all aspects of water resources in a region. IRWM crosses jurisdictional, watershed, and political boundaries; involves multiple agencies, stakeholders, individuals, and groups; and attempts to address the issues and differing perspectives of all the entities involved through mutually beneficial solutions. A majority of projects funded through this grant program pertain to water supply, flood control, and habitat protection. Although some of these project types would not be applicable for the LADWP to implement in order to ensure stormwater compliance, there are some eligible project types that would coincide with LADWPs needs, including:

- Stormwater capture, storage, clean-up, treatment, and management;
- Non-point source pollution reduction, management, and monitoring;
- Groundwater recharge and management projects;
- Planning and implementation of multipurpose flood management programs; and
- Watershed protection and management.

**Clean Water State Revolving Fund Program**

| | |
|---|---|
| **Program Name:** | Clean Water State Revolving Fund Program |
| **Department:** | SWRCB |
| **Type:** | Financing (loan) |
| **Purpose:** | Provide funding for publically-owned facilities |
| **Eligibility Requirements:** | Public agencies and nonprofit organizations |

| | |
|---|---|
| **Eligible Uses:** | Stormwater treatment and diversions, sediment and erosion control, stream restoration, and land acquisitions |
| **Ineligible Uses:** | Operation and maintenance activities, legal fees |
| **Funding Limits:** | $50 million per agency per year |
| **Terms/Dates:** | Interest rate is one-half general obligation bond rate.<br>Repayment term of twenty years<br>Applications accepted continuously |
| **Website:** | http://www.waterboards.ca.gov/water_issues/programs/grants_loans<br>/srf/index.shtml |

Various projects within California have utilized this funding program. Some projects considered through this program include the City of Anaheim Sewer Reconstruction Project and the Eastern Municipal Water District Recycled Water Pond Expansion and Optimization Project. Other project types that are considered under this financing program include:

- Construction of publicly-owned facilities:
    - Wastewater treatment
    - Local sewers
    - Sewer interceptors
    - Water reclamation facilities
    - Stormwater treatment

- Expanded Use projects include, but are not limited to:
    - Implementation of nonpoint source projects or programs
    - Development and implementation of estuary comprehensive conservation and management plan

**Infrastructure State Revolving Fund (ISRF) Program**

| | |
|---|---|
| **Program Name:** | ISRF Program |
| **Department:** | California Infrastructure and Economic Development Bank |
| **Type:** | Loan |
| **Purpose:** | Provide financing for public infrastructure projects |
| **Eligibility Requirements:** | Applicant must be a local municipal entity<br>Project must promote economic development and attract, create, and sustain long-term employment opportunities |
| **Eligible Uses:** | Construct or modify public infrastructure, purchase and install pollution control or noise abatement equipment, or acquire land. Project must meet tax-exempt financing criteria. |

| | |
|---|---|
| **Ineligible Uses:** | Privately owned facilities or debt refinancing |
| **Funding Limits:** | $2 million maximum per environmental mitigation project per fiscal year<br>$10 million maximum per project for all other purposes per fiscal year<br>$20 million per jurisdiction per fiscal year |
| **Terms/Dates:** | Maximum 30 year term and open application process<br>Preliminary application available at www.ibank.ca.gov |
| **Website:** | http://ibank.ca.gov/infrastructure_loans.htm |

This program provides low-cost, long-term financing to local governments for a variety of public infrastructure projects.

### Supplement Environmental Project (SEP) Funds

| | |
|---|---|
| **Program Name:** | SEP Funds |
| **Department:** | EPA |
| **Type:** | Violation Reduction |
| **Purpose:** | Provide a fine reduction as part of a settlement of an enforcement action |
| **Eligibility Requirements:** | The project must improve, protect, or reduce risks to public health, or the environment at large. The project must also relate to the original violation. |
| **Eligible Uses:** | Improvement to public health, pollution prevention through source reduction, environmental restoration and protection, environmental compliance promotion, and emergency planning and preparedness. |
| **Ineligible Uses:** | Project not related to original violation |
| **Funding Limits:** | The amount of penalty mitigation is based on the cost of the SEP and whether or how effectively the SEP:<br>• Benefited the public or environment;<br>• Was innovative;<br>• Considered input from affected community;<br>• Reduced emissions to more than one media (e.g. air, land, water);<br>• Factored in environmental justice issues; and<br>• Implemented pollution reduction through source reduction. |
| **Terms/Dates:** | Continuously accept applications |
| **Website:** | http://ibank.ca.gov/infrastructure_loans.htm |

This program would benefit the City of Los Angeles (City) if any enforcement actions were taken against the City. This program assists with compliance and promotes action to fix current problems. One main goal of SEPs is to improve the environmental health of communities that have been put at risk due to the violation of an environmental law.

**2014 Water Bond**

| | |
|---|---|
| **Program Name:** | 2014 Water Bond (Proposition 1) |
| **Department:** | State of California |
| **Type:** | Grant |
| **Purpose:** | Provide funding for projects that ensure reliable water supply for future generations. |
| **Eligibility Requirements:** | Unclear at this time. |
| **Eligible Uses:** | Provide funding for projects must address regional water reliability, water storage capacity, water recycling, groundwater sustainability, safe drinking water, watershed projection, ecosystem restoration, state settlements, and flood management. |
| **Ineligible Uses:** | Unclear at this time. |
| **Funding Limits:** | $810 million on regional water reliability<br>$2.7 billion water storage capacity<br>$725 million water recycling<br>$900 million groundwater sustainability<br>$520 million safe drinking water<br>$1.5 billion watershed projection, ecosystem restoration, and state settlements<br>$395 million on flood management |
| **Terms/Dates:** | On the 2014 California ballot. |
| **Website:** | http://www.acwa.com/spotlight/2014-water-bond |

The 2014 Water Bond is the product of a comprehensive legislative package developed in 2009 by Governor Schwarzenegger and state lawmakers to meet California's growing water challenges. This package represented a major step toward ensuring reliable water supply for future generations as well as restoring the Sacramento-San Joaquin Delta and other ecologically sensitive areas.

## IX. Study Recommendations

The Old Pacoima Wash Stormwater Capture study has lead to several findings, which are summarized below:

- To evaluate project site conditions, a geotechnical study will need to be conducted. The study will consist of a soil analysis to determine soil classification, percolation rate, and determine whether contamination is present on site.
- Environmental studies for this project will need to be conducted prior to the start of construction to further evaluate the feasibility of the project.

Results from the implemented projects include:

- Reduced flooding during the capital storm event by as much as 9 cfs;
- Increased groundwater recharge by 350 acre-feet per year from local flow;
- Increased groundwater recharge by 1,000 acre-feet per year from flow through PSG;
- Cost savings to LADWP;
- Significant improvement to downstream water quality;
- Improved aesthetics and open space attributes surrounding Old Pacoima Wash and the surrounding area; and
- The project can be used as a regional project for the area EWMP, which may be a potential funding source.

# OLD PACOIMA WASH STORMWATER CAPTURE PROJECT

## SCOPE OF WORK DOCUMENT



August 2015

*Prepared By:*

Los Angeles Department of Water and Power
Water Resources Division
Watershed Management Group

## TABLE OF CONTENTS

## I. Title

**OLD PACOIMA WASH STORMWATER CAPTURE PROJECT**

Functional Item: **TBD**, Job No. **TBD**

## II. Project Objectives

To capture, retain, and infiltrate local stormwater runoff by exposing natural soils and installing inflatable rubber dams to construct infiltration basins along Old Pacoima Wash between Plummer Street to Cabrito Road.

## III. Project Team

| | |
|---|---|
| Project Management: | |
| Manager | TBD |
| | |
| Planning Phase: | |
| Manager | Andy A. Niknafs |
| | Eric M. Yoshida |
| | |
| Design Phase: | |
| Manager | Joseph J. Resong |
| Mechanical Design | John Otoshi |
| Electrical Design | Emmanuel Tan |
| Capital Improvement/Asset Management | Charles C. Ngo |
| Civil/Structural Design | Joseph J. Resong |
| Distribution Engineering | Alvin Z. Bautista |
| Geotechnical | Adam Perez |
| Geology | Clifford C. Plumb |
| Survey | Shereef Surur |
| Right-of-Way | Henry Bui |
| Property Management | Heidi K. Hiraoka |
| Water Transmission Operations | Linh T. Phan |
| Water Quality | Don Christie |
| Treatment Operations | Razmik O. Manoukian |
| Construction Specifications | David F. Neal |
| Environmental Assessment | Charles C. Holloway |
| Safety | Jaime F. Hernandez |
| Security Services | Eddy Allahverdian |
| Trunk Line | Craig A. Davis |

Construction Phase:

| | |
|---|---|
| Manager | Wayne A. Bamossy |
| Resident Engineer | TBD |
| Repair and Construction | Michael E. Grahek |
| Test Lab | Nancy A. Wigner |
| Plant Inspection | Vipin K. Wahi |
| Construction Support Team | TBD |

## IV. Approvals from Originating Organization

Senior Assistant General Manager – Water System Date
Martin L. Adams

Director of Water Operations Date
Richard F. Harasick

Director of Water Engineering & Technical Services Date
Susan R. Rowghani

Director of Water Quality Date
Albert G. Gastelum

Director of Water Distribution Date
Keith D. Session

Director of Water Resources Date
David R. Pettijohn

## V. Approvals

By signing this document, Power System approves the Scope of Work Document for the Old Paicoma Wash Stormwater Capture Project. Approval of this document is not to be construed as approval of design. Construction will not commence until Power System reviews and approves the design.

| | |
|---|---|
| Senior Assistant General Manager-Power System<br>Randy S. Howard | Date |
| Director of Power Supply Operations<br>Kenneth A. Silver | Date |
| Director of Integrated Support Services<br>David B. Thrasher | Date |
| Director of Power System Engineering<br>Marvin D. Moon | Date |
| Manager of Real Estate<br>Reynan L. Ledesma | Date |

## VI. Project Background and Overview

The Old Pacoima Wash Stormwater Capture Project will utilize existing Los Angeles County Flood Control District property to capture and infiltrate local stormwater runoff to recharge the San Fernando Groundwater Basin (SFB). The Old Pacoima Wash was the natural waterway for stormwater flows emanating from the upper Tujunga Watershed prior to the construction of the Pacoima Diversion Channel and the Pacoima Spreading Grounds. The proposed Project will be approximately 2 miles long and will be situated along the existing Old Pacoima Wash. The project will begin near Plummer Street on the north and terminate at Cabrito Road on the south, as depicted in Figure 1.

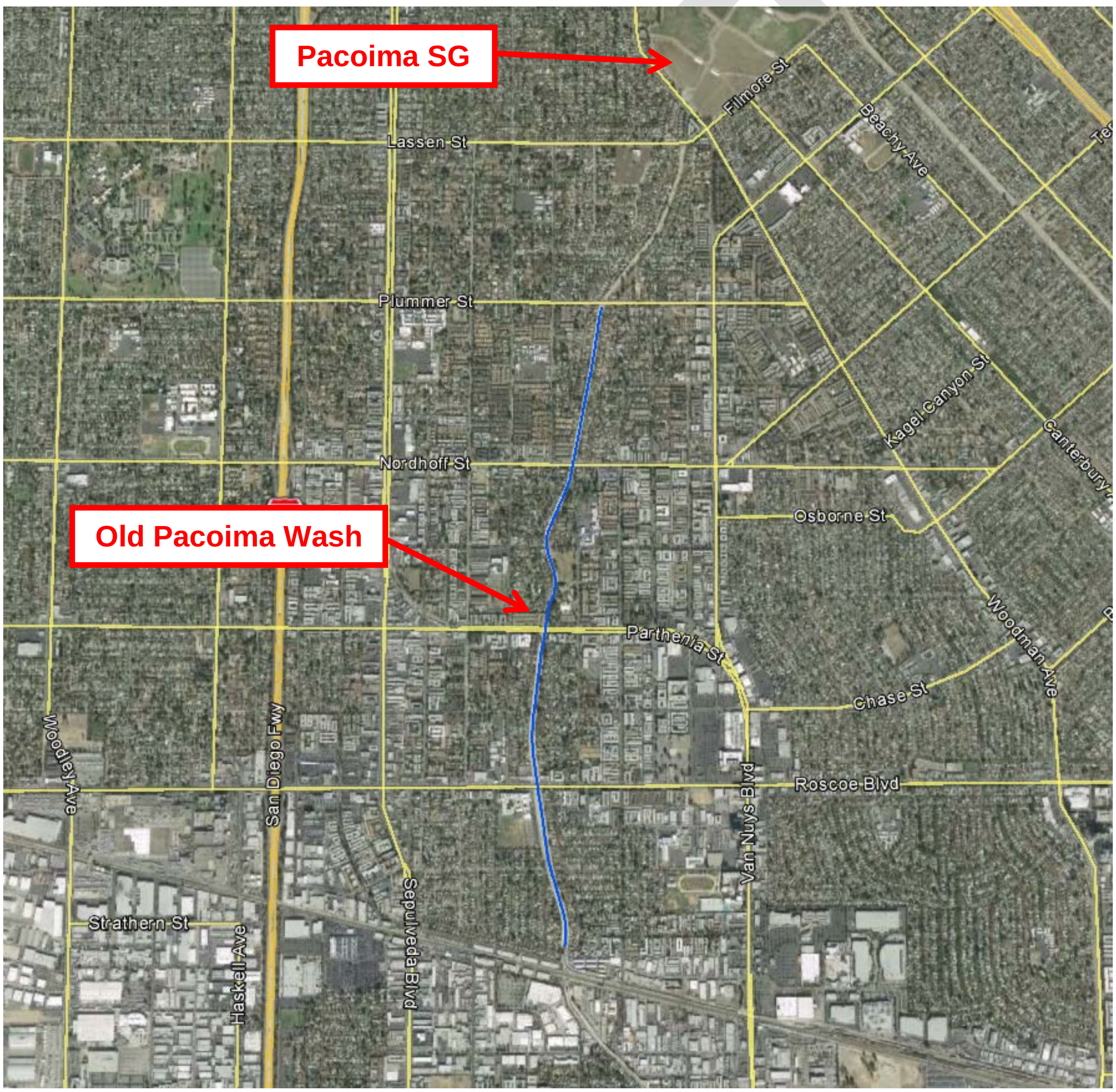


**Figure 1 - Project Location Overview**

The upstream portion of the channel from the spreading grounds to Parthenia Street is 8,600 feet-long and 40 feet wide at the bottom. It is concrete lined on the bed and banks. The downstream 4,700 foot-long portion of the Old Pacoima Wash, from Parthenia Street to Cabrito Road is rock bottomed, with concrete bank protection. There are drop structures for energy dissipation located throughout this reach. The channel is owned by US Army Corp of Engineers and operated and maintained by the Los Angeles County Flood Control District (District).

Existing 5,700 foot-long concrete invert portions of the channel will be removed, exposing natural soils, and allowing local runoff and flows from PSG to percolate. An infiltration test will be needed to determine whether the 4,700 foot-long rip-rap bottom portion of the channel allows for sufficient infiltration in the current condition. If the test determines the current condition is not sufficient, this portion of the channel will also be modified to allow for sufficient infiltration. Each of the local drainage systems that collects stormwater flows from the tributary area will pass through catch basin screen inserts for pretreatment before entering into the infiltration basins for groundwater recharge.

The Old Pacoima Wash Stormwater Capture Project will be designed as an in stream infiltration system by installing rubber dams on drop structures throughout the entire reach, as presented in Figure 2. With the length of the wash and the assumed depth of 7 feet, the proposed improvements are expected to have a storage capacity of 67.2 acre-feet.

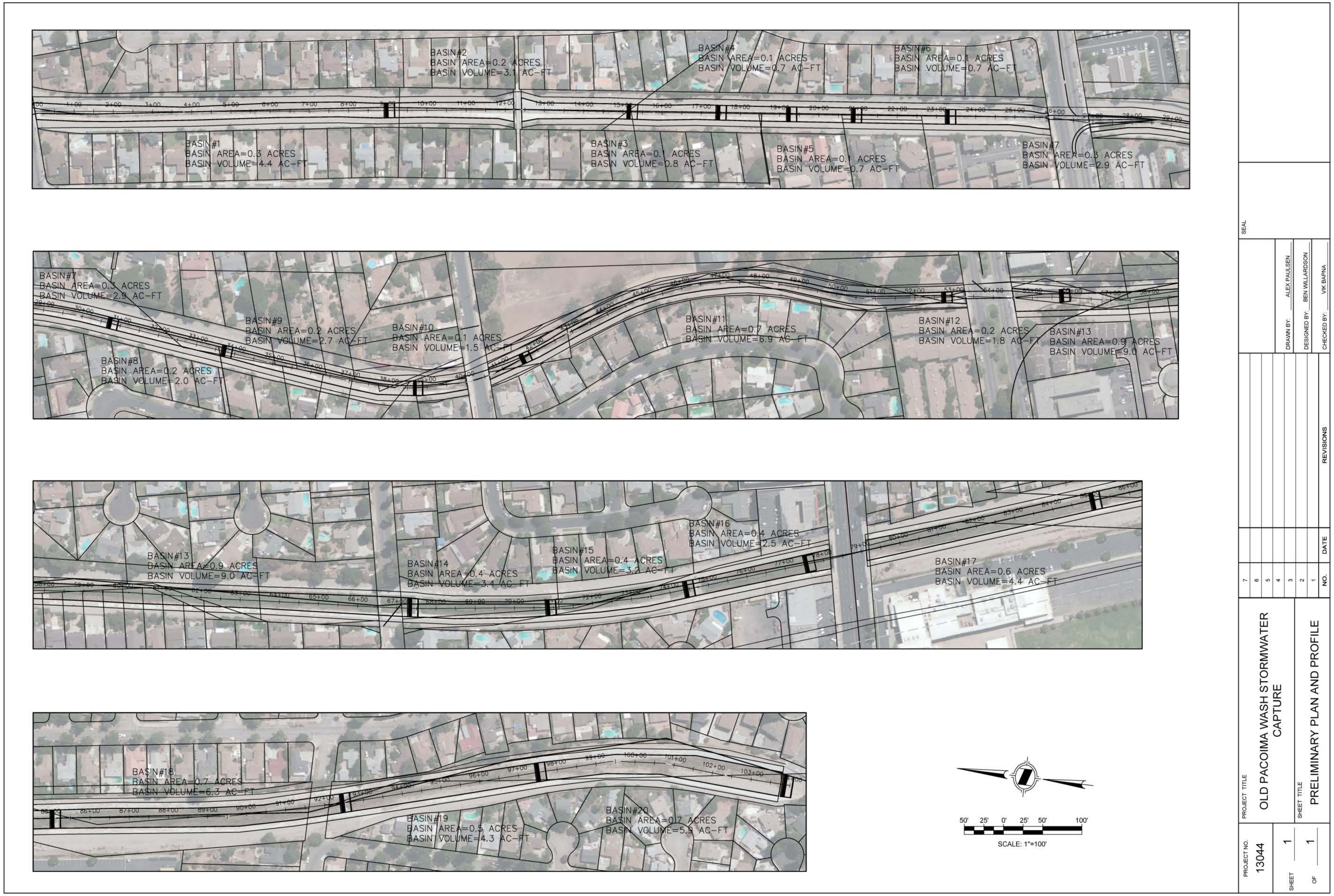


**Figure 2 - Project Basins**

Depending on several factors, the Old Pacoima Wash Stormwater Capture Project may incorporate open space attributes similar to those the Pacoima Spreading Grounds have to keep the same continuous green space amenities for the neighboring community.

## VII. Project Justification

The San Fernando Valley Groundwater Basin supplies about 10% of the City of Los Angeles' drinking water. Supply levels in the groundwater basin have been in decline for several decades due to insufficient recharge. The Old Pacoima Wash is located within the San Fernando Valley Groundwater Basin and stormwater captured from Old Pacoima Wash will alleviate downstream flooding and will aid in groundwater recharge. The Old Pacoima Wash Stormwater Capture Project will provide recharge to the San Fernando Valley Groundwater Basin.

## VIII. Project Description

### 1. Hydraulic Criteria

The approximate 13.2 acre project area, a local tributary area of 4.53 square miles, and an upstream watershed of over 40 square miles tributary to PSG form the Project's tributary area. Project components are sized based on site constraints such as current land use and the estimated percolation rate of two and a half feet per day.

### 2. Project Location

The Old Pacoima Wash is located within the Tujunga Watershed, in the North Hills neighborhood of the San Fernando Valley. The project area will be located along the existing Old Pacoima Wash south of the Pacoima Spreading Ground between Plummer Street and near the Wash divergence at Marson Street. Figure 1presents the project location.

### 3. Project Layout

Figure 3 though Figure 4the conceptual layout of the proposed project.

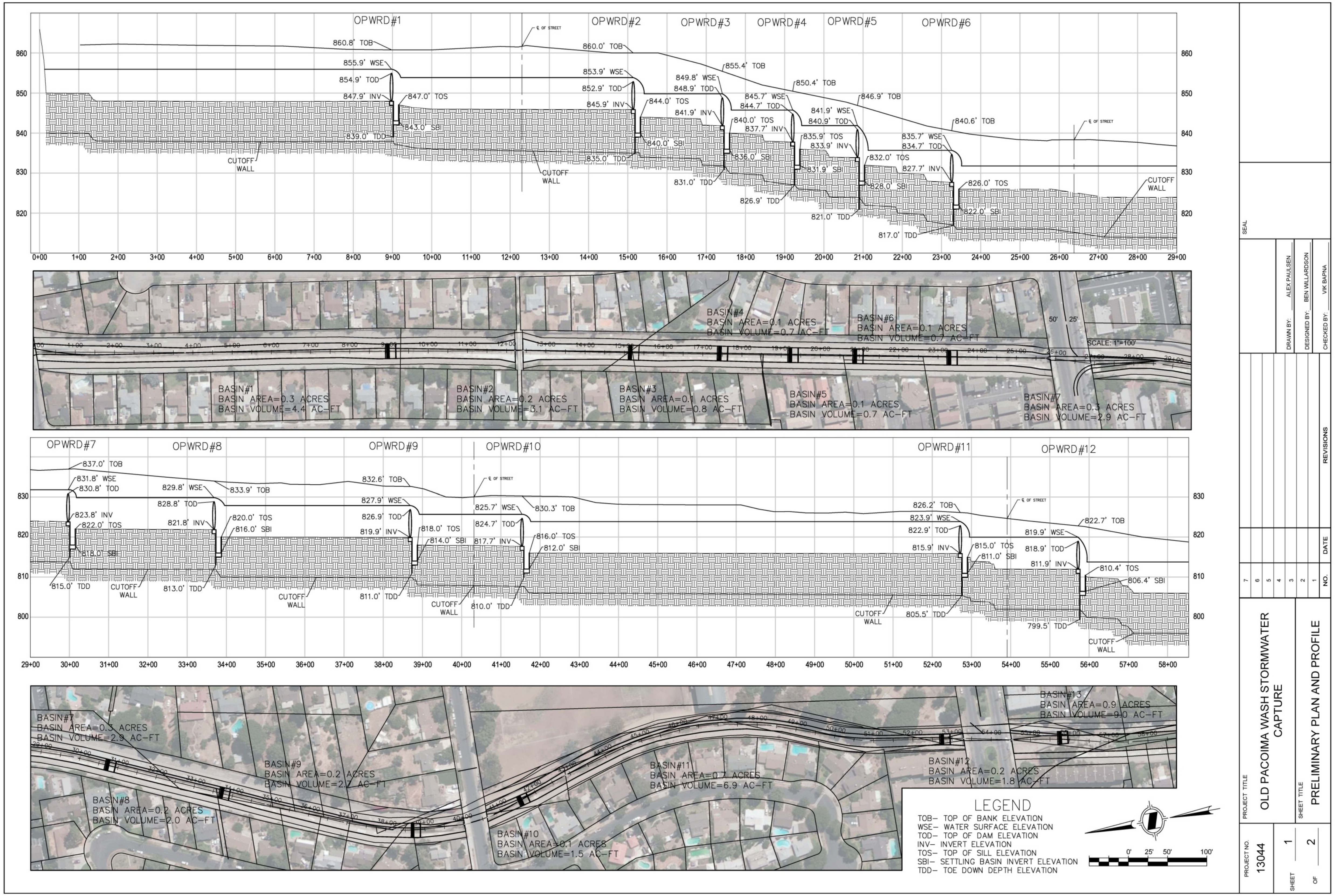


**Figure 3 - Conceptual Project Layout Page 1**

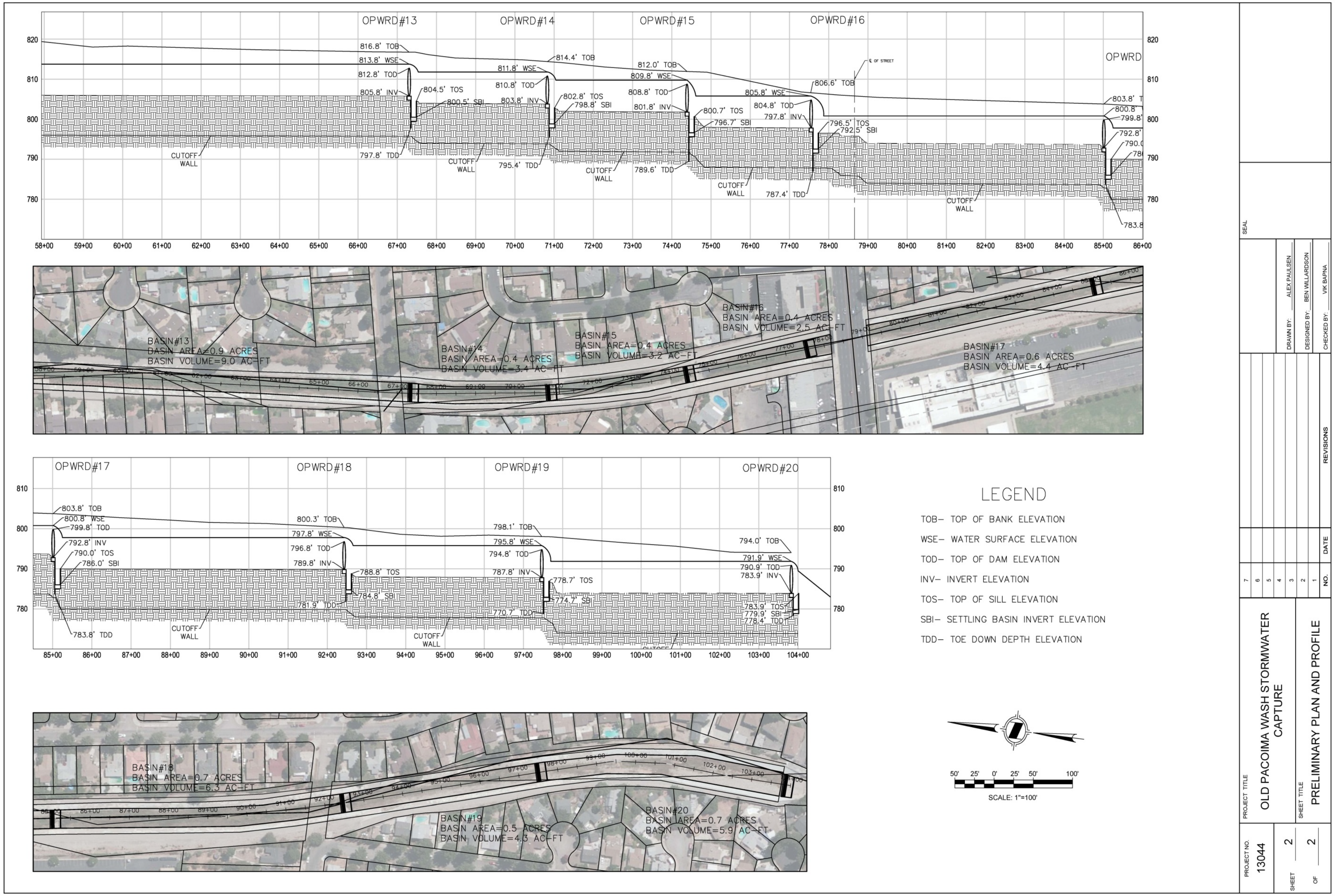


**Figure 4 - Conceptual Project Layout Page 2**

## 4. Project Details

Design and construction of all elements should adhere to all constraints detailed in the *Old Pacoima Wash Stormwater Capture Project Conceptual Report* (Attachment 1). All infiltration basins should be designed to completely infiltrate within 48-72 hours following a storm event and should be sized accordingly.

Old Pacoima Wash will be modified for the construction of 20 infiltration basins. Each infiltration basin will receive and retain stormwater from upstream spreading ground, such as Pacoima and Lopez Spreading Grounds, as well as local tributary flow, and will act as an extension of the spreading grounds. Catch basins with screen inserts will pre-treat tributary flows. To construct the infiltration basin within Old Pacoima Wash, removal of the concrete lined invert is required to allow for infiltration. The project requires installation of rubber dams for retention with stilling basins downstream of each rubber dam for scour protection, bed stabilization, and energy dissipation.

a. Storm Drain and Catch Basin Modification
Stormwater flows from the neighboring tributary area will be captured through existing storm drain lines within the 4.53 square mile tributary area. The local drainage systems will collect runoff from the local tributary area. Catch basin screen inserts will act as a pretreatment system to capture sediment and/or debris, before it reaches the infiltration basins.

b. Infiltration Basins

Prior to the construction of the infiltration basins, the 5,700 foot-long concrete invert portion of the wash will be removed and existing soils will be excavated to the depth of 10 feet. Approximately 116,200 cubic yards of soil will need to be excavated. Cutoff walls will be added to the depth of 10 feet below the invert. The remaining area will be refilled with the excavated soil, assuming the soil excavated is free of pollutants and optimal for infiltration and groundwater recharge. An infiltration test will be conducted on the rocky bottom portion of the channel. If the test determines the rocky bottom portion of the channel does not provide sufficient infiltration, this portion of the channel will also be modified in accordance to the concert inversion portion of the channel. Each infiltration basin will be formed through the installation of inflatable rubber dams. Table 1 presents a summary of each recharge basin area and water storage volume.

| Table 1: Infiltration Basin Area and Water Storage Volumes | | |
|---|---|---|
| **Basin** | **Basin Area (Acres)** | **Water Storage Volume (Acre-Feet)** |
| 1 | 0.3 | 4.4 |
| 2 | 0.2 | 3.1 |
| 3 | 0.1 | 0.8 |
| 4 | 0.1 | 0.7 |
| 5 | 0.1 | 0.7 |
| 6 | 0.1 | 0.7 |
| 7 | 0.3 | 2.9 |
| 8 | 0.2 | 2.0 |
| 9 | 0.2 | 2.7 |
| 10 | 0.1 | 1.5 |
| 11 | 0.7 | 6.9 |
| 12 | 0.2 | 1.8 |
| 13 | 0.9 | 9.0 |
| 14 | 0.4 | 3.4 |
| 15 | 0.4 | 3.2 |
| 16 | 0.4 | 2.5 |
| 17 | 0.6 | 4.4 |
| 18 | 0.7 | 6.3 |
| 19 | 0.5 | 4.3 |
| 20 | 0.7 | 5.9 |
| Project Total | 7.2 | 67.2 |

c. Inflatable Rubber Dams

The inflatable rubber dams will be placed on concrete pads throughout the wash. Each rubber dam will be fixed to the sides of the wash using clamp plates and anchor bolts. Utilizing topographic data, the inflatable rubber dams will be placed at every 7-foot elevation change thought-out the wash, as illustrated in Figure 3 through Figure 4. Based on this criterion, 20 inflatable rubber dams will be installed to create 20 infiltration basins along Old Pacoima Wash. The rubber dams will be inflated by pumping air inside the rubber body to the design height of 7 feet. After the water infiltrates the rubber dams will be deflated, until the next recharge event from a storm or upstream releases from Pacoima Dam.

d. Stilling Basins

Downstream of each rubber dam, a stilling basin will be installed to stabilize the channel bed and dissipate stream flow as water travels between basins. This will help minimize scouring along the bottom of the wash and lessen stream flow velocities along the wash. Each stilling basin, a box type structure, will be 13 feet long by 36 feet wide, and will be 4 feet in depth.

## IX. Environmental Documentation

The LADWP Environmental Affairs Divisions will prepare a Mitigated Negative Declaration (MND) once the scope of work is finalized. If the MND presents substantial evidence that the Project will create significant environmental impacts after mitigation measures are exhausted, LADWP Environmental Affairs Division will prepare an Environmental Impact Report (EIR). Potential environmental issues based on various environmental considerations are also summarized in Attachment 1

## X. Geotechnical Study

A geotechnical study has not been conducted for the Project. The LADWP Geotechnical group will perform a soil analysis of the site to determine soil classification, percolation rates, and determine whether contamination is present. Once the study has been conducted, the results will be provided.

## XI. Related Projects

1. Pacoima Spreading Grounds Enhancement Project

The Pacoima Spreading Grounds comprise 169 acres and consist of a 12-basin shallow facility that can store 530 AF. LADWP, in conjunction with the District, is proposing to upgrade the Pacoima Spreading Grounds by improving the intake and stormwater storage capacity. The average annual stormwater capture is expected to increase by approximately 2,000 Acre Feet/Year (AFY), from the current recharge capacity of 6,453 AFY, and will also improve flood protection, water quality, and passive recreation.

2. Canterbury Avenue Power Line Right-of-Ways Stormwater Capture Project

Canterbury Avenue Power Line Right-of-Way owned by the LADWP, is approximately 12,800 feet long by 200 feet wide, without parcels for private property and streets. The project proposes to construct approximately 24 recharge basins within the right-of-way with depths ranging between 7 to 10 feet. The recharge basins would act as an extension of Pacoima Spreading Grounds, adding a storage volume of 113 acre-feet, with total percolation rate of 24 cfs. Constructing the Canterbury Avenue Power Line Right-of-Way project would yield an estimated annual recharge benefit of 1,335 acre-feet per year from local rainfall.

3. Tujunga Spreading Grounds

Tujunga Spreading Grounds modifications include basin and intake improvements. The improvements have the potential to increase the estimated annual recharge up to 8,000 acre-feet. Modifications include the consolidation of 20 basins into nine deeper, larger basins and one bypass basin that would increase the storage capacity from 100 acre-feet to 790 acre-feet. Inter-basin flashboard structures will be replaced with concrete overflow structures, drains, and electric motor gates. The most significant improvement proposed is changing the existing intake into a low-flow intake and adding the following facilities:

- One located just downstream of the 5/170 freeway interchange on Tujunga Wash
- One downstream that would enable flows from Pacoima Diversion Channel to be diverted into the spreading grounds

Both intake facilities would require rubber dams and slide gates, increasing the maximum intake capacity from 250 cfs to 450 cfs.

## XII. Codes, Regulations, Permits and Approvals

The new facilities shall meet the requirements of all applicable regulations, codes, permits and approvals. The permits required for this project will be determined during design. Permits could potentially include, but are not limited to the following:

**1. City of Los Angeles, Department of Building and Safety Permits**
- o Grading
- o Plumbing
- o Demolition

**2. City of Los Angeles Fire Department**
- o Risk Management Plan

**3. City of Los Angeles, Department of Public Works, Bureau of Engineering**
- o Excavation and Class ‘A’ Permanent Resurfacing Permit

**4. City of Los Angeles, Bureau of Sanitation**
- o Industrial Waste Permit

**5. City of Angeles, Department of Transportation**
- o Traffic Control Plan or WATCH Manual

**6. City of Los Angeles, Planning Department**
- o Conditional Use Permit
- o Cultural Affairs

7. **State of California, Regional Water Quality Control Board**

8. **County of Los Angeles, Department of Public Works, Flood Control**

## XIII. Elected Officials

Honorable Eric Garcetti, Mayor of the City of Los Angeles
Mr. Felipe Fuentes, Councilmember 7th Council District
Sheila Kuehl, Los Angeles County Supervisor 3rd District

## XIV. Public Access/Community Outreach

Open communication with key community groups and neighborhood councils should continue throughout the entire life of the project and should include regular updates as to the status of the project as well as key milestones.

Sun Valley Watershed Stakeholders:

- City of Los Angeles – Bureau of Sanitation
- City of Los Angeles – Bureau of Street Services
- City of Los Angeles – Recreation and Parks
- Los Angeles County Flood Control District
- LADWP
- US Army Corps of Engineers
- TreePeople
- LA Trails Project
- The River Project
- East Valley Coalition
- Sun Valley Area Neighborhood Council
- Arleta Neighborhood Council
- Mission Hills Neighborhood Council
- Council for Watershed Health
- County of Los Angeles Supervisor District 3
- City of LA Council District 6
- Area Residents

## XV. Baseline Division of Responsibilities

Project Management will determine division responsibilities and prepare a work breakdown structure, which will include the following work groups.

1. **Water Engineering and Technical Services Division**

   The Water Engineering and Technical Services Division will be responsible for Project Management to oversee and coordinate all phases of design and construction including obtaining the proper permits, Project Design which includes generating a set of plans for 30, 60 and 90 percent review and approvals, and

Construction Management to administer all negotiations with chosen contractor. Construction will be completed either in house by the Integrated Support Services Division or contracted out, this still needs to be determined.

**2. Water Operations Division**

The Water Operations Division will be responsible for operation and maintenance of the basins. Debris removal in the basins, pretreatment devices, culverts and swales will be necessary prior to the beginning of storm season and after each storm event to ensure effectiveness of the project. See Section XVII for estimated operation and maintenance costs and labor required.

**3. Watershed Management Group of Water Resource Division**

The Watershed Management Group will be responsible for the planning phase which focuses on the development of the project's concept. It will involve outlining the tasks and responsible groups who will perform the work, obtain management approvals, risk management and legal approvals and ensure the project follows deliverables to completion.

**4. Power System Engineering Division**

The Water Engineering and Technical Services Division will coordinate with the Power System Engineering Division during the design phase to ensure design constraints of all elements related to overhead and underground distribution and transmissions lines are met. The constraints include, but are not limited to, the details in the Old Pacoima Stormwater Capture Study (Conceptual Report, Attachment 1).

**5. Integrated Support Services Division**

The Integrated Support Services Division will be responsible for the construction of the project, if construction is determined to be completed in house by the Water Engineering and Technical Services Division.

## XVI. Project Schedule

| | |
|---|---|
| Planning | Early 2015 |
| Environmental | Early 2017 |
| Engineering and Design | Early 2018 |
| Advertise (Out to Bid) | Mid 2019 |
| Award | Late 2019 |
| Construction | Early 2020 |
| Completion | Mid 2022 |

## XVII. Project Budget, Cost Estimates, and Funding Opportunities

Construction of the project will begin when construction funds are secured at a later time. The project budget, preliminary cost estimates and potential funding opportunities are summarized below.

### 1. Work Order Information

| | |
|---|---|
| Title | Old Pacoima Wash Stormwater Capture Project |
| Functional Item | TBD |
| Job Number | TBD |
| Parent Work Order | TBD |
| Planning | TBD |
| Design | TBD |
| Construction | TBD |

### 2. Preliminary Cost Estimate

| ITEM NO. | ITEM | APPROX.QTY | Unit | UNIT PRICE | Total (2014 Dollars) |
|---|---|---|---|---|---|
| **MISCELLANEOUS** | | | | | |
| 1 | Mobilization (10% Max of Contract Bid) | 1 | LS | $8,559,000 | $8,558,600 |
| 2 | Contingency (30% Construction Cost) | 1 | LS | $2,853,000 | $2,852,900 |
| 3 | Inflation ( @ 3% per year for 5 years) | 1 | LS | $4,280,000 | $4,279,300 |
| **DEMOLITION** | | | | | |
| 4 | Demo of Existing Concrete Lined Wash Bottom | 11,630 | CY | $25 | $290,700 |
| **CONSTRUCTION** | | | | | |
| 5 | Excavation | 116,200 | CY | $6 | $698,000 |
| 6 | Cutoff Walls | 7,700 | CY | $520 | $4,004,000 |
| 7 | Concrete pads | 2,100 | CY | $520 | $1,092,000 |
| 8 | Rubber Dams | 20 | EA | $1,000,000 | $20,000,000 |
| 9 | Stilling Basins | 1,300 | CY | $520 | $676,000 |
| 10 | Passive recreation (walking paths) | 312,000 | SF | $4 | $1,248,000 |
| 11 | Educational signage | 40 | EA | $3,000 | $120,000 |
| 12 | Fencing | 10,510 | LF | $38 | $400,000 |
| | | | | **Cost Estimated Total** | **$44,219,500** |

### 3. Estimated Operation and Maintenance Costs

Annual operation and maintenance (O&M) costs were estimated using baseline data on a per acre-foot cost provided by LACDPW. LACDPW provided the recharge basins operational costs of $317 per acre-foot of facility capacity using 2007 data, With inflation operational costs for the recharge basins is calculated to be $364 per acre-foot of facility capacity. Based on these number, the total anticipated annual O&M cost would be approximately $24,400.

### 4. Funding Opportunities

To secure funds for the project, a number of funding opportunities exists. These opportunities exist as grants and loans to provide the needed financial assistance to initiate the project. Additional information regarding funding opportunities is provided in the Old Pacoima Wash Stormwater Capture Conceptual Report found in Attachment 1.

## XVIII. Risk Assessment

Potential risk factors that may influence design and construction schedules include: community involvement, coordination with other projects (in-house or otherwise), permit processing, environmental considerations regarding the wash, geotechnical investigations, changed field conditions, etc.

## XIX. Safety

The Old Pacoima Wash Stormwater Capture Project including planning, design, installation, and in-service phases, shall conform to safety regulations, especially those from the Division of Occupational Safety and Health, State of California (formerly CAL OSHA). In addition, during the design process, the Corporate Safety Group will be included in plan reviews and discussions to ensure safety is considered and incorporated in the design of the project.

ATTACHMENT 1
Old Pacoima Wash Stormwater Capture
Conceptual Study Report
November 2014

# APPENDIX I. STORMWATER CAPTURE PROGRAM FACT SHEETS

Geosyntec consultants

3415 S. Sepulveda Blvd. Suite 500
Los Angeles, CA 90034
PH 310.957.6100
FAX 310.957.6101
www.geosyntec.com

# Los Angeles Department of Water and Power
# Stormwater Capture Master Plan
# Program Fact Sheets

## INTRODUCTION

Stormwater capture programs fall within two general categories – (1) infiltration programs and (2) direct use programs. Within these two programmatic categories, subcategories capture the full range of potential stormwater capture programs. Within each subcategory, different programs could be developed depending on land use, specific property owners, etc. Specific stormwater capture practices can be applied across multiple program types.

Specific infiltration or direct use practices are discussed in detail in the following sections, but all practices include the following general components:

*Capture, Diversion, and Conveyance* - Stormwater is captured from the tributary area and delivered into the Best Management Practice (BMP) using practices such as trench drains, area drains, swales, sheet flow, gutters and downspouts, or in the case of subregional practices, diversion structures which draw on flows from the public stormwater conveyance system and into a BMP.

*Pre-treatment* - Pretreatment improves the quality of stormwater inflow before reaching the BMP by removing trash, debris, and sediment. Pretreatment may consist of a simple trash screen to remove trash and debris, or more complex filter system such as a vortex filter or hydrodynamic separator which can remove finer sediments. The extent of pretreatment necessary depends on the type of BMP, influent water quality, and use purpose of the harvested water. Pretreatment will extend the life and enhance the effectiveness of a BMP.

*Storage* - Storage allows BMPs to stormwater and allow this water to infiltrate or be used slowly after the storm has passed. Larger storage greatly enhances the capture potential of a BMP up to a point of diminishing returns. Additional storage usually increases the excavation requirements of a BMP, so benefits have to be weighed against costs. For infiltrative practices storage can be provided in the void space of biofiltration media or gravel, above the surface of the BMP through the use of grading, or structural vaults. For direct use practices, this includes the volume stored with a cistern.

*Infiltration / Use* - Infiltration and direct use are the end uses for stormwater capture practices. Infiltration refers to allowing the water stored within an infiltrating BMP to slowly seep into the ground in the hours or days preceding a rain event. Direct use refers to using captured stormwater for non-potable uses either outdoor (e.g. irrigation) or indoors (e.g. toilet flushing).

*Vegetation* – Vegetation is provided in biofiltration BMPs to increase pollutant removal, maintain absorptive characteristics, and/or provide visual interest. Biofiltration vegetation consists of facultative wetland plant species that can tolerate saturated conditions but can also survive periods of drought conditions. Vegetation is often a component of direct use practices as well. To maximize the reduced potable water demand, existing vegetation or low water use plants are used. Plants add a number of benefits to stormwater capture practices (refer to benefits section for additional detail).

*Overflow/Bypass* - When volume entering a BMP is in excess if its storage capacity, flows are diverted into an overflow structure or bypass mechanism. In simpler systems, sheet flow or trenches can serve as an overflow. An overflow structure directs excess volumes via pipe into the storm sewer system, or other location where they will not create issues such as localized flooding and erosion. If a bypass is utilized, inflow will simply continue on when the storage capacity of the BMP is reached, bypassing the BMP entirely.

## INFILTRATION PROGRAMS

### General

Infiltration is a stormwater management strategy used to intercept, capture, and store stormwater runoff for slow infiltration into the ground to recharge groundwater aquifers.

<u>Site Suitability Constraints</u>

*Site Topography:* The infiltration practice itself will need to be placed on a relatively flat area (less than 5% slope), and the contributing drainage area should not exceed 15% slope.

*Permeability of Soils:* A minimum infiltration rate of 0.5 inches per hour is recommended for all infiltrative practices. In cases of exceptionally high infiltration, 5 inches or more per hour, runoff should be treated prior to being released into the infiltration practice.

*Proximity to Structures:* Since additional water is being introduced into the soil, the stability of the surrounding structures and foundations should be considered. Los Angeles Building code prohibits infiltration practices from being constructed within specified distances of building footings to prevent flows from traveling horizontally through the soil and causing saturated conditions around the building foundation.

*Contamination:* Land management within the tributary area and the quality of the influent will influence BMP design. In some cases, the influent may not receive high quality treatment before interacting with groundwater, particularly if the groundwater is shallow. Therefore, infiltration practices may not be appropriate in locations where the contributing runoff is expected to be contaminated.

*Street Use Considerations (Green Streets only):* Parking availability, handicap accessibility, driving speed, and safety are all factors of concern for green street designs. Accessibility and visibility are important factors to consider from the pedestrian perspective as stormwater BMPs should not inhibit foot traffic patterns. ADA guidelines should always be adhered to in public spaces to maintain handicapped access.

*Traffic Loads (subterranean galleries and permeable pavement only):* The structural components must be able to accommodate multi-axle vehicles unless heavy loading is not anticipated or if it is prohibited, such as a residential driveway.

*Community Needs:* The BMPs must meet the community needs and not compete with other purposes for the space, such as parking or recreational space.

*Depth to Groundwater:* Many of the infiltration BMPs are not applicable where groundwater depths are shallow (less than 10 feet below ground surface).

*Available space:* The footprint of many of these BMPs is relatively small, minimizing sizing constraints.  However, adequate space must be available for the desired BMP, including setbacks where applicable.

*Pre-treatment* – The size and material of the contributing drainage area determines the potential volume and quality of runoff to be infiltrated. Residential and commercial land uses could produce runoff with high rates of trash, bacteria, metals, and nutrients. Industrial land uses may have runoff with heavy metals and organics. Asphalt shingles and high-traffic parking areas can slough off toxic chemical and particulates. School playgrounds and commercial corridors will produce runoff with comparatively high levels of trash. Pre-treatment will be determined by the nature of influent and practice.

*Method of Diversion* – Capturing flows for use in subregional infiltration requires a concentrated flow that can be diverted into the BMP. Storm sewer infrastructure is typically located in the roadway or alleyway, so a main could be diverted to a cistern. Catch basins found along the curb can be directed into the BMP as well. If new or re-development is taking place on a site, there may be the opportunity to incorporate off-site BMPs into site design so that runoff exits at a single point and into a BMP on a nearby parcel.

Operations and Maintenance (O&M)

*Monitoring:* Monitoring is an important component of a successful O&M program as regular feedback on the performance of a BMP can inform the type and frequency of ongoing O&M activities. Monitoring to quantify the volume of runoff infiltrating will inform cost effectiveness of BMPs and can be used to support additional pumping rights in the Central and West Coast Basins and potentially other aquifers in the future.

*Maintain Vegetation and Soil (turf replacement and bio-infiltration practices only):* Routine inspection of plantings, pruning, replacing and/or dividing plants/trees, and drip irrigation are needed to maintain vegetation and soil. Planted areas must be kept well mulched, increasing both water conservation and the absorptive capacity of the landscape. Plantings should be replaced or much added if patches of bare soil begin to emerge. If there are gravel or rocks within these areas used for energy dissipation, they should be cleaned of organic matter such as leaves, mulch and debris.

*Remove Debris and Accumulated sediment:* Pre-treatment such as a grass filter strip is recommended, as well as regular trash, debris, and sediment removal, to maintain adequate BMP function. For permeable pavement, vacuuming is needed and prevention of clogging is critical. Permeable pavement must remain free of debris such as sediment, leaves, and trash to avoid clogging.

*Routine Inspection of Facilities and Structures (i.e., dry well, pipes used in infiltration galleries or trenches, media, geotextile fabric, inlets and outlets, and observation wells):* These components may suffer damage due to normal wear and tear, extreme weather, or unexpected pressures from surrounding land uses, such as traffic, vandalism, or wildlife. Routine inspections should be made to verify that each structural component is serving its intended function. Re-establishing design grading at inlets and outlets may need to take place as erosion is common at locations where flow is concentrated. Cleaning existing gravel, or removing and adding new gravel, may be required.

*Rehabilitation and Reconstruction:* Substantial corrective actions will be necessary at various intervals of a BMP's useful life. Rehabilitation is typically scheduled at intervals of 15 to 30 years and consists of replacing aggregates, soil media, underdrains, inlets/outlets, and creating deeper excavations within the BMP to provide a new surface for exfiltration. Reconstruction takes place at intervals of 30 to 50 years and consists of a complete reconstruction of the BMP.

**Practices**

Infiltration practices include:

- Turf removal
- Permeable pavement
- Bio-infiltration
- Subsurface infiltration

<u>Turf Removal</u>

**Description**. Turf grass is commonly used for home and business landscapes; however, it is an option that consumes water and is expensive to maintain. Turf removal is the process of replacing turf grass with drought-tolerant plants, mulch, and/or permeable pathways. Typically, this practice is combined with removal of a traditional irrigation system and replacement with drip irrigation or hand watering, which tends to reduce potable water consumption and overwatering. Different land uses can implement and benefit from turf removal, including residential, commercial, industrial, and educational properties. Although turf removal is primarily a water conservation measure, it does provide additional infiltration benefits in so far as the soil is amended and tilled when the turf is replaced with drought tolerant vegetation. In this manner, the absorptive capacity of the soil is increased as the root system maintains soil infiltration rates by aerating the soil and decreasing compaction over time.

**Schematic Design**. The schematic design involves removing water-intensive turf grass and replacing it with a suite of drought-tolerant plants, mulch, and/or permeable pathways. Many agencies provide information on drought-tolerant species, including:

- Tree People offers a Residential Parkway Landscaping Guideline (Tree People, 2010) that includes a listing of drought-tolerant species.
- The Metropolitan Water District of Southern California (MWD) has a web site (www.bewaterwise.com) that provides photos and information on appropriate, water-wise, California Drought tolerant® gardens.

An example drought-tolerant landscape is shown in the following photograph.

**Example Drought-Tolerant Landscaping in Southern California**
*(photo obtained from http://www.landscapingla.com, accessed 10/2014)*

<u>Permeable Pavement</u>

**Description**. Permeable pavement is an engineered pavement system that captures and stores stormwater runoff through what would otherwise be impervious surfaces. It can be designed to infiltrate runoff from tributary areas or simply direct rainfall. Permeable pavement is a general term that includes a number of different highly permeable hardscape surfaces (e.g., porous concrete, porous asphalt, interlocking concrete pavers, or other types of pavers) set atop a gravel/coarse aggregate base. Runoff can quickly flow through the permeable hardscape into the gravel layer, where it is collected in underdrain pipes and allowed to infiltrate slowly into the surrounding soil.

Because hardscape surfaces are pervasive within the urban environment, there is potential for widespread application of permeable pavement systems throughout the City of Los Angeles, both as retrofits and new construction. Example applications include large-scale parking areas in commercial properties, churches, schools, libraries, and multi-family residential properties. Permeable pavement is appropriate for low-traffic roadways, parking lanes, bike lanes, patios, driveways, and sidewalks. Similarly, permeable pavement can also be utilized on a smaller scale by replacing patios and driveways on single-family residential properties.

**Schematic Design**. The key design features of permeable pavement include layers of gravel that provide storage capacity and a highly infiltrative pavement surface that allows runoff to penetrate at a very rapid rate. Pavement options for permeable pavement systems include the following:

- Porous asphalt/concrete: A standard hot mix asphalt or Portland cement is mixed with aggregate that has a reduced sand/fines content. The resultant texture creates interlocking void spaces that comprise 15-20% of the total volume of the material. Asphalt or concrete is generally poured between 4- to 12-inches thick.
- Permeable pavers: Typically pre-cast concrete pavers with a height of 4 inches are spaced and installed 3/8-inch apart, although there are many types on the market. Voids are filled with fine-grained gravel to allow stormwater to penetrate.

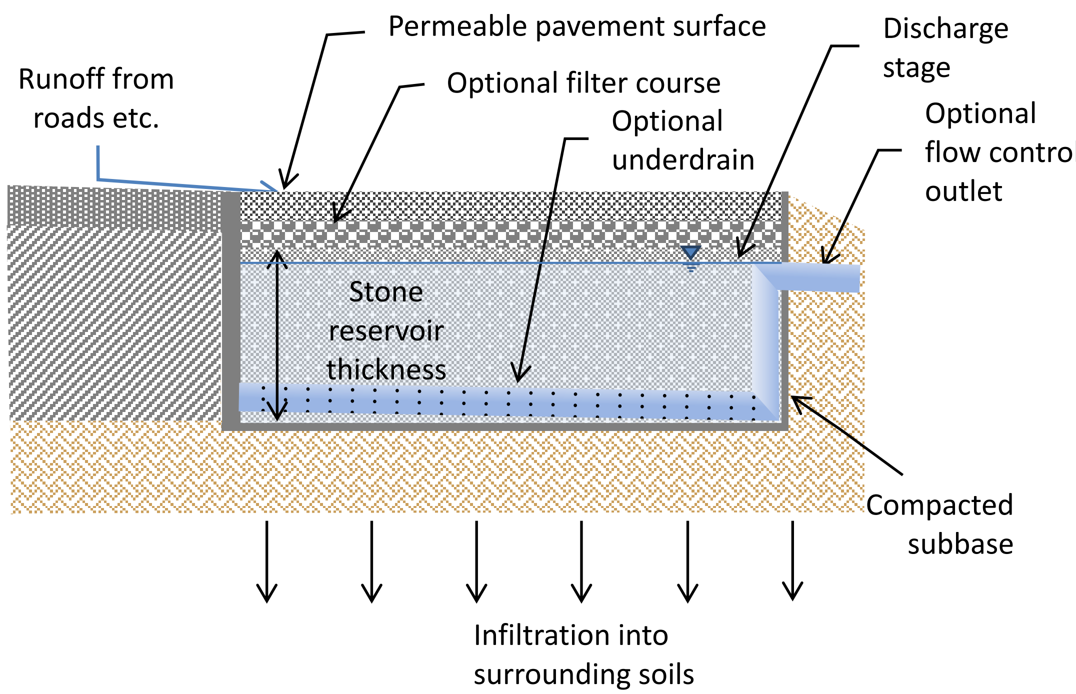


**Figure: Permeable Pavement Typical Cross Section**


**Figure: Example Plan View Configuration - Permeable Pavement Application on Single-Family Residential Property can include a Permeable Pavement Driveway and Walkway**

Bio-Infiltration

**Description**. Bio-infiltration BMPs can take a variety of forms, but they all have the common elements of storage, bio-filter media, and plants adapted to tolerate periods of inundation and dryness. Specific bio-infiltration types are described below.

*Rain Garden/Bio-Infiltration Basin* - A rain garden is a depressed vegetated area underlain by porous soil media and sometimes open-graded gravel. The wide, shallow excavation allows runoff to collect and be used by the vegetation. Water in excess of what the plants need to survive can slowly seep into the surrounding soils. Large-scale rain gardens are often referred to as bio-retention or bio-infiltration basins. Bio-infiltration basins typically have a deeper gravel layer to accommodate larger runoff volumes and some form of pre-treatment is provided due to the higher amount of debris, trash, and sediment in the inflow due to the larger tributary area.

*Tree Wells/Planters* – Tree wells and planters are a type of bio-infiltration BMP that is most typically used in parking lots, highly-trafficked pedestrian corridors, and commercial or residential parkways and streetscapes. Storage is provided in the void space of the soil and a gravel base below the root zone. These BMPs have a small footprint, providing wide application to locations where space constraints exist. Planters are designed to treat roof runoff and runoff from small tributary areas, accepting runoff from roofs, walkways, sidewalks, or parking areas and holding the runoff so that it can slowly be infiltrated into the ground.

*Vegetated (Parkway) Swales* - A vegetated swale is a shallow (3-feet or less), vegetated hydraulic conveyance that collects runoff while slowing it down and allowing it to infiltrate. Infiltration capacity can be maximized through the use of small berms running perpendicular to flow. Vegetated swales are most commonly found along roadways.

*Bump-Outs* - A curb bump-out is traditionally a traffic calming measure in which the curb is extended into a crosswalk or roadway to reduce crossing distance for pedestrians, increase pedestrian safety, and create the visual effect of the roadway narrowing for drivers. Curb bump outs can act as bio-infiltration BMPs when runoff from the roadway, sidewalks, or the roofs of adjacent buildings is allowed to enter the bump out via a curb cut.

**Schematic Design**.

Schematics and/or illustrations for bio-infiltration BMPs are presented below.

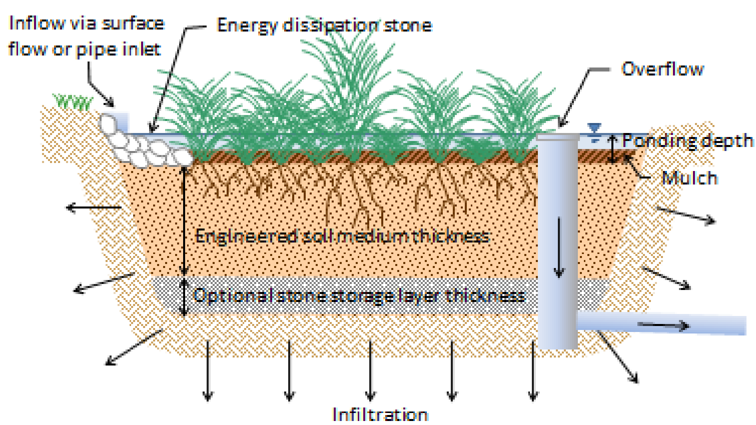


**Figure: Rain Garden Schematic**

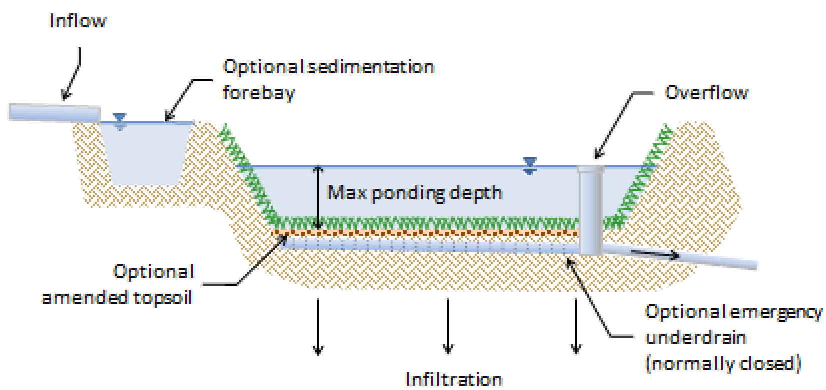


**Figure: Bio-Infiltration Basin Schematic**


**Figure: Example Tree Well installed in Lakewood, CA and Tree Well Schematic Design showing Filterra® Internal By-Pass - Curb**
(*photos courtesy of Filterra, 2014*)

**Figure: Example Stormwater Planter on Hope Street in Downtown Los Angeles, CA**
(*photo courtesy of California Regional Water Control Boards, 2014*)

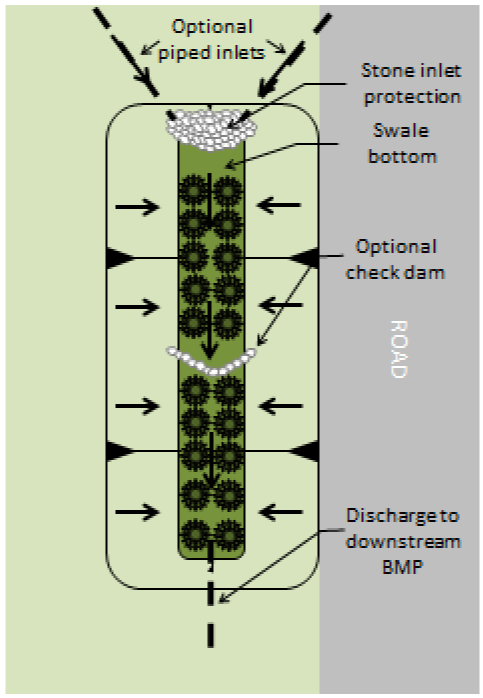


**Figure: Vegetated Swale Site Plan Schematic**

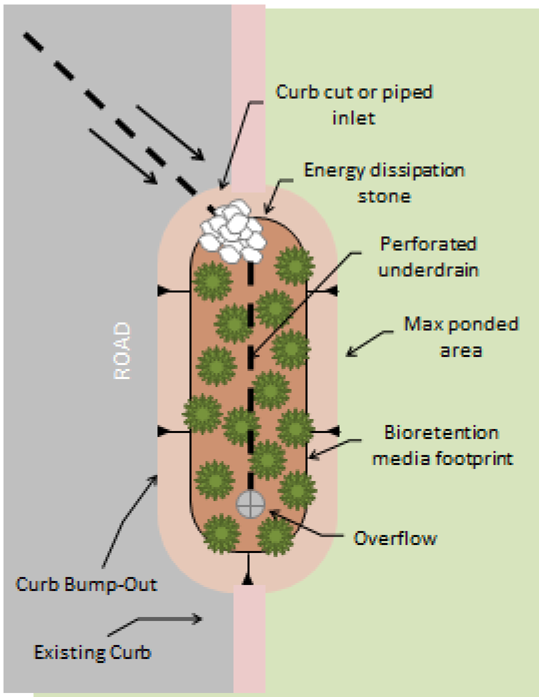


**Figure: Curb Bump-Out Schematic Design**

Subsurface Infiltration

**Description**. Subsurface infiltration BMPs collect runoff into a subsurface storage chamber and allow it to infiltrate slowly over time. Infiltration BMP types are described below.

*Dry Well* - A dry well is a deep narrow hole filled with gravel or perforated pipe to maintain the structural stability of the hole. The hole can be 1-6 feet in diameter and from less than 10 to over 100 feet deep. Stormwater infiltrates through the base and the sides of the hole. Dry wells allow significant storage capacity while occupying a minimal footprint. On residential properties, dry wells are typically placed between a driveway or patio and a vegetated area, where runoff from the paved surfaces is used to soak deep into roots of adjacent plants. They can be installed under lawns, sidewalks, in parkways, in parking lots, or traffic islands, providing a good way to incorporate stormwater capture without reducing the amount of available space for other interests such as parking, pedestrian flow, or vehicular access. However, dry wells are not suitable for areas that generate sediment or silt laden runoff unless pre-treatment is provided.

*Infiltration Trench* - An infiltration trench consists of a long, narrow, rock-filled trench. Runoff is stored in the void space between the stones and infiltrates through the bottom and sides into the underlying soil. The buffer strips adjacent to the trench can provide pre-treatment and limit the amounts of coarse sediments entering the trench, thereby reducing O&M costs. .

*Infiltration Gallery* – An infiltration gallery is a large underground storage vault. These galleries provide storage where space is constrained because they can be placed under parking lots or streets, schools, and at parks under playing fields.

**Schematic Design**. Schematic designs for each of the below ground infiltration BMPs described above are provided below.

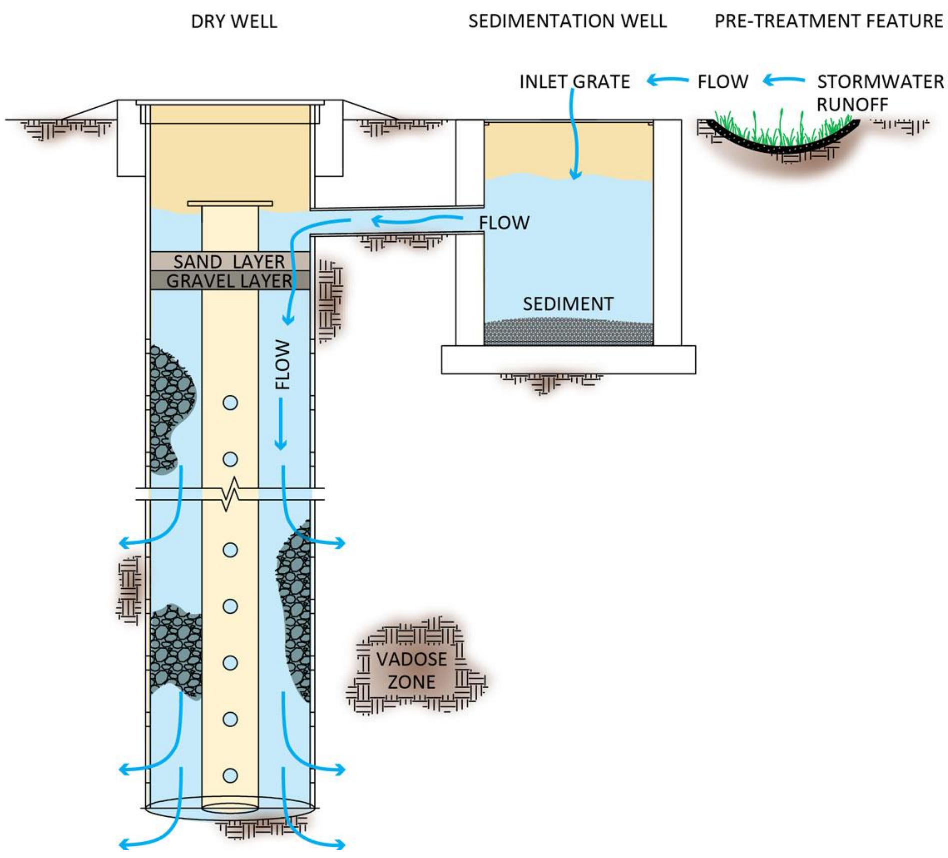


**Figure: Dry Well Typical Cross Section**
*(Image obtained from http://www.oehha.ca.gov/ecotox/drywells/index.html, accessed 09/2014)*

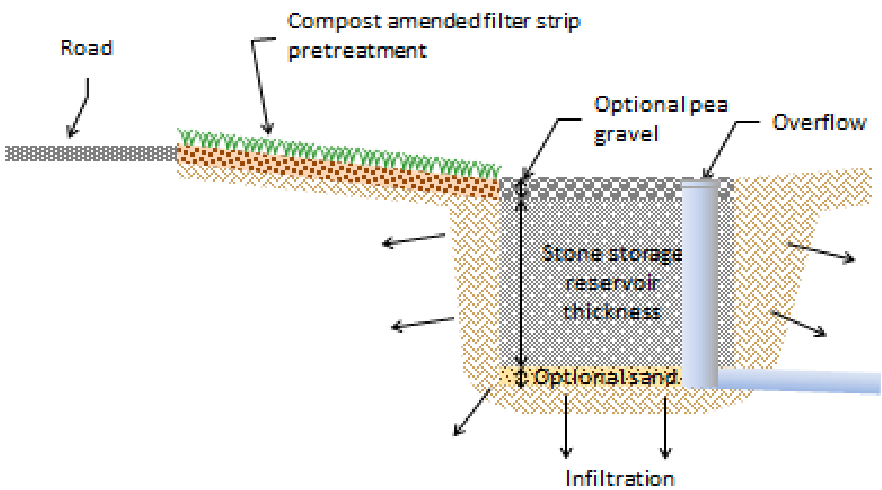


**Figure: Infiltration Trench Typical Cross Section**

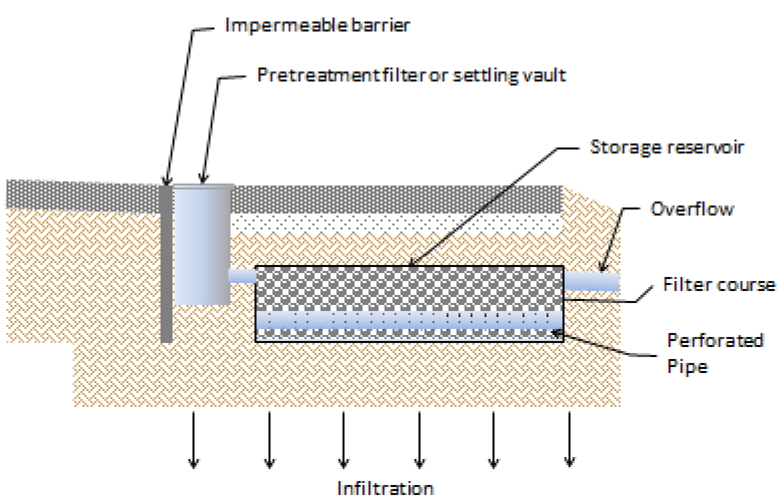


**Figure: Infiltration Gallery Typical Cross Section**

## Programs

For the purposes of the SCMP, programs were organized into four general categories, as follows:

- Self-mitigating practices
- Distributed (onsite) infiltration

- Green Streets
- Sub-Regional infiltration

Self-Mitigating Practices

**Program Description**. Self-mitigating practices occupy a relatively large footprint and are designed to infiltrate water that directly falls on them rather than collect runoff from a larger tributary area. Applicable practices include permeable pavement and turf replacement. Though these practices cannot capture runoff from larger areas, they can be applied over a large area and have a significant cumulative impact.

**Applicability**. There is widespread opportunity for application of self-mitigating practices in all land uses across the City of Los Angeles. Descriptions of how the practices might be applied in different land uses are provided below:

**Table: Site Specific Opportunities for Self-Mitigating Practices**

| **Land Use** | **Site Specific Opportunity** |
|---|---|
| Single-Family Residential | Patios, walkways, driveways, parking lots, and courtyards are examples of impervious surfaces that could be replaced with permeable pavement. Residential lawns could be replaced with mulch and drought tolerant vegetation. |
| Multi-Family Residential | Patios, parking lots and courtyards can be replaced with pervious pavement. |
| Commercial | Parking lots, outdoor seating areas, walkways, and loading docks seen in commercial developments can be retrofitted with permeable pavement. Commercial applications of pervious pavement offer educational value due to high pedestrian visibility. |
| Institutional | Institutional buildings such as hospitals, police stations, and universities often have large parking lots and impervious gatherings spaces such as courtyards and plazas which could be retrofitted with permeable pavement, and grassy areas which could be replaced with mulch and drought tolerant vegetation. |
| Industrial | For industrial sites, there is often a high percentage of impervious area that makes up the total area that could be retrofitted with permeable pavement. |

| | |
|---|---|
| Educational | Playgrounds and parking lots on Los Angeles Unified School District (LAUSD) can be replaced with pervious hardscape on school grounds. These projects offer an important educational opportunity for school children to see firsthand how land use and stormwater interacts with the health of the environment. |

**Local Examples**.

**Figure: LAUSD has implemented asphalt removal; Before/After on at Main Street Elementary School.**

**Figure: Patio replacement with porous concrete at the Los Angeles Department of Water and Power on September 9, 2009. Note the gravel bed underlying the porous concrete layer.**

Onsite Infiltration

**Program Description**. Onsite infiltration is the practice of collecting stormwater runoff from impervious or compacted areas on a property for infiltration within the same parcel. Practices that can be implemented as part of onsite infiltration include permeable pavement, bio-infiltration, and subsurface infiltration.

**Applicability.** For each of the land uses in the City, different onsite infiltration practices may be suitable and can be scaled depending on the contributing area. The table below highlights a selection of practices that could be potentially implemented for different land uses, though it is not meant to be an exhaustive list.

**Table: Site Specific Opportunities for Onsite Infiltration**

| Land Use | Site Specific Opportunity |
|---|---|
| Single-Family Residential | Residential downspout disconnect program (directing downspouts to newly installed rain gardens, permeable pavement, and/or dry wells) |
| Multi-Family Residential | Apartment building parking lot retrofit program (to treat parking lot runoff using permeable pavement, tree wells, and/or planters) |
| | Apartment building infiltration gallery program |
| Commercial | "Big box store" parking lot retrofit program (to treat parking lot runoff using permeable pavement, tree wells, and/or planters or to treat entire site using infiltration galleries beneath parking lot) |
| Institutional | Library/police station/fire station stormwater retrofit program (treat onsite runoff using site appropriate infiltration practices |
| | Hospital parking lot retrofit program (to treat parking lot runoff using permeable pavement, tree wells, and/or planters or to treat entire site using infiltration galleries beneath parking lot) |
| Industrial | LADWP-owned power plants and water treatment facilities stormwater retrofit program (onsite capture using bio-infiltration basins and/or subsurface infiltration practices) |
| Educational | Los Angeles Unified School District stormwater retrofit program to enhance green space and educate youth about stormwater (bio-infiltration practices) |

**Local Examples**.

*Peck Park*. Permeable asphalt was installed as part of the Peck Park parking lot stormwater and drainage enhancements in 2009. One lane of parking stalls was replaced with permeable asphalt as a demonstration project. Runoff first flows through 1 foot of permeable asphalt and then enters a 1-ft deep gravel sub-layer. Runoff is then collected in a perforated underdrain and into a vegetated swale. Ultimately, runoff is delivered into a bio-retention facility.

**Figure: Peck Park Community Center Parking Lot Permeable Pavement**

*Los Angeles Zoo* - The Los Angeles Zoo Project included a system of swales and grade adjustments on the 33-acre parking lot to direct surface water to permeable pavement and vegetated swales for infiltration (LA Stormwater, 2011).

**Figure: Los Angeles Zoo Parking Lot**
*(photo courtesy of LA Creek Freak)*

*Single-Family Residential and Church Parking Lot* – Photographs of distributed onsite infiltration at a local single-family residential and church site are shown next.


**Figure:  Permeable Pavement in a Church Parking Lot with Roof Runoff Contributing to Tributary Area**

Green Streets

**Program Description**. A green street is a right-of-way that maximizes stormwater capture through a combination of stormwater BMPs and design considerations. Practices could be placed in the street and sidewalk (permeable pavement, dry wells) or in the parkways (vegetated swales, parkway bioretention with curb cuts, bio-retention curb bump-outs, tree wells, planters, and bio-retention basins). Green streets provide an alternative to traditional impervious roadways and streetscapes by incorporating one or more BMPs to manage stormwater runoff while still maintaining the roadway's primary function of accommodating vehicular traffic and safe pedestrian access. Stormwater BMPs capture and infiltrate runoff from both the street itself, as well as some percentage of adjacent properties.

Even though streets are a critical component of the urban infrastructure, they constitute a high percentage of the overall impervious area, and therefore finding ways to capture runoff generated in these areas is a critical component of a stormwater capture master plan. Additionally, streets undergo a regular cycle of repair and replacement by the City and therefore offer an important opportunity for stormwater oriented retrofits.

**Applicability**. Green streets may be implemented in residential and commercial streets, at street-ends that dead end at major rivers (i.e. "Rio Vistas"), and in specially-zoned areas such as Pedestrian Oriented Districts and Business Improvement Districts.

**Local Examples**.

*Elmer Avenue Green Street*. The Elmer Avenue green street, part of the Los Angeles Basin Water Augmentation Study, re-designed a residential block with 24 homes with a variety of stormwater BMPs, including permeable pavement, cisterns, parkway bio-retention with curb cuts, infiltration galleries, and vegetated swales. The re-designed street can capture runoff from 40 acres.

**Figure: Elmer Avenue Parkway Green Street with Bio-Retention BMPs in Dry and Wet Weather**

*Oros Green Street*. Oros Street was the first green street in the City of Los Angeles. The street was designed to capture runoff from both private homes and the roadway through parkway bio-retention and a street end infiltration trench that is located in a park adjacent to the LA River. The total treatment area is 2.3 acres.

**Figure: Oros Green Street and Street Ends – Example of Green Street and "Rio Vista"**

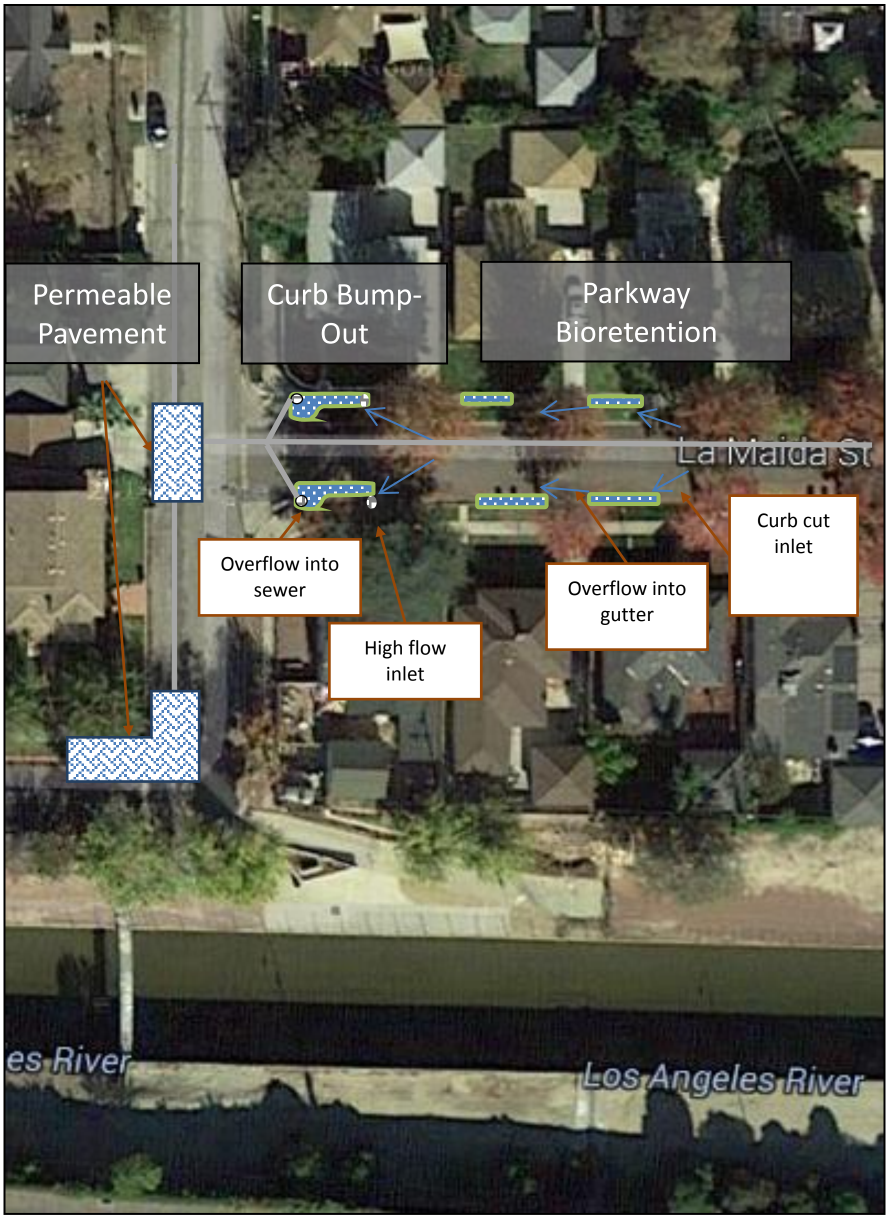


**Figure: Example Green Street Plan View Configuration for a Rio Vista Land Use Application along the Los Angeles River**

Sub-Regional Infiltration

**Program Description**. In sub-regional infiltration, stormwater runoff is collected from multiple parcels, city blocks, or entire neighborhoods into a shared infiltration practice within the public right-of-way or adjacent public/private lands. When possible, existing stormwater infrastructure can be used to convey flows to desired location. Sub-regional infiltration is dependent on available land area for the BMP and a storm drain from the local network that can be diverted into it. Example stormwater BMPs include underground infiltration galleries and bio-infiltration basins.

**Applicability.** Generally, sub-regional infiltration is best suited for areas with ample open space (either unpaved or paved) and close proximity to a storm sewer for diversion. Infiltration galleries can be installed beneath parking lots to provide capture for volume for large tributary areas without losing the parking. Projects can be sponsored by the City and the land for the project can be either purchased outright, or as a permanent easement. Any land use with large impervious areas could be potentially suitable for this practice, including commercial, industrial, and institutional.

Schools and parks offer another opportunity for sub-regional BMP programs, because they have available area, and can stand to benefit from the addition of bio-infiltration practices as they would enhance the park environment while adding the potential for an educational component in the park.

**Local Examples**.

*Broadway Neighborhood Stormwater Greenway Project* - The Broadway Neighborhood Stormwater Greenway Project is a joint partnership between the LABOS, WRD, the Council for Watershed Health (CWH), Santa Monica Bay Restoration Commission (SMBRC), and Geosyntec Consultants. The project includes stormwater capture and infiltration BMPs throughout the neighborhood, including local parcel-based BMPs capturing up to 12 acres, street-corner BMPs that can capture up to 7 acres on two residential streets, commercial corridor green street BMPs, and a sub-regional scale infiltration facility for 30 acres for mixed land uses. The sub-regional BMP is a subsurface infiltration gallery located in a church parking lot that will capture and infiltrate all dry weather flow from 228 acres of mixed land uses and the first flush of stormwater runoff from 22 acres of residential and commercial land uses.

**Figure: Subsurface Infiltration Gallery**
(*photo obtained from [http://stormtrap.com](http://stormtrap.com), accessed online 09/2014*)

*Tujunga Greenway Project* - The Tujunga Greenway Project diverts low flows from the Tujunga Wash Channel allowing it to flow to the LA County right-of-way adjacent to the channel for recharge and the creation of green space.

**Figure: Runoff in Tujunga Wash diverted into the Tujunga Greenway**
(*photo courtesy of LA Stormwater, 2014*)

## DIRECT USE

### General

Direct use of stormwater runoff is the capture and storage of runoff for use in outdoor or indoor non-potable applications.

Site Suitability Constraints

*Pre-treatment* – The size and material of the contributing drainage area determines the potential volume and quality of runoff to be stored in the cistern. Residential and commercial land uses could produce runoff with high rates of trash, bacteria, metals, and nutrients. Industrial land uses may have runoff with heavy metals and organics. High-traffic parking areas can slough off toxic chemicals from automotive fluids such as gas, oil, or antifreeze and particulates. School playgrounds and commercial corridors will produce runoff with comparatively high levels of trash. Pre-treatment will be determined by the nature of influent and plan for use. The nature of the contributing drainage area will dictate how and to what degree debris and particulate matter will need to be filtered out in order to avoid accumulation in the cistern, piping, or valves.

*Method of Diversion* – Capturing flows from off-site parcels requires a concentrated flow that can be diverted into the cistern or storage facility. Storm sewer infrastructure is typically located in the roadway or alleyway, so a main could be diverted to a cistern. Catch basins found along the curb can be directed into the BMP as well. If new or re-development is taking place on a site, there may be the opportunity to incorporate off-site BMPs into site design so that runoff exits at a single point and into a BMP on a nearby parcel.

*Size of Cistern* – The size of the storage facility or cistern will be dictated by the size of the tributary area, hydraulic detention time, and rate of use on site.

*Material* – Cisterns are made from a number of materials including plastic, concrete, fiberglass and steel. Budget, aesthetics, and functionality are considerations when choosing a cistern material.

*Available Space* – The size of the site and availability of space will also factor into sizing and installation of the cistern.

*Intended Use of Water* – The nature and extent of the use dictate the level of treatment that may be required as well as the amount of storage that should be provided. A close look into water demand and feasibility for both indoor or outdoor use applications is necessary to ensure that the quantity of stormwater available will meet needs.

*Stormwater Detention* – Storing runoff during large storms can reduce peak flows and prevent flooding. In order for direct use systems to serve this function effectively, storage volume must be available at the start of a storm. To balance this objective with the desire to have a continuous source of water available for the intended onsite use, “Smart Cisterns” can be utilized. These systems have automated valves that are linked with weather forecasts and can be programed to operate according to system of rules that maximizes stormwater capture and peak flow reduction benefits.

O&M

Successful O&M of direct use systems include regular inspections of the inlets and outlets, cistern structure and stability, pump, and plumbing. Example O&M activities for cisterns are shown in the following table.

**Table: O&M for Cisterns**

| **Component** | **Maintenance Activities** |
|---|---|
| Gutters or inlet piping structure | Clean gutters of debris and check for leaks |
| Inlet screen | Clean screen of leaves, twigs and other debris |
| Cistern stability | Check ground is level, cistern stable, and anchors in place |
| Overflow/outlet | Remove debris or clogging from inlet and overflow pipes |
| Pump | Mechanical repairs |
| Cistern | Remove settleable solids via vacuuming |
| Irrigation piping and plumbing | Repair breaks, flush system to resolve clogging |

**Practices**

Description

Direct use includes a cistern that collects water for irrigation or indoor non-potable demand. Cisterns receive stormwater from an impervious surface, such as roof, parking, or patio areas, and store it for use at a later time.  Cisterns have applicability for nearly all land uses as they can be easily scaled up or down to fit size and water use demands of a site.  Residential, commercial, institutional, industrial, and educational land uses can implement cisterns to capture stormwater and use it for irrigation, toilet flushing, or other non-potable uses (i.e. cooling towers, cleaning tools or equipment, concrete mixing, dust control, etc.).

Simple systems (i.e., small cisterns) have smaller storage and use water for irrigation (hand watering, drip, or gravity fed irrigation).  Soaker hoses or drip irrigation lines can be used to passively drain above-ground cisterns into vegetated area or use the water for washing cars and tools. Soaker hose or irrigation pipe length available for irrigation is limited by height of the cistern.

More complex systems are generally larger, utilize pumps, and employ Smart Cistern technology, and/or include some level of treatment that enables use of the water for spray irrigation, wherein a pump is used to pressurize water from a cistern for use in spray irrigation, or for indoor, non-potable use, such as toilet-flushing, whereby the water can be treated and introduced back into a structure.

A Smart Cistern is an advanced green infrastructure facility. It incorporates a "smart" technology, such as OptiRTC. OptiRTC is a suite of computing services for data monitoring and automated control of water resource systems and advanced green infrastructure. The OptiRTC computing environment enables distributed monitoring and control of a variety of engineered systems (hence the term "Smart Cistern"), bringing real-time, low-cost, flexible computing to green infrastructure. OptiRTC technology allows on-site systems to drain storage in advance of forecasted weather events or other triggers, improving their stormwater-management capacity at the time of the storm. By combining real-time weather forecasts, urban runoff models, redundant cloud computing, OptiRTC can actively operate cisterns to dramatically improve multi-objective wet weather performance.

Schematic Design

A typical cistern application involves collecting runoff from an impervious area, such as a roof or impervious parking area, into a cistern for use purpose. From a roof, runoff is directed into a cistern via a gutter and downspout. For buildings with internal stormwater plumbing, the cistern can either be installed inside the building, at the basement or ground floor, or the stormwater piping can be diverted to make it external to the building. Runoff from paved areas can be collected and diverted to a cistern. Screens or pretreatment is often necessary when harvesting runoff from paved areas to manage trash accumulation and prevent clogging. In this situation, an underground cistern is typically used, unless topography allows for flow to a down gradient cistern. The LADPH has regulations for pipeline construction and use of stormwater to protect public health as described in the Permitting Section.

Cisterns are equipped with two outlets, one for controlled discharge into the direct use application, typically a spigot or ball valve, and an overflow. The overflow is designed to automatically discharge runoff volumes that are in excess of the design volume back into the downspout, into storm sewer infrastructure, or into a downstream BMP.

Underground cisterns can range in size from 50 cubic feet to hundreds of thousands of cubic feet. Runoff first enters a pre-treatment mechanism where sediment, trash, and debris can be settled out for removal later. Water enters a storage reservoir were it is stored until it is pumped for direct use. Treatment, typically chlorination, may be necessary depending on the direct use purpose. When the design volume is exceeded, runoff enters an overflow pipe where it can be discharged back into a storm drain.

A Smart Cistern has a similar schematic design, but is enhanced by smart technology that automates functionality.

Gravity-fed/drip irrigation relies on the downgradient flow of water without the use of pumps. In contrast, spray irrigation and indoor use incorporates a pump to pressurize and transport water for irrigation.

Example schematics for a range of potential systems are provided below.

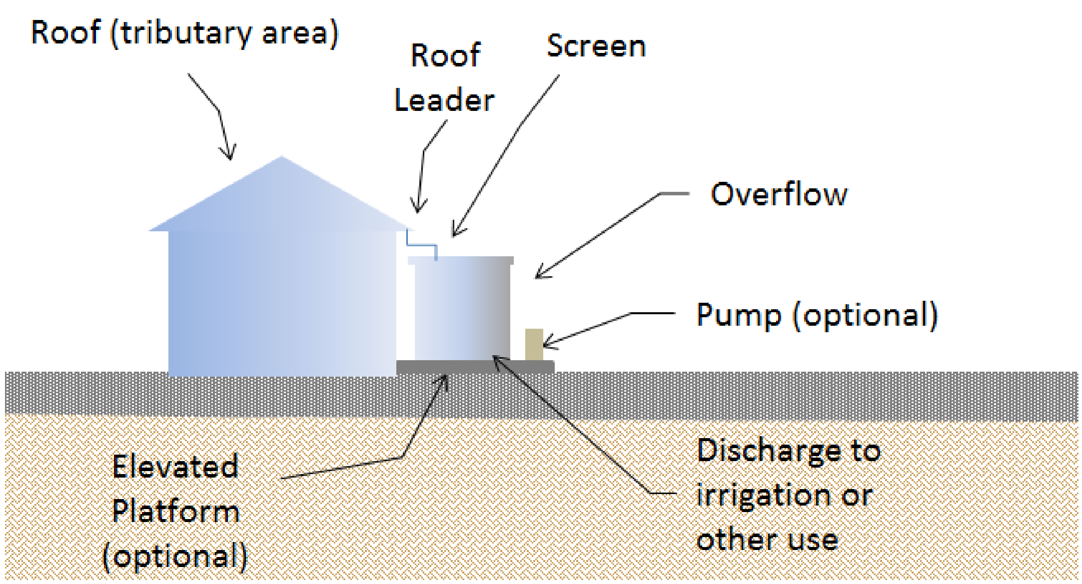


**Figure: Simple Direct Use BMP at a Single-Family Home Typical Cross Section**

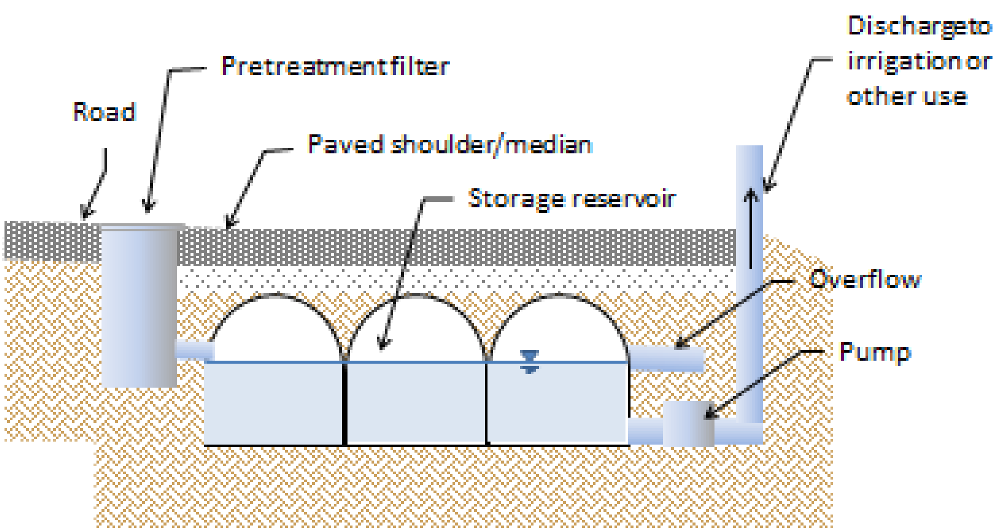


**Figure: Complex Direct Use from Parking Lot Typical Cross Section**

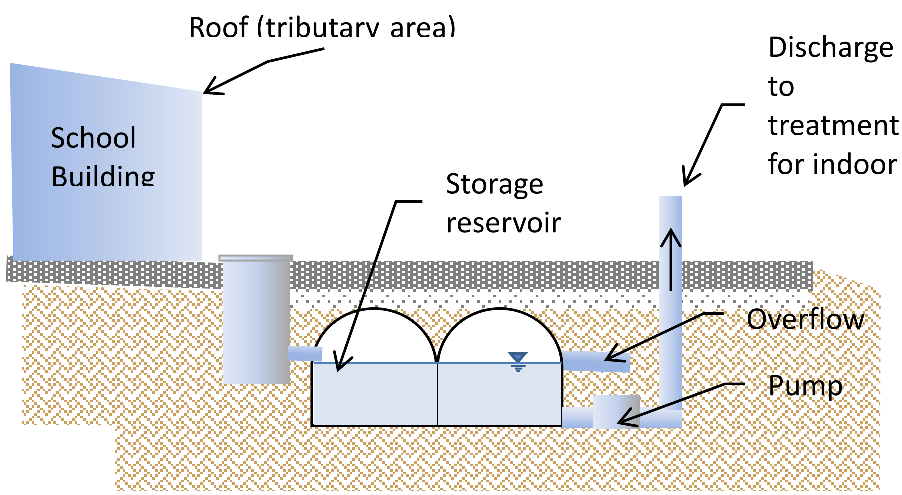


**Figure: Complex Direct Use from School Typical Cross Section**

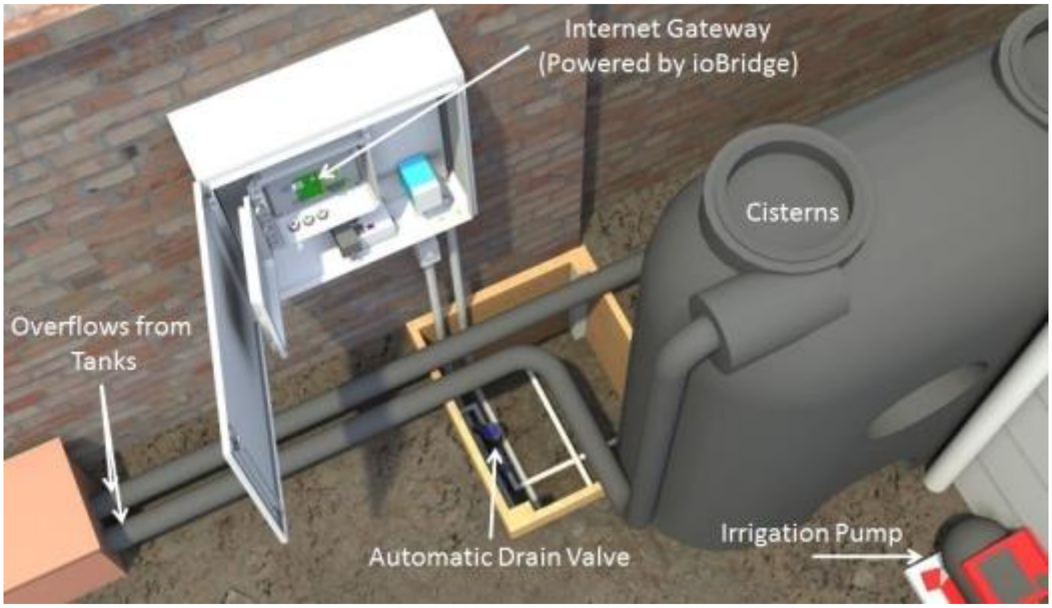


**Figure: Schematic showing a Smart Cistern using OptiRTC for Data Visualization, Operational Alerting, and/or Automated Control**
*(photo courtesy of Geosyntec Consultants, 2014, obtained from [www.optirtc.com](http://www.optirtc.com))*

**Programs**

Direct use programs include:

- Distributed (onsite) direct use
- Sub-regional direct use

Onsite Direct Use

**Program Description**. Onsite direct use of stormwater includes the collection and use of stormwater onsite. This program reduces potable demand, takes pressure off of the municipal water supply, and provides property owners with self-reliance during dry weather. Additionally, property owners will save money on their water bill as they are purchasing less potable water.

**Applicability.** For each of the land uses in the City, different onsite direct use practices may be suitable and can be scaled accordingly. In general, this program is most suitable for areas where soils, depth to groundwater, and geologic conditions preclude infiltration. The table below highlights a selection of practices that could be potentially implemented for different land uses, though it is not meant to be an exhaustive list. Industrial lands uses may be limited to harvesting runoff from roof areas due to high pollutant loading, or treatment may be necessary to reuse water.

**Table: Site Specific Opportunities for Onsite Direct Use**

| Land Use | Site Specific Opportunity |
|---|---|
| Single-Family Residential | Capture runoff from roof for irrigation. |
| Multi-Family Residential | Capture runoff from roof for irrigation. |
| | Divert runoff from storm infrastructure for flushing toilets. |
| Commercial | Car dealerships and mechanics to wash inventory and tools. |
| Institutional | Shopping and retail centers for use in irrigating landscaped areas. |
| | Garden centers for use in irrigating inventory. |
| Industrial | Use harvested rain water to watch fleet of vehicles |
| | Supply decorative water features in hospital and university courtyard and plaza spaces. |
| Educational | Capture runoff from roof for irrigation. |
| | Flushing toilets in hospital and university buildings. |

**Local Examples**.

*Cisterns on Single-Family Homes* - The MWD currently provides a $75 rebate to homeowners for cisterns. Homeowners can receive up to four rebates and are encouraged to use the water for irrigation or other outdoor use. LADWP offered a similar incentive for cisterns in the past (SoCal Watersmart, 2014).

**Figure: Cistern on Single-Family Homes**
*(photo courtesy of SoCal Watersmart, 2014, accessed on-line 08/2014)*

*Cistern at the Santa Monica Public Library* - A 200,000-gallon cistern was constructed under the Santa Monica Public Library building to store and filter runoff from the roof, keeping it out of the storm sewer system. Landscaped areas at Santa Monica Public Library are irrigated with roof runoff captured in the cistern. Only drought tolerant and drought tolerant plants were used (City of Santa Monica, 2013).

**Figure: Inside the Cistern at the Santa Monica Public Library**
*(photo courtesy of the City of Santa Monica)*

Sub-Regional Direct Use

**Program Description**. In sub-regional direct use, stormwater runoff is collected from multiple parcels, blocks, or an entire neighborhood and directed for use in indoor or outdoor non-potable uses. Collection and use of stormwater has many benefits, most importantly supplementing and reducing dependency on municipal water supplies.

Sub-regional direct use includes collecting large volumes of water in cisterns ranging in size from 500 to 100,000 cubic feet. Flows can be routed into storage facilities by diverting storm sewer infrastructure from the public right-of-way onto a private or publicly-owned parcel with available space and adequate use purpose. In most cases, the stormwater is routed into an underground cistern; however, an above ground cistern may be applicable when topography allows. An element of pre-treatment should be incorporated into the system in order to prevent clogging.

The Los Angeles Department of Public Health (LADPH) has regulations for pipeline construction and use of stormwater to protect public health as described in the Permitting Section. Captured runoff can be used to irrigate vegetated areas; however, risks due to exposure are minimized by selective location of irrigation equipment and timing irrigation during the hours of least public exposure. Non-potable and potable water lines must remain separate and be clearly labeled to avoid accidental cross-connections or leaking between lines. The spigot or valve can be connected to a use purpose for drawdown over a prescribed amount of time. The overflow is designed to automatically discharge runoff volumes that are in excess of the design volume into the storm sewer or downstream BMP.

The advantage of sub-regional direct use is that runoff from a relatively large tributary area can be captured using existing stormwater infrastructure; however, the challenge lies in that the BMP site must have the available space to store and a use purpose that draws down the water level in the BMP in timely manner. When considering feasibility for a sub-regional direct use BMP, one should consider tributary area and method of diversion, BMP location, pumping and infrastructure, and use purpose.


**Figure: Direct Use at a Commercial Property Adjacent to the Harbor Freeway**

**Applicability.** Site specific opportunities for sub-regional direct use include applications on commercial, institutional, industrial, recreational and educational land uses. Sites with relatively large amounts of open space and/or high use that would drive the need for toilet flushing are good candidates for sub-regional use. A summary of potential applications for various land uses is shown in the following table.

**Table: Site Specific Opportunities for Sub-Regional Direct Use**

| **Land Use** | **Site Specific Opportunity** |
|---|---|
| Commercial | Car dealerships and mechanics to wash inventory and tools |
| | Shopping and retail centers for use in irrigating landscaped areas |
| | Garden centers for use in irrigating inventory |
| Institutional | Supply decorative water features in hospital and university courtyard and plaza spaces |
| | Flushing toilets in hospital and university buildings |
| Industrial | Water supply in manufacturing processes |
| | Cooling towers |
| | Cleaning tools and equipment |
| Parks (New and Redeveloped) | Toilet flushing in recreation centers |
| | Irrigation of ball fields, landscaped areas |
| Educational | Irrigation of ball fields, edible gardens, landscaped areas |
| | Flushing toilets |

**Local Examples**.

*Legacy Park* - The Legacy Park stormwater BMP diverts a storm drain into a pond that is able to store 2.6 million gallons of runoff. This volume is sent to a water treatment facility and then discharged into Malibu Creek or used for irrigation (RMC Water and Environment, 2014).

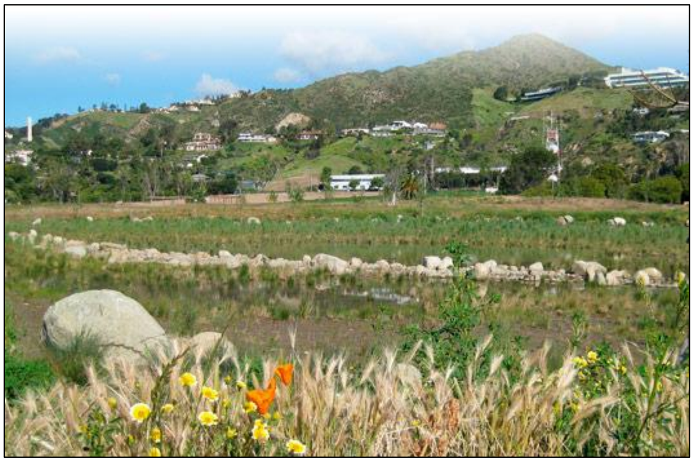

**Figure: Legacy Park Best Management Plan**
*(photo courtesy of RMC Water and Environment, 2014)*

*Garvanza Park Stormwater BMP Project* - The Garvanza Park stormwater BMP is an underground cistern and treatment system that takes runoff from the Avenue 63 storm drain, filters out trash, oil, and other pollutants, and stores it in two detention tanks with a combined capacity of 1 million gallons. Stormwater in one tank is used to irrigate Garvanza Park from a drip system, whereas the other tank infiltrates water into the ground to recharge groundwater (LA Stormwater, 2012).

**Garvanza Park Cistern during Construction**
*(photo courtesy of City of Los Angeles)*

**BENEFITS**

Collection and use of stormwater through the use of infiltrative BMPs and direct use has many benefits. Infiltrative practices such as dry wells, infiltration galleries, permeable pavement and biofiltration help recharge aquifers, thereby augmenting local water supply, while direct use BMPs reduce water demand. Additional benefits are outlined below.

*Water Conservation (direct use BMPs and turf removal)*: Direct use is often described as a demand management technique, offsetting potable demands. In addition, a key benefit of turf removal is water conservation (using less potable water onsite), assuming a change in irrigation practices may result in reduced runoff and pollutant loading into the stormwater system from overspraing and overwatering.

*Recharge of Groundwater Aquifers:* Stormwater infiltration increases the potential for groundwater recharge, allowing stormwater to infiltrate and recharge groundwater aquifers.

*Water Quality:* Water quality benefits include removal or reduction in pollutants of concern from entering the region's surface water bodies.

*Air Quality*: Green streets and other vegetated options for BMPs improve local air quality by providing interception of airborne particulates through the uptake of pollution by trees and vegetation. Where local water supplies are increased, these benefits extend to the reduction in carbon production and greenhouse gas emissions from delivering imported water from the Bay-Delta and the Colorado River.

*Climate Change:* As stated above under air quality, whenever local water supplies are increased, there is a commiserate reduction in carbon production and greenhouse gas emissions from delivering imported water from the Bay-Delta and the Colorado River. If the materials used have a lower reflectivity, the heat island effect in an urban environment will take place. Porous concrete or light colored pavers compared to asphalt will improve the impacts of climate change.

*Flooding:* There are flood control benefits associated with stormwater capture programs. BMPs reduce the amount of stormwater discharged to the storm drain as well as control runoff from sites, which may reduce flooding in some watersheds.

*Sustain Adjacent Vegetation:* Some practices help to sustain adjacent vegetation and increase survival rates of surrounding vegetation. By introducing water into the local soils, the survival rate of vegetation on site will improve as roots have increased access to water.

*Green Space:* Green spaces provide substantial aesthetic improvements to the urban landscape. Specific benefits include:

- Reducing the urban heat island effect. This occurs in urban areas where buildings, roads, and other infrastructure replace open land and vegetation. As a result, surfaces that were once permeable and moist become impermeable and dry, causing urban regions to become warmer than their rural surroundings, forming an "island" of higher temperatures in the landscape.
- Enhancing carbon sequestration, which is the process by which atmospheric carbon dioxide is taken up by trees, grasses, and other plants through photosynthesis and stored as carbon in biomass (trunks, branches, foliage, and roots) and soils.
- Providing wildlife habitat. Infiltration basins provide open, green space, and, if the correct plant species are used, they will provide habitat to native bird and insect species.
- Revitalizing the urban environment and enhancing the surrounding aesthetics.

*Traffic Calming and Roadway Safety:* Green streets provide for calmer traffic as well as improved pedestrian and vehicular access. Similarly, roadway safety conditions are improved by permeable pavement because stormwater infiltrates rather than accumulating on the surface, causing a reduction in instances of hydroplaning. Also, curb bump-outs contribute to increased pedestrian safety.

*Cost Savings (direct use and turf removal)*: There are significant cost savings (less purchased water, minimizing the need for purchasing imported water) that result from implementing direct use programs and/or replacing turf with drought-tolerant plants, mulch, and/or permeable pathways.

*Local jobs:* According to the Water Use Efficiency and Jobs report (Water Use Efficiency and Jobs, Economic Roundtable, December 2011), stormwater projects have the ability to create local jobs and increase the local economy through direct investment, and indirect and induced spending. For every one million dollars invested in local stormwater projects, 12.6 to 16.6 annualized jobs are created, more than other industries such as motion picture and home construction. .

## PERMITTING

### California Environmental Quality Act (CEQA)

The California Environmental Quality Act (CEQA), is a statute that requires state and local agencies to identify the significant environmental impacts of projects and to avoid or mitigate those impacts, if feasible. A project is defined as an activity undertaken by a public agency or a private activity which may cause either a direct physical change in the environment or a reasonably foreseeable indirect change in the environment. The environmental review required by CEQA imposes both procedural and substantive requirements. At a minimum, an initial review of the project and its environmental effects must be conducted. Depending on the potential effects, a further and more substantial review may be conducted in the form of an environmental impact report (EIR).

Small BMP projects installed by private property owners will likely not trigger CEQA requirements, but a project sponsored by the City or other public agencies will have to go through the CEQA review process. However, most BMP projects would qualify for a CEQA Categorical Exemption Class 3 and 4, which limits the CEQA compliance requirements substantially. Class 3 exempts new, small facilities or structures; installation of new equipment and facilities in small structures; and the conversion of existing small structures from one use to another where only minor modifications are made in the exterior of the structure. This includes water mains and other utility extensions, including street improvements of reasonable length to serve such construction. Class 4 consists of minor public or private alterations in the condition of land, water, and/or vegetation which do not involve removal of healthy, mature, scenic trees except for forestry or agricultural purposes. This includes new gardening or landscaping, including the replacement of existing conventional landscaping with water efficient or fire resistant landscaping.

**Regulation of Stormwater Discharges**

Regulation of stormwater discharges by the Federal Clean Water Act and California Porter Cologne Act will add permitting requirements to some BMP projects, but more often these acts will trigger the construction of more stormwater capture BMPs.

<u>Federal Clean Water Act Section 303(d) and California Porter-Cologne Act</u>

Section 303(d) of the Clean Water Act (CWA) requires identifying and listing “impaired” water bodies (water bodies for which designated beneficial uses are being compromised by water quality). This is done by conducting a Water Quality Assessment that addresses the condition of regional surface waters. Findings are reported into the Integrated Report. The 2010 Integrated Report and updated 303(d) list were approved by the State Water Board on August 4, 2010 and by the EPA on October 11, 2011.

Once a water body has been deemed impaired, a total maximum daily load (TMDL) must be developed for the impairing pollutant(s). A TMDL is an estimate of the total load of pollutants from point, non-point, and natural sources that a water body may receive without exceeding applicable water quality standards. Once established, the TMDL allocates the loads among current and future pollutant sources to the water body.

The Porter-Cologne Act is the primary vehicle for implementation of California's responsibilities under the federal CWA by granting the State Water Resource Control Board (State Water Board) and the Regional Water Quality Control Boards (Regional Water Boards) power to protect water quality. The Porter-Cologne Act grants the State Water Board and the Regional Water Boards authority and responsibility to adopt plans and policies, to regulate discharges of waste to surface and groundwater, to regulate waste disposal sites and to require cleanup of discharges of hazardous materials and other pollutants.

National Pollutant Discharge Elimination System (NPDES) Stormwater Permits

CWA Section 402(p), requires certain permits for stormwater discharges via the National Pollutant Discharge Elimination System (NPDES). Two NPDES permits have the potential to impact BMP implementation in Los Angeles.

The 1987 amendment to the CWA, required that the EPA issue National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater permits for discharges from large Municipal Separate Storm Sewer Systems (or MS4s), which are systems serving a population of 250,000 or more. An NPDES Permit allows clean stormwater discharges into rivers, lakes or the ocean. The Los Angeles Regional Board issues NPDES Permits in the Los Angeles area with the permit requiring a decrease in pollutants in stormwater and urban runoff.

**NPDES Municipal Separate Storm Sewer Systems (MS4) Permit Order No. R4-2012-0175 (MS4 Permit).** MS4 Permits are required for all large MS4s, which are storm sewer systems serving a population of 250,000 or more. This MS4 permit was adopted on November 8, 2012, by the Los Angeles Regional Water Board and became effective December 28, 2012 (LA Regional Water board, 2012). Part VI.D.7.c.i. of the Permit requires that new development/ redevelopment projects that meet threshold criteria provide onsite stormwater treatment and infiltration. Specifcally, these projects are required to retain on-site the 0.75-inch, 24-hour rain event or The $85^{th}$ percentile, 24-hour rain event, *whichever is greater*.

The MS4 Permit will therefore dictate minimum BMP sizing requirements for development/redevelopment projects that meet the MS4 threshold criteria.

**NPDES Construction General Permit Order No. CAR000002 (Construction General Permit).** The current Construction General Permit was adopted by the State Water Board on September 2, 2009 to regulate stormwater discharges from construction sites.

Under this Construction General Permit, discharges of stormwater from construction sites with a disturbed area of one or more acres are required to either obtain individual NPDES permits for stormwater discharges or to be covered by the Construction General Permit. Coverage under the Construction General Permit is accomplished by completing a construction site risk assessment to determine appropriate coverage level; preparing a Stormwater Pollution Prevention Plan (SWPPP), including site maps, a Construction Site Monitoring Program (CSMP), and sediment basin design calculations; and completing a Notice of Intent. All of these documents must be electronically submitted to the State Water Board for General Permit coverage. The primary objective of the SWPPP is to identify and apply proper construction, implementation, and maintenance of BMPs to reduce or eliminate pollutants in stormwater discharges and authorized non-stormwater discharges from the construction site during construction. The SWPPP also outlines the monitoring and sampling program.

Coverage under this permit would not be required for construction of BMPs where the total project (i.e. the BMP plus any other project component) disturbs less than one acre, as would be the case for most residential BMP projects.

**City of Los Angeles Low Impact Development Ordinance**

Similar to the MS4 permit, the City of Los Angeles Low Impact Development (LID) Ordinance puts stormwater capture requirements on new and redevelopment projects. The thresholds for the LID Ordinance are lower than those for the MS4 Permit, so it applies to more projects but the BMP sizing requirements are less rigorous, in that project sites have to capture the 0.75-inch storm, or the 85th percentile storm, *whichever is smaller*.

**Construction on Private Property**

The Los Angeles Department of Building and Safety (LADBS) is responsible for permitting improvements on private property. The LADBS may require permits for BMPs on private property. The LADBS provides guidelines for stormwater infiltration. According to these "Guidelines for Storm Water Infiltration" (LADBS, 2011), infiltration facilities that are adjacent to buildings or structures are required to be evaluated by a soils engineer and approvals from the Grading Division and the Bureau of Sanitation are required before any permit can be issued. A Soils Report, written by the soils engineer and submitted to the Grading Division, is required to evaluate the effects of infiltration prior to the issuance of any permit. The Guidelines state that stormwater infiltration is not allowed anywhere that is subject to liquefaction, and also lists a number of minimum design requirements, including the following:

- Infiltration must occur at least 10 feet above the groundwater table.

- The distance between the infiltration facility and private property is 10 feet minimum; the distance between the bottom of the footing and the expected zone of saturation is also a 10 foot minimum.
- Infiltration facilities should be designed to overflow to the street if their drainage capacity is exceeded or infiltration abilities fail.

These permitting requirements, especially as they pertain to residential BMP installations, pose potentially insurmountable obstacles to implementation of infiltration BMPs. To reduce this impediment and encourage the implementation of BMPs on residential properties, WaterLA (www.waterla.org) is currently working with Departments of Planning, Sanitation, Street Services, Building & Safety and LADWP to create consistent guidance and achievable permitting requirements for residential BMPs that adequately protect public health and safety. As a part of this effort standard plans are being developed to streamline the permitting process. Once finalized, these plans and 'How-To' guides will become a new chapter in the City's Low Impact Development guidebook for voluntary adoption by homeowners.

**Construction in the Public Right of Way**

Los Angeles Municipal Code (LAMC), Section 62.105, requires permits be obtained for construction in the public right-of-way. The public right-of-way generally consists of street easements that contain City streets, lanes, alleys, parkways, and sidewalks. The public right-of-way also includes public easements and unimproved streets. All green street projects would require these permits, and some projects on private property may also require these permits in order to tie in to the storm sewer system. The LAMC, Section 62.106 prescribes the types of construction permits required based on the scope of construction work. The Los Angeles Bureau of Engineering (BOE) is the agency responsible for granting these permits.

The following is a list of potential permits that may be required for BMP construction projects:

- A-Permit (Minor Street Construction)
- B-Permit (Larger More Complex Construction in the Public Right-of-Way).
- Revocable Permit (R-Permit):
- Excavation in Public Streets (E-Permit and U-Permit)
- Sewer and Storm Drains Connections Permit (S-Permit)
- Construction in Watercourse (W-Permit)

The "Manual for Work in the Public Right-of-Way" (BOE, 2014) provides a guide to the process of obtaining permits required for construction projects within the City's public right-of-way.

The City of Los Angeles has developed standard plans for green streets to facilitate and expedite permitting (City of Los Angeles, 2010). The document is entitled, "Green Streets and Green Alleys: Design Guidelines Standards" (City of Los Angeles Department of Public Works, 2009).

Green Street Standard Plans are City-approved construction details for Green Street elements that incorporate stormwater BMPs into the pre-approved designs. These standard plans were adopted to facilitate inclusion of BMPs in street projects and ensure more uniform stormwater BMPs throughout the City. As pre-approved engineering drawings, they can be readily incorporated into construction and contract documents by reference. Since most of the design parameters are pre-approved, these plans require minimum engineering and hence receive expedited plan checks and receive reduced permit fees.

Green Street Standard Plans are used by City staff when designing new streets or improving existing streets, and can also be used by developers, contractors or other municipal users. They can be incorporated into specific plans, redevelopment areas, private developments, and public works improvement areas. Specifically, the guidelines and standards address the following:

- Design strategies for green streets and parking lots
- Design strategies for green alleys
- Design examples for the City of Los Angeles
- Implementing green streets and parking lot projects.
- Key design and construction details
- SUSMP infiltration requirements and guidelines
- General guidelines for stormwater infiltration

**Los Angeles Department of Water and Power (LADWP)**

Bio-infiltration BMPs may require new water connections to provide temporary irrigation during the establishment period for project plantings. The LADWP requires a permit to connect to existing LADWP water lines. However, it is assumed that water connections already exist for the residential homeowners, commercial property owners, and sub-regional BMP locations.

**Direct Use**

The Los Angeles County Department of Public Health (LACDPH) "Guidelines for Harvesting Rainwater, Stormwater, & Urban Runoff for Outdoor Non-Potable Uses" (LACDPH, 2011) provides necessary information on direct use of stormwater. Requirements, uses, water quality standards, and treatment processes are summarized in the following table.

**Table: LACDPH Guidelines for Harvesting Rainwater, Stormwater, & Urban Runoff for Outdoor Non-Potable Uses** (*adapted from LACDPH, 2011*)

| **Requirements** | **Use** | **Minimum Water Quality Standard** | **Treatment Process** |
|---|---|---|---|
| Tier I – Onsite Collection of Rainwater in Rain Barrels for Onsite Use in Gravity Flow Systems | | | |
| - Rain barrels must have a screened inflow opening, a spigot, and/or hose bib, and an overflow pipe or equivalent.<br>- Rain barrels shall be labeled to indicate non-potable water use only.<br>- The system may not be connected to indoor/outdoor municipal potable plumbing, and shall not be pressurized or sprayed.<br>- The system must be installed in accordance with the rain barrel manufacturer's installation instruction and requirements of local agencies. | Landscape irrigation<br><br>Car washing | N/A | N/A |
| Tier II – Onsite Collection of Rainwater in Cisterns for Onsite Use | | | |
| - Must exclude rainwater collected from locations zoned for agricultural, manufacturing, or industrial use.<br>- Must be installed in accordance with the manufacturer's instructions and local agency requirements; be equipped with an overflow device or rain diverter; be screened or otherwise equipped to prevent vector intrusion.[1]<br>- Requires prior review by LACDPH Cross Connections Program or appropriate local agency in order to reduce risk of cross connection with potable water supplies.<br>- Spray irrigation of Tier II water is allowed only when there is negligible human exposure (i.e., between the hours of sunset and sunrise).[2] | Drip or subsurface irrigation | N/A | Pre-screening |
| | Spray irrigation<br><br>Non-interactive outdoor water feature | Total coliforms <10,000 MPN/100 mL<br><br>Fecal coliforms <400 MPN/100 mL<br><br>Enterococcus <104 MPN/100 mL | Pre-screening<br><br>Disinfection-chlorination or equivalent treatment required for systems other than private residential systems. All Tier II systems will be inspected and approved by LACDPH. |
| Tier III – Onsite or Offsite Collection of Rainwater, Stormwater, and Urban Runoff in Cisterns for Onsite or Offsite Use (excludes water collected from locations zoned | | | |

| **Requirements** | **Use** | **Minimum Water Quality Standard** | **Treatment Process** |
|---|---|---|---|
| for high use transportation corridors, industrial, agricultural, or manufacturing uses) | | | |
| - Must be installed in accordance with the manufacturer's instructions and local agency requirements and be equipped with an overflow device, vector control measures, and screened openings.<br>- Require prior project plan review by LACDPH and by the local building & safety department.<br>- Spray irrigation of Tier III water is allowed only when there is negligible human exposure, such as sunset to sunrise.[2, 5]<br>- A Typical Tier III system for offsite collection may also require one or more of the following: [4]<br>○ Storm drain diversion<br>○ Pre-treatment screening/sedimentation device<br>○ Pump station (where applicable)<br>○ Underground retention facility and disinfection facility (where applicable)<br>○ Recirculation system<br>○ Connection to a distribution system<br>○ A supplemental water supply from a domestic source via an approve dedicated backflow prevention device | Drip or subsurface irrigation | N/A | Pre-screening |
| | Spray irrigation<br>Non-interactive outdoor water feature<br>Street sweeping<br>Dust control | Total coliforms <10,000 MPN/100 mL<br>Fecal coliforms <400 MPN/100 mL<br>Enterococcus <104 MPN/100 mL<br>Tier III water shall meet all bacterial limits at the point of use when distributed offsite. | Disinfection – chlorination, or equivalent<br>For street sweeping, retention/sedimentation |
| Tier IV – Onsite or Offsite Collection of Rainwater, Stormwater, and Urban Runoff in Cisterns for Onsite or Offsite Use (includes water collected from locations zoned for high use transportation corridors, industrial, agricultural, or manufacturing uses)[3] | | | |
| - Require prior review by LACDPH and by the local building & safety department.<br>- Shall have a stormwater monitoring plan that includes sampling and analysis for a minimum of 3 storm events per year. Analyses shall be performed for metals, VOCs, and semi-VOCs. Annual summary of | Onsite drip or subsurface irrigation | N/A | Pre-screening |
| | Spray irrigation<br>Non-interactive | Total coliforms <10,000 MPN/100 mL | Disinfection – chlorination, or equivalent |

| **Requirements** | **Use** | **Minimum Water Quality Standard** | **Treatment Process** |
|---|---|---|---|
| analyses must be maintained on premises. After 9 storm events with sampling & analysis, LACDPH will assess sampling results and notify operator if continued sampling is required.<br>- Must be installed in accordance with the manufacturer's instructions and local agency requirements; be equipped with an overflow device; be equipped with screened openings for vector control.<br>- When Tier IV treated water is present in the system, it shall be tested on a quarterly basis to determine compliance with the referenced water quality standards. If exceeded, then the operator shall cease further distribution of Tier IV treated water until it meets the standards, and shall promptly notify the local enforcement agency.<br>- Spray irrigation of Tier IV water is allowed only when there is negligible human exposure, such as sunset to sunrise.[2,]<br>- A typical Tier IV system for offsite collection may also require any of the following items listed for a Tier III system. | outdoor water feature<br><br>Street sweeping<br><br>Dust control | Fecal coliforms <400 MPN/100 mL<br><br>Enterococcus <104 MPN/100 mL<br><br>All bacterial limits must be met at point of use.<br><br>Must also meet CA MCLs and the CA Toxics rule Standards | For street sweeping, retention/sedimentation |

N/A – Not Applicable

MPN/mL – Most Probably Number/milliliters

[1] Due to an absence of a national standard, a plan review by LACDPH or the local building & safety department is also necessary.

[2] Spray irrigation during daylight can be done if a dedicated supply of potable water is used, and the potable water is protected by an approved backflow device.

[3] Tier IV water qualities will be reviewed case by case by the LACDPH, Los Angeles Regional Water Board, and other applicable local agencies.

[4] If quarterly testing indicates compliance with state MCLs, then treated rainwater, stormwater, and/or urban runoff can be used for all the listed uses. If testing is not compliant with MCLS, but compliance with the CA toxics Rule standards for human health, then the water can be used for spray irrigation only during sunset to sunrise and/or when there is negligible potential for human exposure. A dedicated supply of potable water protected with an approved backflow device is allowed to be connected to the cistern irrigation system to supplement spray irrigation during daylight hours.

5 Studies of Tier III waters are not a current requirements, but proposed studies by the City of Los Angeles and other entities will be reviewed by LACDPH for consideration in future revisions.

## IMPLEMENTATION STRATEGIES

Strategies for implementation of the six proposed programs throughout the City could involve both regulatory and incentive components.

Parcels undergoing new and redevelopment will trigger stormwater regulations, and thus will be required to mitigate stormwater through the use of stormwater BMPs. As a result, stormwater BMPs are quickly becoming standard in new construction; however, much of the existing building stock in the City of Los Angeles will not trigger these regulations for many years, if at all. For this reason, technical and financial assistance through voluntary incentive programs could be made available to hasten implementation of stormwater capture BMPs. In order for wide-spread implementation to take place, an economic case must be made for BMP installation. Programs, such as stormwater utility fee/discounts, direct grants, and inter-agency Memorandum of Understanding (MOUs), are all important tools for implementing these practices throughout the City of Los Angeles. Specific program implementation strategies will be developed in Task 5, but possible incentives and agreements may include:

Stormwater Utility Fee/Discount Program

A stormwater utility fee/discount program assigns a fee to properties based on the amount of impervious area on site and will apply an associated discount if runoff is mitigated through stormwater BMPs. By creating a disincentive to create impervious area and an incentive to capture stormwater, the financial case is strengthened for installing stormwater BMPs. Implementing a stormwater utility fee/discount program is applicable for all privately-owned properties such as residential, commercial, institutional, and industrial land uses as the property owners will be able to draw clear parallels between the amount of their impervious area and financial interests.

Direct Grants

Direct incentive programs comprised of grants are appropriate for multi-family residential, institutional, industrial, and commercial land uses. These property owners may not be willing to pay for the full project cost or have the technical expertise, but they are aware of the long-term financial benefits of water use and infiltration. Partial financial assistance and technical resources will provide just enough support to encourage the property owner to move forward. The exact grant or amount necessary can be determined using focus groups. Grants are more appropriate for larger-scale projects that will require oversight and management from City of Los Angeles.

Rebates

Rebates are appropriate for existing developments, particularly smaller, more dispersed practices such as small cisterns and permeable pavement for single-family homes. A dollar amount per square foot rebate can be offered for each square foot of impervious surface mitigated. Rebates can be used on multi-family residential, commercial, institutional, and industrial properties as well, but different processes and design standards would need to be developed as compared to single-family residential. Rebates that are applicable can be administered using a standard application and simple verification process.

Memorandum of Understanding (MOUs)

Given that stormwater BMPs often serve across purposes and have benefits for water conservation, water quality improvement, flood control, aesthetics, and educational benefit, there is great opportunity for partnership between agencies, and MOUs provide a mechanism for this collaboration. For example, LAUSD can partner to incorporate permeable pavement into existing school modernization efforts, and funding can be transferred using a MOU.

Ordinances

The City of Los Angeles passed and Low Impact Development (LID) ordinance in May of 2012, which ensures that development and redevelopment projects incorporate stormwater capture at its source.  Currently, this ordinance applies to the following developments:

- Single-family hillside residential developments
- Housing developments of 10 or more dwelling units (including single family tract developments)
- Industrial /Commercial developments with one acre or more of impervious surface area
- Automotive service facilities
- Retail gasoline outlets
- Restaurants
- Parking lots of 5,000 square feet or more of surface area or with 25 or more parking spaces
- Projects with 2,500 square feet or more of impervious area that are located in, adjacent to, or draining directly to designated Environmentally Sensitive Areas (ESA)

To increase stormwater capture program implementation, this ordinance can be expanded or additional ordinances passed to include stormwater capture and infiltration or use on:

- All single-family or multi-family housing units getting bought or sold

- Industrial /Commercial/Institutional developments with 1/4 acre or more of impervious surface area
- On single or multi-family residential and commercial properties that are undergoing rehabilitation or remodels

Market-Based Approaches

A volume-based stormwater credit trading system can be implemented which creates market-based incentives to voluntarily implement stormwater capture. In the market-based approach, property owners or third-party entities can elect to implement stormwater BMPs and either sell those volume-based credits back to LADWP or to other property owners that are unable to meet their own volume regulatory requirements for a development.

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# APPENDIX J. TM3 PROGRAM UNIT RESPONSE CURVES

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# Technical Memorandum 3

Date: January 15, 2015; revised August 2015

To: Andy Niknafs, Rafael Villegas, LADWP

From: Mark Hanna, Rebecca Batchelder, Scott Mansell, Leah Lemoine, and Aaron Poresky, Geosyntec

Subject: Stormwater Capture Master Plan: Task 3-Develop Stormwater Capture Alternatives
Geosyntec Project: LA0282

## 1. PURPOSE AND OBJECTIVE

The purpose of Task 3 of the Los Angeles Department of Water and Power's (LADWP) Stormwater Capture Master Plan (SCMP) was to identify and develop stormwater capture alternatives to be potentially included as components of the SCMP. This memo focuses on the programmatic alternatives that were developed; the centralized alternatives that were also developed as part of Task 3 are described in the SCMP and its appendices. Its appendices are not part of this memo.

For the purposes of this report, a stormwater capture program is defined as a coordinated effort to install similar BMPs throughout the City. Stormwater capture programs can be implemented to varying degrees in a variety of different locations and settings, with varying results. To assist LADWP in selecting where and to what degree programs should be implemented for the SCMP, it is necessary to understand their cost and benefits under a range of implementation scenarios. This memo describes the programs that were identified for potential inclusion in the SCMP and outlines the methodology used to determine where they could be appropriately implemented and evaluate their cost and benefits under different implementation scenarios. Finally, this memo summarizes the preliminary conclusions that can be drawn from the technical analyses that will be used to guide the development of the programmatic component of the SCMP.

## 2. DEFINITION OF STORMWATER CAPTURE PROGRAMS TYPES

As mentioned above, a stormwater capture program is a coordinated effort to install similar distributed BMPs throughout the City, often on a specific land use or property type. Example programs include a residential rain barrel rebate program, or an incentive program for commercial parking lot retrofits. To maximize the reach of the modeling efforts performed for this task, rather than developing individual programs, like those described above, general program categories (referred to as program types in this report) were developed.

Program types and the BMPs they might include are described below. A more detailed discussion of each program type including program details, BMP schematics, permitting considerations, and potential funding strategies, can be found in the Stormwater Capture Program Fact Sheets in Appendix A.

## 2.1 Best Management Practices

As described above, a stormwater capture program involves repeated applications of a single type of distributed BMP across the City. The BMPs evaluated in this task, which are considered to be a representative mix of general BMP types, are described below:

**Self-mitigating permeable pavement.** Porous asphalt, porous concrete, or interlocking pavers installed on top of gravel subbase and bedding layers, to facilitate stormwater flow through the pavement to be stored and infiltrated in the subbase. Because this sub-category of permeable pavement is designed to capture only the stormwater that falls directly on the BMP footprint (self-mitigating), the subbase is relatively small.

**Permeable pavement with tributary area.** Permeable pavement receiving run-on from tributary areas beyond the BMP footprint. This sub-category of permeable pavement requires a deeper subbase to store and infiltrate runoff from the larger tributary area.

**Simple on-site rain garden.** A depressed landscaped area which is designed to store and infiltrate stormwater runoff. Simple on-site rain gardens can be used in green streets applications in parkways. Rain gardens installed as parkway retrofits are relatively simple systems that accept runoff from the roadway via curb cuts and do not have direct connection to sewer infrastructure.

**Complex bioretention.** A depressed landscaped area underlain by a gravel subbase which is designed to store and infiltrate stormwater runoff. Can infiltrate larger volumes of stormwater than a simple rain garden because of the additional storage provided by the gravel subbase.

**Dry wells.** An underground chamber filled with gravel and/or a vault structure that accepts and stores stormwater for infiltration into the surrounding soils.

**Right-of-Way (ROW) bulb-out.** Complex bioretention implemented along the road way, which requires moving the curbline into the roadway to make space for the BMP footprint. ROW bulb-outs differ from parkway bioretention in that more infrastructure and design is needed to account for more challenging site conditions. Such items include moving the curb, adding additional storage capacity, and connecting the overflow to the storm sewer system.

**Underground infiltration gallery.** An underground structure capable of storing large volumes of stormwater for infiltration in the surrounding soils, typically used for subregional applications.

**Infiltration basin.** A large shallow artificial pond with porous bottom and side-slopes, typically 4 to 6 feet deep, designed to infiltrate stormwater through permeable soils into the surrounding soils, typically used for subregional applications.

**Simple direct use.** An above-ground cistern for stormwater capture for use in gravity-fed, outdoor use.

**Complex direct use.** An above or below-ground cistern with pumps and treatment system to allow for indoor non-potable use and/or pressurized outdoor use.

## 2.2 Program Types

The program types developed for this task are general categories that are inclusive of several specific programs that, from a stormwater capture perspective, behave similarly. These program types were developed using two program attributes: type of capture and potential tributary area. Type of capture describes how the stormwater is used; either to augment groundwater aquifers (infiltration) or for local non-potable uses (direct use). Potential tributary area could be the footprint of the BMP (self-mitigating), the property on which the BMP is installed (on-site), the ROW and the portion of properties draining to the ROW (ROW contributing), or a group of properties or neighborhood draining to the BMP (subregional). Combining different permutations of these attributes resulted in six general program types, as illustrated in Table 1.

**Table 1. Program Types**

| Capture Type | Tributary Area | Program Type |
|---|---|---|
| Infiltration | Self-mitigating | Self-mitigating BMPs |
| | On-site | On-site infiltration |
| | ROW contributing | Green Streets |
| | Subregional | Subregional infiltration |
| Direct Use | On-site | On-site direct use |
| | Subregional | Subregional direct use |

Each of these program types may be applied in different land uses or have different land uses contributing runoff to them. Though they would behave similarly in terms of physical processes across land use types, the area available for implementation and the implementation strategies may be different. Program type subcategories were developed to provide additional information during the implementation planning task of the SCMP. Each of the program types and their program type subcategories are described in further detail below.

**Self-Mitigating BMPs** Self-mitigating BMPs are designed to infiltrate water that falls directly on them rather than collect runoff from a larger tributary area. Since there is not a tributary area other than the footprint of the BMP, the pavement system will require less excavation and fewer materials than permeable pavement designed to treat a larger tributary area, making it a good option for smaller scale projects. Though these BMPs capture runoff from just their own footprints, they can be applied over a large area, for example driveway retrofits for an entire block or neighborhood, to have a significant cumulative impact. The subcategories for this program type include single-family residential, multi-family residential, commercial, institutional, industrial, and educational.

**On-site Infiltration** The on-site infiltration program type includes all programs that collect stormwater runoff from impervious or compacted areas on a property for infiltration within the same parcel. BMPs that can be implemented as part of on-site infiltration include permeable pavement, bio-infiltration, and subsurface infiltration. These BMPs can be integrated into existing landscaping or hardscaping and can help improve the aesthetics of a property in addition to providing an environmental resource. For each land use in the City, different on-site infiltration BMPs may be suitable and can be scaled depending on the contributing area. Multiple BMP types can be implemented on a single site to tailor fit stormwater capture and infiltration designs and, as a result, maximize capture. The subcategories for this program type include single-family residential, multi-family residential, commercial, institutional, industrial, and educational.

**On-site Direct Use** On-site direct use of stormwater includes the collection of stormwater generated on a parcel for non-potable on-site uses (e.g. irrigation or toilet flushing). On-site direct use reduces potable demand, thereby relieving the municipal water supply. On-site direct use BMPs can be scaled up or down to meet the user's water reuse demand, whether the BMP is a cistern at a single family home used for irrigation or a school or commercial facility using the water for flushing toilets. Some degree of treatment will be necessary when capturing and using stormwater on site. A simple, low-volume system used for outdoor use may require coarse screens to capture large debris; whereas indoor use will require more complex treatment to meet Los Angeles County Department of Public Health (LACDPH) water quality standards and treatment processes. The subcategories for this program type include single-family residential, multi-family residential, commercial, institutional, industrial, and educational.

**Green Streets.** Green streets programs involve incorporating one or more BMPs to manage stormwater runoff within the street right-of-way while still maintaining the roadway's primary function of accommodating vehicular traffic and safe pedestrian access. Stormwater BMPs implemented in a green street application can capture and infiltrate runoff from the street itself as well as runoff from adjacent properties that flows into the curbline of the street. BMPs can be located in/or beneath the street and sidewalk (permeable pavement, dry wells) or in parkways (vegetated swales, bio-retention curb bulb-outs, tree wells, and planters, and bioretention basins). Streets undergo a regular cycle of repair and replacement by the City and consequently offer an important opportunity for stormwater-oriented retrofits.

Similar to the program types above, land use was used as a basis for developing subcategories (commercial green streets and residential green streets). Additionally, a third subcategory (rio vistas) was developed that represents a unique implementation opportunity to leverage and expand the work of the Los Angeles River Cooperation Committee's Rio Vista Project that has the goal of converting entry points of the Los Angeles River into community assets.

**Subregional Infiltration.** In subregional infiltration, stormwater runoff is collected from multiple parcels, city blocks, or entire neighborhoods into a single infiltration BMP within the public right-of-way (ROW) or adjacent public/private lands. Subregional infiltration projects often divert water from a storm drain line. However, in some instances, they may be fed via surface flow. BMPs that could be used for a subregional infiltration program include underground infiltration galleries and bio-infiltration basins. Subregional infiltration BMPs can be adapted to meet the needs of a property owner or neighborhood. For example, a vegetated bio-infiltration basin can provide habitat and visual interest. When space constraints are such that land area is needed for other purposes such as parking, bike paths, or sidewalks, the BMP can be contained underground as with an infiltration gallery. Because the land uses contributing to a given BMP would be mixed, the subregional infiltration program type was not broken out into multiple subcategories.

**Subregional Direct Use.** In subregional direct use, stormwater runoff is collected from multiple parcels, city blocks, or an entire neighborhood and stored for use in potentially indoor or outdoor non-potable and potentially potable uses. Flows are routed into storage facilities, such as a cistern or pond, by diverting storm drain infrastructure from the ROW onto a private or publicly owned parcel with available space and adequate reuse purpose. Stored water is treated and then pumped to its end purpose, which may include irrigation, toilet flushing, or cleaning vehicles and equipment. Collection and use of stormwater has many benefits – most importantly, supplementing and reducing dependency on municipal water supplies. Because the land uses contributing to a given BMP would be mixed, the subregional direct use program type was not broken out into multiple subcategories.

## 2.3 Program Type Summary

The table below lists all of the program types, subcategories, BMPs that could be used as part of implementation, and examples of specific programs that could be applied to different land use types throughout the City. The program examples are provided to give some context to the program types; a more complete discussion of specific programs will be included in the implementation section of the SCMP.

**Table 2. Stormwater Capture Program Types, Associated BMPs, and Program Examples**

| Program Type | Subcategory | BMPs | Specific Program Examples |
|---|---|---|---|
| **Impervious Replacement** | Single-Family Residential | Self-Mitigating Pervious Pavement | Driveway, patios, and walkways retrofit program |
| | Multi-Family Residential | | Driveway, parking lot, patios, and walkways retrofit program |
| | Commercial | | Parking lot retrofit program |
| | Institutional | | Parking lot/courtyard retrofit program |
| | Industrial | | Loading docks and parking lots retrofit program |
| | Educational | | School yard retrofit program |
| **On-site Infiltration** | Single-Family Residential | Permeable Pavement with Tributary Area, Simple On-site Rain Gardens, Complex Bioretention, Dry Wells , ROW Bulb-outs | Residential rain garden program |
| | Multi-Family Residential | | Residential rain garden program |
| | Commercial | | "Big Box Store" parking lot retrofit program |
| | Institutional | | Hospital parking lot retrofit program |
| | Industrial | | LADWP-owned facilities implement bio-infiltration basins and subsurface infiltration BMPs |
| | Educational | | Los Angeles Unified School District schoolyard retrofits with bio-infiltration |
| **On-site Direct Use** | Single-Family Residential | Simple Direct Use, Complex Direct Use | Residential cistern program for irrigation |
| | Multi-Family Residential | | Residential cistern program for irrigation |
| | Commercial | | Commercial cistern program for irrigation or indoor use |
| | Institutional | | Cistern program at police and fire stations for use in vehicle cleaning |
| | Industrial | | Industrial cistern program for irrigation or indoor use |
| | Educational | | Cistern program for universities for irrigation or indoor use |
| **Green Street Programs** | Commercial Streets | ROW Bulb-outs, Permeable Pavement | Green streets program in commercial corridors |
| | Residential Streets | | Parkway bioretention program |

| Program Type | Subcategory | BMPs | Specific Program Examples |
|---|---|---|---|
| | Rio Vistas | with Tributary Area, Simple On-site Rain Garden, Dry Wells | Green streets retrofits along street ends adjacent to major streams and rivers |
| **Subregional Infiltration** | N/A | Underground Infiltration Gallery, Infiltration Basin | Install infiltration galleries on school properties to capture runoff from neighborhood |
| | | | Incentives to manufacturing and shipping companies to house subregional infiltration facilities |
| | | | Program to standardize the integration of subregional infiltration in all park retrofits and new parks, when feasible |
| | | | Incentive program for hospitals and universities to house subregional infiltration facilities |
| | | | Incentive program for “big box stores” to house subregional infiltration facilities |
| **Subregional Direct Use** | N/A | Complex Direct Use | Underground cistern for use in toilet flushing in school building |
| | | | Incentives for stormwater capture and use in manufacturing processes or cleaning of equipment |
| | | | Program to standardize the integration of stormwater capture for irrigation in park retrofits and new parks, when feasible |
| | | | Incentives to house large cisterns for indoor use such as toilet flushing at universities and hospitals |
| | | | Incentives to house large cisterns for outdoor use in irrigation |

# 3. OPPORTUNITY AREA

Each program type has an associated opportunity area which generally describes how much potential for implementation a given program has throughout the City (this potential does not take into consideration the effectiveness of each program type in capturing stormwater, which is discussed in later sections of this report). Precisely defined, the term describes the total area throughout the City that could potentially contribute stormwater to a given program type.

The opportunity area for a given program type is a function of:

- **Geophysical characteristics.** The geophysical characteristics of different areas of the City make them more suitable for either infiltration programs or direct use programs based characteristics such as soil type, slope, depth to groundwater and liquefaction potential. Infiltration programs are more suited to areas with conditions favorable to infiltration, and direct use programs would be most suitable in areas where conditions unfavorable to infiltration. Areas throughout the City were classified as favorable (geophysical classifications A and B) or unfavorable (geophysical classification C) to infiltration in Task 2 of the SCMP. SCMP TM 2.1, which can be found as an appendix to the SCMP and provides details the methodology used to define these areas.

- **Land use types.** Most program types were considered suitable for a variety of land uses, though the programs might be implemented differently depending on which land use it was applied to (i.e. a residential green street program may look different from a commercial green street program, both in terms of BMP design and program implementation strategy). Therefore, the opportunity areas for many of the programs types was divided by subcategory to provide additional insight into how and where different programs could be most effectively implemented. As mentioned above, the subregional program types collect runoff from a mixture of land uses, and therefore the opportunity area for these programs was not divided into subcategories.

- **Drainage characteristics.** Because the opportunity area includes only the area which would contribute runoff to the BMPs constructed as part of the program, drainage characteristics of each land use were evaluated for each program type.

The sections below describe the methodology for calculating the opportunity area for each program type and its associated subcategories.

## 3.1 Self-Mitigating BMPs

Self-mitigating BMPs (i.e. permeable pavement) could be implemented on nearly all land use types within the City, including multi-family residential, single-family residential, commercial, institutional, educational and industrial. As an infiltration program for potable water supply, it is most suitable for areas with a geophysical classification of A and B. By definition, the opportunity area for self-mitigating BMPs is limited to the footprint of the BMP, which could include parking lots, driveways, sidewalks, and walkways on any of the potential land uses. Therefore, to determine the total opportunity area, the total impervious cover for each land use was broken down into areas that are suitable for self-mitigating permeable pavement (e.g. parking lots, driveways etc.) and those that are not (e.g. roofs, streets, etc.). Research originally conducted as part of the development of the WinSLAMM model resulted in the development of typical source area distributions for different land use types (Pitt, personal communication). A source area distribution defines the portion of a land use made up of parking, roads, roofs, walkways, landscaping, and other impervious and pervious areas. The research to develop these typical source area distributions was conducted in Alabama, Wisconsin, and Toronto; however, the study investigators found that these typical land distributions could be reasonably extended to geographic regions that were not surveyed (Pitt, personal communication). These typical distributions of source areas were used to estimate the portion of the impervious surface in each land use that is suitable for impervious area replacement. Total imperviousness by land use was still obtained from the Los Angeles County Hydrology Manual assumptions, as has been used throughout this analysis. The fraction of the impervious area in each land use suitable for replacement with pervious pavement, along with total opportunity area throughout the City is shown in Table 3. A map of the opportunity area for self-mitigating BMPs can be found in Figure 1.

**Table 3. Pervious Pavement Opportunity Area**

| Program Type Subcategory | Total Impervious Area (acres) | Fraction of Impervious Area Suitable for Pervious Pavement | Impervious Opportunity Area (acres) |
|---|---|---|---|
| **SF Residential** | 23,100 | 21% | 4,833 |
| **MF Residential** | 14,921 | 42% | 6,325 |
| **Commercial** | 11,847 | 34% | 4,011 |
| **Industrial** | 9,913 | 45% | 4,499 |
| **Institutional** | 1,686 | 39% | 651 |
| **Educational** | 3,567 | 57% | 2,026 |
| **Total** | 65,034 | 34% | 22,346 |

### 3.2 On-site Infiltration

On-site infiltration could be implemented on most land use types throughout the City, including multi-family residential, single-family residential, commercial, institutional, educational, and industrial. As an infiltration program type, it is most suitable for areas with a geophysical classification of A and B. It was assumed that runoff from all of the impervious area located within the parcel boundary, including roofs could potentially be captured by BMPs installed through this program type. However, the public ROW, which includes sidewalks, was assumed to drain into the street. Therefore, opportunity area was calculated as the total impervious area of land uses suitable for implementation, minus the ROW area.

A map of on-site infiltration opportunity area can be found in Figure 2 and the areas are quantified by land use in Table 4

**Table 4. On-site Infiltration Opportunity Area**

| Program Type Subcategory | Total Opportunity Areas (acres) | Impervious Opportunity Area (acres) |
|---|---|---|
| SF Residential | 42,997 | 11,425 |
| MF Residential | 15,290 | 10,201 |
| Commercial | 8,861 | 8,248 |
| Institutional | 1,642 | 1,330 |
| Industrial | 9,683 | 7,868 |
| Educational | 4,150 | 2,895 |
| Total | 82,623 | 41,967 |

### 3.3 On-site Direct Use

On-site direct use could be implemented on most land use types throughout the City, including multi-family residential, single-family residential, commercial, institutional, educational, and industrial. As a direct use program, it is most suitable for areas with a geophysical classification of C, but can also be used in areas A and B if overflow is directed toward pervious surfaces, so that infiltration opportunities are not lost. As with on-site infiltration opportunity area, all of the impervious area located within the parcel boundary was considered as opportunity area except the public ROW. A map of on-site direct use opportunity area can be found in Figure 3 and the areas are quantified by land use in Table 5.

**Table 5. On-site Direct Use Opportunity Area**

| Program Type Subcategory | Total Opportunity Areas (acres) | Impervious Opportunity Area (acres) |
|---|---|---|
| SF Residential | 46,437 | 12,236 |
| MF Residential | 14,309 | 9,292 |
| Commercial | 6,573 | 6,090 |

| | | |
|---|---|---|
| Institutional | 1,398 | 1,121 |
| Industrial | 7,340 | 5,303 |
| Educational | 2,966 | 2,075 |
| Total | 79,023 | 36,116 |

### 3.4 Green Streets

As an infiltration program type, Green Streets are most suitable for areas with a geophysical classification of A and B. The commercial streets subcategory would, by definition, be applied to commercial land use. The residential subcategory would be applied to single-family residential and multi-family residential land use. The Rio Vistas subcategory would be applied to commercial, industrial, single-family residential, and multi-family residential land uses adjacent to a river.

For any of the green street program type subcategories, the opportunity area would include the street, the ROW adjacent to the street, and the portion of the adjacent properties that would be expected to drain into the roadway via surface flow.  The portion of adjacent land flowing into the ROW was assumed to vary depending on the land use type adjacent to the street, as described below. A map of green street opportunity area can be found in Figure 4 and areas are quantified by land use in Table 6.

**Table 6. Green Streets Opportunity Area**

| Program Type Subcategory | Total Opportunity Areas (acres) | Impervious Opportunity Area (acres) |
|---|---|---|
| Commercial Streets | 11,550 | 11,442 |
| Residential Streets | 35,603 | 34.174 |
| Rio Vistas | 2,547 | 2,471 |

| | | |
|---|---|---|
| Total[1] | 49,701 | 48,088 |

[1]All commercial and residential land uses adjacent to rivers which are in the Rio Vista opportunity area were removed from the opportunity area for Commercial Streets and Residential Streets

*Commercial Green Streets.* Because commercial properties are generally highly impervious with drainage expressly designed to direct stormwater runoff to the streets, the opportunity area for commercial green streets included 100% of the ROW in commercial areas with 100% of the impervious area within the adjacent commercial parcels.

*Residential Green Streets*. Residential properties have large pervious areas capable of containing some portion of runoff generated onsite. Therefore, less than 100% of runoff generated on residential properties will reach the adjacent streets. To determine what percent of a residential property will drain towards the street, a desktop GIS analysis of several sites was performed to determine what percent of the impervious area of single- and multi-family properties drains toward the street. This analysis indicated that approximately 91% and 84% of the impervious area within residential parcels directly drain to the street from multi-family residential and single-family properties, respectively. Drainage delineations from this case study can be found in Appendix B. The green streets opportunity area was therefore calculated by summing 100% of the street ROW in multi-family residential and single-family residential areas with the portion of the adjacent single- and multi- family properties according to the above percentages.

*Rio Vistas.* Rio Vistas are renovations of street ends that dead end into a river, which could potentially be designed to include stormwater capture BMPs. There is currently an effort to implement Rio Vista projects on the LA River, but this effort could potentially be expanded to all major rivers in the City of Los Angeles. Therefore, the opportunity area for this opportunity category included all parcels within in a 400-ft buffer from the banks of a river in residential, multi-family residential, commercial, and industrial land uses. Rio Vistas opportunity area was calculated by summing 100% of the street ROW and a percent of the impervious area from the adjacent parcels, as described above (industrial land uses were assumed to have the same drainage patterns as commercial for the purposes of this analysis). The opportunity area for Rio Vista in commercial and residential land uses was removed from Commercial Green Streets and Residential Green Streets to avoid counting this opportunity area twice.

The streams and rivers used for the Rio Vista buffer can be found in Table 7.

**Table 7. Rivers and Streams Used for Rio Vista Buffer**

| Stream or River |
|---|
| Arroyo Seco |
| Ballona Creek |
| Bell Creek |

| |
|---|
| Browns Creek |
| Bull Creek |
| Burbank Western Channel |
| Caballero Creek |
| Calabasas Creek |
| Compton Creek |
| Dayton Creek |
| Dominguez Channel |
| East Canyon Channel |
| Los Angeles River |
| Pacoima Wash |
| Pacoima Diversion Channel |
| Tujunga Wash |
| Verdugo Wash |

## 3.5 Subregional Infiltration

As an infiltration program type, subregional infiltration is most suitable for areas with a geophysical classification of A and B. Though the siting of subregional BMPs would be limited to parks, industrial, commercial, institutional, or educational land uses they would be capable of receiving runoff from all tributary developed land uses. The opportunity area for this program type included runoff generated from both the parcels and the ROW. A map of subregional infiltration opportunity area can be found in Figure 5 and opportunity areas are quantified in Table 8.

**Table 8. Subregional Infiltration Opportunity Area**

| Total Opportunity Areas (acres) | Impervious Opportunity Area (acres) |
|---|---|
| 116,079 | 69,792 |

## 3.6 Subregional Direct Use

As an infiltration program type, subregional direct use is most suitable for areas with a geophysical classification of C. Though the siting of subregional BMPs would be limited to parks, industrial, commercial, institutional, or educational land uses they would be capable of receiving runoff from all tributary developed land uses. The opportunity area for this program type included both runoff generated from the parcels and the ROW. A map of subregional direct use opportunity area can be found in Figure 6 and opportunity area is quantified in Table 9.

**Table 9. Subregional Direct Use Opportunity Area**

| Total Opportunity Areas (acres) | Impervious Opportunity Area (acres) |
|---|---|
| 115,876 | 66,026 |

## 3.7 Opportunity Area Comparison

Figure 7 shows the total impervious opportunity area for each of the program types and subcategories in the City for comparison purposes.

- **Subregional infiltration and subregional direct use.** The subregional stormwater capture program types include the impervious area of the entire City, with the exception of vacant and agricultural land uses. Consequently, subregional infiltration and subregional direct use have the highest opportunity area – approximately 70,000 impervious acres for subregional infiltration and 66,000 impervious acres for subregional direct use.

- **On-site infiltration and on-site direct use.** These on-sites stormwater capture program types contain only the parcel portions of each land use (i.e. they exclude the ROW) and do not include parks and transportation land uses like subregional programs do. As a result, they have much less opportunity area – approximately 42,000 impervious acres in for on-site infiltration and 36,000 acres for on-site direct use.

- **Green streets.** Green streets opportunity area includes the ROW of commercial, single-family residential, and multi-family residential as well as the portion of the parcel area that drains to the street. This portion is substantial for all three of those land uses. Approximately 48,000 of the 70,000 impervious acres suitable for infiltration are also suitable for green streets.

- **Self-mitigating BMPs.** Impervious replacement has the smallest opportunity area of the program types, because it includes only the portion of impervious areas within parcels that can be replaced by pervious pavement.

# 4. PROGRAM COST

Cost were developed as an input to the cost-benefit analysis for each program type to guide program prioritization and to provide a basis for developing a cost estimate for the final SCMP implementation plan. Because program types could be implemented to capture different volumes of runoff depending on location and other factors, costs were developed as a function of BMP sizing criteria. The costs over the range of BMP size are also referred to as “cost curves”. Multiple cost curves were developed for each program type to represent the range of conditions that programs might be applied under.

A key objective in developing the cost curves is that the basis for all cost assumptions be transparent and supported by published data wherever possible. All of the unit costs and cost assumptions that went into developing the cost curves were vetted by both the Technical Advisory Team (TAT) and the key stakeholder group. The methodology for developing the cost curves is detailed in the following sections.

## 4.1 Cost Scenarios

The cost to implement a given program type is dependent on a variety of factors, and therefore rather than reporting a single cost curve for each program type, it was considered more appropriate to present a range of costs. This was achieved by evaluating two implementation scenarios for each program; a low cost scenario which represents cases with favorable conditions for BMP implementation and opportunities where BMP installation is a part of new or redevelopment, and a high cost scenario which represents cases with design challenges and more ambitious design goals. These scenarios are intended to reflect conditions that might be encountered in different implementation instances, and are not representative of specific design standards or criteria.

Design assumptions for the low and high cost scenarios for each BMP and line items costs and sources are presented in Appendix C.

The cost estimates for all BMPs were normalized by storage volume and costs per unit of BMP storage volume provided (i.e., dollars per cu-ft). These unit costs were then multiplied by the BMP design volumes used in various scenarios in the SCMP Program Evaluation Framework to calculate the total estimated cost to achieve a given level of implementation. This approach provides a reasonable basis for comparison of different BMP scenarios because most stormwater capture BMPs are “volume-based” and given similar geophysical conditions and watershed properties, it would be expected that the stormwater capture performance associated with a BMP of a given storage volume would be reasonably consistent across BMP types.

However, dry wells tend to differ from typical volume-based stormwater capture BMPs in their hydrologic processes. Dry wells are typically designed to infiltrate in subsurface soil horizons that have higher permeability than surface soils and are designed to infiltrate water in three dimensions and have a unique geometry that provides a large surface area per storage volume. Given these factors, the ratio of the discharge rate to storage volume is substantially higher than other BMPs, and these BMPs operate more like a "flow-based" BMP. As a result, the physical storage volume provided in the BMP does not need to be as large to achieve the same level of long term stormwater capture as other BMPs that were considered. To account for the fact that dry wells require less physical storage to achieve the same long term performance in like conditions, a "routing factor" was applied to the volume to normalize dry well costs. This factor accounts for the physical storage of the facility plus the additional volume of water routed through the facility as compared to other BMPs. Based on case study analyses of the relative sizes of BMPs needed to achieve the same long term capture, a factor of three was applied to the storage volume that was used to normalize costs for dry wells. In other words, while dry wells tend to cost more per cubic foot of storage than other BMP types, they also capture more water per cubic foot of storage than other BMPs types. The routing factor approach helps equalize this difference and is considered to be reliable for planning level analysis.

## 4.2 BMP Cost Components

To ensure transparency and thus defensibility of the program type cost curves, a detailed cost estimate under the high and low cost scenarios was developed for each of the ten representative BMPs discussed in section two. This cost estimate included capital costs, soft costs, and operation and maintenance costs. Each of these costs is discussed in more detail below.

### 4.2.1 Capital Costs

A line item unit cost approach was used to determine capital costs. The line item approach, as opposed to empirical formulas using past BMP cost data, accounts for each material cost element required for the installation of a given BMP. Quantities of each line item were calculated based on the BMP storage volume and typical design configurations. Three different storage volumes were evaluated for each BMP and design scenario to develop the cost curve. The range of sizes considered for each BMP are found in Table 10. Appendix C provides the sizing assumptions that served as the basis for all line item quantity calculations. Unit costs were taken from RS Means, past projects based in Southern California, and vendors of products such as cisterns, filters, proprietary pretreatment devices, and pumps. Costs and line items can be found in Appendix C.

The line item cost approach was considered most appropriate because it allowed the cost curves to reflect different implementation scenarios, as opposed to empirical formulas which tend to group all costs from a single BMP type, regardless of variations in site constraints or design complexity.

It should be noted that land acquisition costs were not considered as part of this analysis.

BMP sizes are project-based and do not necessarily reflect the size of a single BMP. For example, an 8,000 cu-ft BMP could be a single BMP at 8,000 cu-ft or could be a multiple BMPs summing to 8,000 cu-ft undertaken as part of the same project. Significant economies of scale are realized for BMPs implemented within the same project.

**Table 10, BMP Size Ranges Contributing to Cost Curves**

| Best Management Practice | Small Size | Medium Size | Large Size |
|---|---|---|---|
| Self-Mitigating Permeable Pavement | 100 cu ft | 750 cu ft | 1,500 cu ft |
| Permeable Pavement with Run-On | 500 cu ft | 10,250 cu ft | 20,000 cu ft |
| Simple Rain Garden | 100 cu ft | 550 cu ft | 1,000 cu ft |
| Complex Bioretention | 500 cu ft | 4,100 cu ft | 8,000 cu ft |
| Dry Wells with Pretreatment | 275 cu ft | 2,650 cu ft | 5,000 cu ft |
| Simple Direct Use | 200 cu ft | 1,050 cu ft | 2,000 cu ft |
| Complex Direct Use | 200 cu ft | 4,100 cu ft | 8,000 cu ft |
| ROW Bulb-out | 300 cu ft | 4,100 cu ft | 8,000 cu ft |
| Underground Infiltration Gallery | 30,000 cu ft | 77,500 cu ft | 150,000 cu ft |
| Infiltration Basin | 30,000 cu ft | 77,500 cu ft | 150,000 cu ft |

### 4.2.2 Soft Costs

"Soft costs" refer to project costs that cannot be calculated on a unit cost basis. For conceptual cost estimating, these costs are generally calculated as a percentage of total capital costs. The soft considered for each BMP were:

- Contingency – Costs intended to compensate for any estimating inaccuracy based on assumptions or measured values, unanticipated market conditions, scheduling delays and acceleration issues, lack of bidding competition, and subcontractor defaults.
- Specialized Engineering – Cost related to internal plumbing retrofits needed for to treat and use stormwater for indoor non-potable. Specialized engineering was added for the high cost scenario of complex direct use only.
- Material Cost – Line item costs that go into BMP construction, for example costs for demolition, excavation, hauling, and building materials such as aggregates, soil, concrete, pipes, pumps, and cisterns.
- Utility Realignment – Cost to relocate gas, electric, sewer, water or other buried utilities that may fall within the footprint of a BMP. Utility realignment is incorporated into green streets and subregional BMPs only.
- Mobilization – The costs associated with activation of equipment and manpower resources for transfer to a construction site until completion of the contract.
- Permitting – Cost, including permit fees and personnel hours, of obtaining required permits for BMP installation. Examples of permits needed may include erosion and sediment control, stormwater, construction, public space permits.

- Engineering and Planning – Costs associated with BMP and site design, as well as access for maintenance, environmental mitigation, buried objects, safety/security, traffic control, limited space, and site restoration.

The expected costs for each of these soft costs as percent of total project capital costs are presented in Table 11. These percentages were based on literature, best professional judgment, experiences from past projects, and input from the TAT and the key stakeholders group.

**Table 11. Soft Costs as Percent of Capital Costs**

| Soft Cost | Percent of Capital Costs | | Notes |
|---|---|---|---|
| | Low Cost Scenario | High Cost Scenario | |
| Contingency | 20% | 30% | |
| Specialized Engineering | | 15% | Applied to Complex Direct Use Only |
| Material Cost | 40% | 80% | Applied to Complex Direct Use Only |
| Utility Realignment | | 3% | Applied to Subregional and High Cost ROW Bulb-out Only |
| Mobilization | | Base cost: $2,000<br>Additional cost: 10% | |
| Permitting | | 5% | |
| Engineering and Planning | Small scale BMPs (simple rain garden, dry well, simple direct use):10%<br>Non-small scale BMPs: 20% | 35% | Implementing small scale BMPs programmatically can reduce engineering and planning costs significantly; as such 10% is a conservative and may be lower in some cases |

### 4.2.3 Operation and Maintenance

The operation and maintenance (O&M) costs is a significant factor in the total life-cycle cost of a BMP, as they can often exceed the capital cost of the BMP over the course of its lifecycle. O&M activities can include vegetation maintenance, structural maintenance, maintenance of mechanical components, maintenance of soil mixes and aggregate, sediment removal, and debris and litter removal. Three distinct O&M categories were considered: 1) routine annual maintenance; 2) major corrective maintenance (rehabilitation); and 3) reconstruction costs incurred at the end of the BMP's useful life. Similar to the soft costs, O&M costs were calculated as a percent of capital costs. Descriptions of maintenance activities can be found in Table 12. The table below presents example activities that may be included in an O&M program, but were not itemized in O&M cost calculation.

**Table 12. Description of Maintenance Activities**

<table>
<tr><th rowspan="2">Practice</th><th colspan="3">Description of Maintenance</th></tr>
<tr><th>Annual</th><th>Rehabilitation</th><th>Reconstruction</th></tr>
<tr><td>Self-Mitigating Permeable Pavement</td><td>Regular vacuuming, limit debris and sediment falling onto surface by maintaining adjacent planting areas</td><td>Remove and replace surface wearing course</td><td>Excavate sub-base and replace, apply new wearing course</td></tr>
<tr><td>Permeable Pavement with Run-On</td><td>Regular vacuuming, limit debris and sediment falling onto surface by maintaining contributing drainage area</td><td>Remove and replace surface wearing course</td><td>Demolish entire system, deep rip sub-base to restore infiltrative capacity, apply new wearing course</td></tr>
<tr><td>Simple Rain Garden</td><td rowspan="2">Repair eroded areas, vegetation management, remove trash and debris, remove aged mulch and apply fresh layer,</td><td rowspan="2">Excavate and dispose of first 4 to 6 inches of soil media, vegetation management as needed</td><td rowspan="2">Excavate and dispose of existing media, backfill with new soil media layer, replace inlet/outlet structures</td></tr>
<tr><td>Complex Bioretention</td></tr>
</table>

<table>
<tr><th rowspan="2">Practice</th><th colspan="3">Description of Maintenance</th></tr>
<tr><th>Annual</th><th>Rehabilitation</th><th>Reconstruction</th></tr>
<tr><td>ROW Bulb-out</td><td>inspect outlet/inlets, remove sediment from pretreatment (if applicable)</td><td></td><td></td></tr>
<tr><td>Dry Wells with Pretreatment</td><td>Cleaning and removal of debris, disposal of sediment, removal of debris and trash</td><td>Control structure repairs, disposal of sediment, excavation of aggregate and back fill with new aggregate as needed</td><td>Replace dry well at a new location</td></tr>
<tr><td>Simple Direct Use</td><td rowspan="2">Inspection, reporting, information management, clean filters, tank inspection and cleaning, system flush</td><td rowspan="2">Pump replacement (if applicable), irrigation tubing replacement</td><td rowspan="2">Replace whole system</td></tr>
<tr><td>Complex Direct Use</td></tr>
<tr><td>Underground Infiltration Gallery</td><td>Remove sediment from pretreatment, inspect inlet and outlets</td><td>Replace upper layers of gravel/top soil as needed, inspect and repair inlet/outlet structures</td><td>Remove rock fill, increase dimensions of gallery by 2 inches to provide fresh surface for infiltration. Wash rock and refill gallery with same rock.</td></tr>
<tr><td>Infiltration Basin</td><td>Removal of trash and debris, mowing and maintenance of vegetated areas, stabilize eroded areas, removal of accumulated sediment pretreatment, scarify surface with light</td><td>Removal of accumulated sediment from basin, excavation of amended soil and replace as needed, restoration of vegetation, removal of unwanted species</td><td>Replace all items except bulk excavation and grading of basin; remove sediment and deep rip bottom of basin</td></tr>
</table>

| Practice | Description of Maintenance | | |
|---|---|---|---|
| | Annual | Rehabilitation | Reconstruction |
| | equipment, remove sediment from basin when 10% of storage volume is lost | of vegetation, inspect and repair inlet/outlet structures as needed | |

O&M costs expressed as a percentage of capital costs were developed using published research (EPA 2005; PSBMPM, 2006; WERF 2009). Some adjustments from the published data were necessary to account for a more nuanced understanding of how these BMPs will be implemented. These adjustments, and their rationale, are described below:

- Annual O&M costs were lowered for simple rain gardens, complex bioretention, ROW bulb-outs to account for the fact that much of the maintenance that would be required for these practices, namely landscape maintenance, would likely be required without the implementation of the practice and therefore this aspect of maintenance was not attributed to the practice itself.

- Annual O&M costs were lowered for self-mitigating permeable pavement, simple rain garden, and dry wells to account for the small-scale nature of the practices that are expected to have wide implementation on the residential scale (thus will be designed with relatively simple maintenance component)

- The useful life was reduced for some simple rain gardens, simple direct use, ROW bulb-outs, and permeable pavement to account for the fact they will be primarily implemented on private property where O&M is conducted on a voluntary basis and therefore not always completed on the recommended schedule. Irregular or insufficient maintenance will likely reduce the useful life of these practices. It should be noted that ROW bulb-outs could potentially be maintained regularly by City staff, though this is not always the case. If provisions were made to have City staff conduct maintenance on ROW bulb-outs, the useful life could be extended.

- The useful life of BMPs and O&M cost as a percent of capital can vary substantially depending on a variety of factors, including the quality of influent water, presence of pretreatment, and the quality of the initial BMP design and materials used in original construction.

The useful life and O&M costs as a percent of capital costs (both the values from the literature and the adjusted values used in this analysis) are presented in Table 13. The adjusted values were vetted by the TAT and the Key Stakeholder group.

## Table 13. O&M Costs and Frequencies

| BMP | Source | Values Recommended in Literature | | Values used in SCMP | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Annual Maintenance | Rehabilitation | | Reconstruction | |
| | | Annual Maintenance Costs (% of Capital Cost) | Corrective Cost at End of Useful (% of Capital Cost) | Assumed Cost (% of Capital Cost) | Assumed Cost (% of Capital Cost) | Frequency (years) | Assumed Cost (% of Capital Cost) | Frequency (years) |
| **Self-Mitigating Permeable Pavement** | EPA, 2005 | 3% | 150% for 50 years | 1% | 70% | 33 | 100% | 50 |
| **Permeable Pavement with Run-On** | EPA, 2005 | 3% | 150% for 50 years | 3% | 70% | 20 | 100% | 33 |
| **Simple Rain Garden** | EPA, 2005 | 5 to 7 % | 125% for 50 years | 3% | 50% | 15 | 100% | 33 |
| **Complex Bioretention** | EPA, 2005 | 5 to 7 % | 125% for 50 years | 3% | 50% | 15 | 100% | 33 |
| **Dry Wells** | PSBMPM, 2006 | 5 to 10% | 100% for 25 years | 3% | 50% | 15 | 100% | 33 |
| **Simple Direct Use** | WERF, 2009 | 2 to 4% | 125% for 50 years | 3% | 50% | 10 | 100% | 20 |
| **Complex Direct Use** | WERF, 2009 | 2 to 4% | 125% for 50 years | 3% | 50% | 20 | 100% | 50 |
| **ROW Bulb-out** | EPA, 2005 | 5 to 7 % | 125% for 50 years | 5% | 50% | 10 | 100% | 33 |
| **Underground Infiltration Gallery** | EPA, 2005 | 5 to 20% | 125% for 50 years | 5% | 60% | 20 | 100% | 50 |
| **Infiltration Basin** | EPA, 2005 | 1 to 3 % | 80% for 50 years | 3% | 60% | 20 | 80% | 50 |

## 4.3 BMP Total Costs

The total cost for each BMP was the sum of each of the cost elements described above (capital costs, soft costs, and O&M costs). However, because each BMP has a different useful life and incurs costs at different points in its life-cycle due to varied maintenance frequencies, it was necessary to calculate the total present value cost of each BMP and normalize this cost over a constant time period in order to be able to make useful comparisons between the costs of different BMPs. Therefore, all BMP cost elements (capital costs, soft costs, and O&M costs) were combined into a single present value, normalized over a 100-year period, using a discount rate of 5% as recommended in the literature (EPA, 2007).

The average and range of costs per cubic foot of storage expected for each BMP is found in Figure 8. The range represents both the difference between the high and low cost scenarios for each BMP, as well as the difference in cost between BMPs with small and large volumes (BMPs built with large volumes have a lower unit cost due to economies of scale). BMPs with the largest range of costs include complex bioretention, complex direct use, and ROW bulb-out. This is due to the addition of structural or mechanical and plumbing components into the high cost design scenario. In general, unit costs are lower for the subregional infiltration program type because the capacity of the BMPs in this program is larger, allowing for significant economies of scale.

In order to size the BMPs, a representative drainage area was selected for each program type and subcategory. For on-site programs, GIS case studies were conducted using the Los Angeles County parcel shapefile and the SCAG land use shapefile to estimate a typical parcel size within each land use that would drain to a single BMP. At least three case studies were conducted for each land use type. For self-mitigating BMPs, the fraction of the parcel size determined to be eligible for pervious pavement replacement (from Task 2) was applied to the on-site parcel sizes determined through the case studies. To estimate the typical drainage area for green streets programs, several GIS case studies were conducted in the relevant land uses where the drainage area to a single BMP was the entire ROW of one city block along with the portion of adjacent parcels which drained to that portion of the ROW. Subregional programs were assigned a typical drainage area of 65 acres based on best professional judgment and input from stakeholders. Table 14 shows the typical drainage area to a single BMP for each program and subcategory. To determine costs, the number of BMPs necessary to treat the selected implementation area was determined. Then each BMPs was sized based on the selected design storm and the typical drainage area, and the corresponding cost from the high curve, low curve, and an average of the high and low curves, was used to determine the cost per BMP.

**Table 14. Typical Drainage Areas to a Single BMP for Each Program Type and Subcategory**

| Program Type | Geophysical Classification | Subcategory | Typical Drainage Area to | Source of Estimate |
|---|---|---|---|---|
| | | Educational | 2.79 | |

| Program Type | Geophysical Classification | Subcategory | Typical Drainage Area to | Source of Estimate |
|---|---|---|---|---|
| Self-Mitigating BMPs | A, B | SF Residential | 0.01 | Fraction of on-site drainage area eligible for pervious pavement replacement |
| | | MF Residential | 0.15 | |
| | | Commercial | 3.16 | |
| | | Institutional | 0.51 | |
| | | Industrial | 0.46 | |
| On-Site Infiltration | A, B | Educational | 7 | Case studies for each subcategory to determine typical parcel size draining to a single BMP across a range of scenarios within each land use |
| | | SF Residential | 0.13 | |
| | | MF Residential | 0.55 | |
| | | Commercial | 3.16 | |
| | | Institutional | 0.51 | |
| | | Industrial | 0.46 | |
| On-Site Direct Use | C | Educational | 7 | Case studies for each subcategory to determine typical parcel size draining to a single BMP across a range of scenarios within each land use |
| | | SF Residential | 0.13 | |
| | | MF Residential | 0.55 | |
| | | Commercial | 3.16 | |
| | | Institutional | 0.51 | |
| | | Industrial | 0.46 | |
| Green Street Programs | A, B | Commercial Streets | 13 | ROW of one block plus contributing parcels |
| | | Residential Streets | 3.7 | ROW of one block plus contributing fraction of contributing parcels |
| | | Rio Vistas | 8.35 | Average of Commercial and Residential green streets areas |
| Subregional Infiltration | A, B | All of the above plus Parks and Transportation | 65 | Best professional judgment and discussion with stakeholders |
| Subregional Direct Use | C | All of the above plus Parks and | 65 | Best professional judgment and discussion with stakeholders |

## 4.4 Program Costs

For each program type a variety of different BMPs might be implemented depending on a number of factors. Therefore, to develop costs for each program type, BMP costs were aggregated based on an assumed distribution of BMPs that would potentially be implemented as a part of each program type and opportunity category. The assumed BMP distributions used in this analysis are presented in Table 15. These percentages were based on the best professional judgment of the project team with input from the TAT and the Key Stakeholders Group.

The program type costs per acre foot of capture stormwater are summarized in Figure 9. The wide range of costs seen within a program type is attributable to the fact that some subcategories within a given program will involve more costly BMPs, while other subcategories will involve more economical BMPs. For example, within the on-site infiltration program type, the single-family residential opportunity category will typically utilize less complex and therefore less expensive

BMPs like simple on-site rain gardens and simple direct use, while the commercial opportunity would be expected to require highly engineered BMPs with higher capital and design costs.

## Table 15. Assumed Distribution Used to Compute Weighted Averages for Stormwater Capture Program type Cost Development

| Stormwater Capture Program | Opportunity Category | Self-Mitigating Permeable Pavement | Permeable Pavement; receiving run-on | Simple Rain Garden | Complex Bioretention | Dry Wells | Simple Direct Use | Complex Direct Use | ROW Bulb-out | Underground Gallery | Infiltration Basin |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Self-Mitigating Permeable Pavement** | SF Residential | 1 | | | | | | | | | |
| | MF Residential | 1 | | | | | | | | | |
| | Commercial | 1 | | | | | | | | | |
| | Institutional | 1 | | | | | | | | | |
| | Industrial | 1 | | | | | | | | | |
| | Educational | 1 | | | | | | | | | |
| **On-Site Infiltration** | SF Residential | | | 0.75 | | 0.25 | | | | | |
| | MF Residential | | 0.25 | 0.25 | 0.25 | 0.25 | | | | | |
| | Commercial | | 0.4 | | 0.4 | 0.2 | | | | | |
| | Institutional | | 0.4 | | 0.4 | 0.2 | | | | | |
| | Industrial | | 0.4 | | 0.4 | 0.2 | | | | | |
| | Educational | | 0.25 | 0.25 | 0.25 | 0.25 | | | | | |
| **On-Site Direct Use** | SF Residential | | | | | | 0.8 | 0.2 | | | |
| | MF Residential | | | | | | 0.2 | 0.8 | | | |
| | Commercial | | | | | | 0.5 | 0.5 | | | |
| | Institutional | | | | | | 0.2 | 0.8 | | | |
| | Industrial | | | | | | 0.2 | 0.8 | | | |
| | Educational | | | | | | 0.5 | 0.5 | | | |
| **Green Street Programs** | Commercial | | 0.25 | | | | | | 0.75 | | |
| | MF, SF Residential | | 0.25 | 0.5 | | | | | 0.25 | | |
| | MF, SF Residential, Commercial, Industrial | | 0.25 | | 0.25 | | | | 0.5 | | |
| **Subregional Infiltration** | N/A | | | | | | | | | 0.5 | 0.5 |
| **Subregional direct use** | N/A | | | | | | | 1 | | | |

# 5. PROGRAM BENEFITS

## 5.1 Unit Stormwater Capture

A program type's ability to capture stormwater is a critical factor in the evaluation of any stormwater program. To determine the stormwater volume captured by each program type under a range of different implementation scenarios, it was necessary to quantify the unit stormwater volume captured by each BMP for a range of BMP design criteria in different locations throughout the City. As part of Task 2, unit stormwater capture curves were created to determine the long-term capture rate of a range of BMP sizes over a range of drawdown times for all 71 rain gauges in the City. Details on this methodology are included in Technical Memorandum 2.1 which is included as an appendix to the SCMP. The result of this analysis was a database providing the long term average volume captured (acre-feet) per acre of impervious contributing area for each distinct combination of rain gauge, BMP size (determined by design storm from 0 to 3.33 inches), and drawdown time (2 hours to 15 days).

For all program types except self-mitigating BMPs, the BMP unit capture database was used to evaluate the stormwater capture benefit of each program type.

To relate the database to the programs, each program was assigned a drawdown time based on soil characteristics (for infiltration programs), or typical usage rates (for direct use programs). Infiltration programs implemented in geophysical category A have the shortest drawdown times because the soils in these areas have the highest infiltration capacity. For example, a bioretention BMP with 24 inches of ponded water in an area with infiltration rates of 4 inches per hour will drawdown in 6 hours. The same bioretention unit in an area with a lower infiltration rate, 2 inches per hour, will draw down in 12 hours. Direct use programs will have longer drawdown times because they are designed to release water slowly between storm events. The assumed range of drawdown times for each program type is show in Table 16. Geophysical category A has a relatively higher permeability rate and as a result will have higher drawdown rates.

**Table 16: Drawdown Times Associated with Different Geophysical Categories**

| Program Type | | Drawdown Time (hours) | | |
|---|---|---|---|---|
| | | Fast | Med | Slow |
| Infiltration Programs | Geophysical Category A | 6 | 12 | 24 |
| | Geophysical Category B | 12 | 24 | 48 |
| Direct Use Programs | Geophysical Category C | 120 | 180 | 360 |

As part of task 2 of the SCMP, the City was divided into 15 subwatersheds. The details of this process are provided in SCMP TM 2.1 which can be found as an appendix to the SCMP. Because the program implementation planning will be at the subwatershed scale, three representative rain gauges for each subwatershed in the City were selected to represent high, medium, and low rainfall rates within the subwatershed. These included the gauge with the minimum annual rainfall depth, the gauge with the maximum annual rainfall depth, and a gauge with a medium annual rainfall depth in each subwatershed. Additionally, three representative rain gauges were selected for the City overall so that a program could be evaluated either by individual watershed, or City-wide.

Because the self-mitigating BMPs program type does not have a tributary area, the unit capture database could not be applied to determine capture. Instead, 90 percent of all precipitation falling directly on the BMP is assumed to be captured while the remaining 10 percent is assumed to be lost to evapotranspiration. Areas converted to self-mitigating BMPs receive no run-on from other areas, so they are able to produce no runoff even from very large storm events. For example, a pervious pavement cross section with an equivalent depth of only 5 inches can capture a 5-inch, 24-hour storm event before producing any runoff. The depth and lack of vegetation keep evapotranspiration at a minimum in these areas, allowing a high recharge rate.

## 5.2 Ancillary Benefits

While the main purpose for the SCMP is to augment municipal water supplies, the programs implemented will also have ancillary benefits such as runoff water quality improvement, runoff peak flow reduction, and addition of green space to urban areas. These ancillary benefits may help leverage funding and cooperation with other efforts that are focused on these benefits and may help guide selection of programs for the SCMP. Therefore, it was necessary to quantify these benefits for each program type.

### 5.2.1 Water Quality Improvements

The release of pollutants from urban areas into surface waters is a very important issue in the City. The discharge of pollutants is highly regulated and compliance with water quality regulations is often a main driver of BMP implementations. Stormwater capture programs decreased the load of pollutants discharged to downstream waterbodies because they capture a portion of the runoff and divert it into groundwater, which also diverts the pollutants associated with that captured water. The estimated pollutant load reductions for a given program were calculated as the average annual volume of stormwater captured for a given program multiplied by the pollutant concentration of the stormwater. The pollutant concentration of the stormwater captured for each program type was calculated using a flow-based weighted average of the event mean concentrations (EMCs) for the contributing land uses for each program type. EMCs for common urban pollutants including nitrate, total copper (TCu), total lead (TPb), total zinc (TZn), fecal coliforms (FC), total suspended solids (TSS), total Kjeldahl nitrogen (TKN), and total phosphorous (TP) for individual land uses were obtained from the SBPAT model technical appendices (Geosyntec, 2008) as shown in Table 17 The relative flow from each contributing land use was determined using the area and imperviousness of each contributing land use area. Because captured water does not carry trash with it, the area "treated" for trash is simply the area over which the program is implemented.

**Table 17: Event Mean Concentrations Used for Each Land Use**

| Land Use | Nitrate (mg/L-N) | Total Copper (ug/L) | Total Lead (ug/L) | Total Zinc (ug/L) | Fecal Coliform, (MPN/100mL) | TSS (mg/L) | TKN (mg/L) | TP (mg/L) |
|---|---|---|---|---|---|---|---|---|
| Education | 0.61 | 19.9 | 3.6 | 117.6 | 1.73E+05 | 99.6 | 1.71 | 0.3 |
| Industrial | 0.87 | 34.5 | 16.4 | 537.4 | 4.23E+08 | 219.2 | 2.87 | 0.39 |
| Commercial | 0.55 | 31.4 | 12.4 | 237.1 | 1.74E+06 | 67.0 | 3.44 | 0.4 |
| Institutional | 0.55 | 31.4 | 12.4 | 237.1 | 1.74E+06 | 67.0 | 3.44 | 0.4 |
| MF Residential | 1.51 | 12.1 | 4.5 | 125.1 | 7.26E+05 | 39.9 | 1.8 | 0.23 |
| SF Residential | 0.78 | 18.7 | 11.3 | 71.9 | 2.79E+04 | 124.2 | 2.96 | 0.4 |
| Parks (Vacant) | 1.17 | 10.6 | 3.0 | 26.3 | 3.32E+03 | 216.6 | 0.96 | 0.12 |
| Transportation | 0.74 | 52.2 | 9.2 | 292.9 | 4.19E+05 | 77.8 | 1.8 | 0.7 |

### 5.2.2 Peak Flow Reduction

While the primary function of stormwater capture BMPs is to capture stormwater, they typically also provide a reduction in the peak flow rate of runoff downstream of the BMP by diverting a portion of the runoff to groundwater. The degree to which stormwater capture programs affect the peak flow rate depends on how they are designed. When stormwater capture BMPs are sized to capture the runoff from smaller events such as the 85th percentile storm event and smaller, they should virtually eliminate runoff from the contributing area for storms smaller than that, thus reducing the peak flow rate by 100%. For storm events larger than the design storm, the storage of the BMP is exceeded, and runoff occurs. If the storm event is only slightly larger than the design event, only a small amount of runoff occurs, and the peak flow rate could be reduced substantially. If the storm event is much larger than the design storm, the peak flow can only be reduced by the drawdown rate, or the rate at which the BMP storage is emptied, which is the infiltration rate in infiltration BMPs and the usage rate in direct use BMPs. Because the drawdown times are typically much longer than the storm duration, and because captured stormwater use is typically minimal during storm events, the peak flow reduction benefit expected from capture BMPs is typically small compared to flow-attenuation BMPs which are BMPs designed for flood control during large storm events. Without site-specific design information for the BMPs, the actual peak flow reduction is difficult to estimate at a planning level. As a conservative assumption, the peak flow rate reduction for the BMPs in each program was estimated as the steady-state drawdown rate, which is indicative of the peak flow reduction for very large storms.

### 5.2.3 Green Space

There are a number of benefits associated with implementing stormwater capture programs that include landscaping or added vegetation as a component, including, but not limited to, reducing the heat island effect, greenhouse gas sequestration, and beautification. To provide information on the potential for each of the program types' ability to provide benefits associated with added vegetation, the green space provided by each program type was estimated. This area was assumed to be equivalent to the footprint of all BMP types that include vegetation, including bioretention, rain gardens, infiltration basins, and ROW planters. The footprint was calculated as the BMP volume times the range of typical BMP depths (see Appendix C for typical BMP depths).

### 5.2.4 Other Benefits

There are numerous additional benefits that may be realized through the implementation of stormwater capture programs, for example heat-island effect reduction from increased green space and reduced carbon emissions resulting from localizing water supply. In addition, property owners utilizing stormwater capture and reuse will save money on their water bills and relieve pressure on the municipal water system during rainy months. These benefits have not been modeled in the Framework.

# 6. SCMP PROGRAM EVALUATION FRAMEWORK

The SCMP Program Evaluation Framework (Framework) was developed to allow the evaluation of the costs and benefits of the six program types City wide or, in specific subwatersheds, to help guide development of the programmatic component of the SCMP. The Framework is a Microsoft Excel-based tool which integrates all of the analyses described above (opportunity area, cost, and benefit) into a single tool. The Framework can be used to evaluate and compare program types generally, or to evaluate and compare the effectiveness of specific program implementation scenarios.

## 6.1 Program Evaluation

The program evaluation section of the Framework allows for comparison of costs and benefits on a per-cubic-foot-of-BMP-volume basis of different program types. Program types can be evaluated at different locations throughout the City (both in terms of subwatersheds and geophysical categories within a given subwatershed). This information will be used to guide selection of programs and sizing of BMPs within a program. For a given program type, program type subcategory, subwatershed, and geophysical category, the program evaluation section of the framework provides unit capture curves, cost curves, and pollutant load information, which are discussed below in more detail.

### 6.1.1 Capture Curves

This curve describes the efficiency of the program type/subcategory at capturing stormwater if implemented at the given location. The framework provides three curves representing the high, medium, and low estimates of capture rate (acre feet captured/acre of impervious tributary area) per unit BMP volume (cubic feet of storage/acre of impervious tributary area). An example of the curves provided is shown in Figure 10 for the on-site infiltration program type in a multi-family residential subcategory in geophysical category B in the Northeast San Fernando Valley subwatershed. The high curve represents the rainfall gauge with the highest rainfall depth combined with the fastest drawdown time. The medium curve represents the rain gauge with the medium rainfall depth combined with the medium drawdown time. Finally, the low curve represents the rain gauge with the lowest rainfall depth combined with the slowest drawdown time. The first section of the curve has a steep slope, which indicates that small increases in BMP storage volume will produce relatively large increases in stormwater capture. The second part of the curve is flatter, meaning that additional BMP volume will produce relatively little additional benefit in terms of stormwater capture. Therefore, the “knee of the curve” where these two sections meet, can be seen as the most cost effective BMP size for the program type/subcategory, at the given location.

Multiple curves can be compared to provide insight both on how different program types/subcategories perform, as well as how the stormwater capture efficiency of a single program type/subcategory is affected by location of implementation.

### 6.1.2 Pollutant Loads

Table 18 shows the flow weighted average pollutant load concentrations that would be expected in the stormwater contributing to the selected program type/subcategory using the same set of parameters as the example capture curve and unit costs shown.

**Table 18: Example of the Pollutant EMCs in the Framework for an On-site Infiltration Program in Multi-family Residential Subcategory in Geophysical Category B in the Northeast San Fernando Valley Subwatershed**

| Pollutant | Average Concentration of Pollutant in Captured Water |
|---|---|
| Trash (cu ft/ac) | 1 |
| Nitrate (mg/L-N) | 1.5 |
| Total Copper (ug/L) | 12 |
| Total Lead (ug/L) | 5 |
| Total Zinc (ug/L) | 125 |
| Fecal Coliform (MPN/100mL) | 726,000 |
| TSS (mg/L) | 40 |
| TKN (mg/L) | 1.8 |
| TP (mg/L) | 0.23 |

## 6.2 Conceptual Management Scenarios

The Framework can also be used to determine the total opportunity for a given program type/subcategory. In addition to the four inputs required for program evaluation (program type, subcategory, geophysical category, and subwatershed) two additional inputs (implementation percentage and BMP design storm depth) are required to yield total costs, total capture, and ancillary benefits of a given application of a stormwater capture program. Implementation percentage is the degree of program application as a fraction of the total opportunity area for a given combination of program type, subcategory, geophysical category, and subwatershed in which the program will be implemented. Design storm depth is the precipitation depth that each BMP will be designed to capture from the typical drainage area. The number of BMPs is the number required to treat the entire implementation area based on the typical drainage area to each BMP. The BMP volume is the total BMP storage required to capture a chosen design storm using a chosen program type, subcategory, geophysical category, subwatershed, and implementation percentage. It is calculated as the BMP design storm depth multiplied by the typical drainage area for all program types except self-mitigating BMPs. For that program type, it is calculated as the typical drainage area multiplied by a typical equivalent depth for self-mitigating permeable pavement from unit cost development.

The results from this section of the Framework can be used to evaluate the total potential benefits of a program type given the available opportunity area and to evaluate the costs and benefits of individual programs at different implementation rates or using different BMP sizes. This enables determination of which programs may be most effective at different locations as well as to select combinations of programs and BMP sizes to maximize efficiency. An example of the framework output is shown in Table 19, and a discussion of each output category is provided in the following sections.

**Table 19. Example Outputs from SCMP Framework**

Results are for On-site Infiltration Program, SF Residential siting opportunity, geophysical category A in the Lopez-Pacoima Spreading Grounds subwatershed with 20% implementation and BMPs sized to capture the 85$^{th}$ percentile storm depth (0.92”).

| Output Description | Medium Output Value (Low-High) |
|---|---|
| **Implementation Area** | |

| | |
|---|---|
| Total Opportunity Area (acres) | 570 |
| Implementation Area (acres) | 114 |
| **Capture Volume** | |
| Total BMP Storage Volume (AF) | 2.7 |
| Capture Efficiency of Program (as percent of long term runoff volume) | 84% (76%-90%) |
| Average Annual Stormwater Capture, AFY | 36 (28-43) |
| **Total Costs and Costs per Captured Volume** | |
| Capital Cost, Millions of $ (2014) | 3.9 (3.0-4.8) |
| O&M Cost Millions of $ (2014) | 5.0 (3.9-6.2) |
| O&M Cost/year $ (2014) | 50,000 (39,000-62,000) |
| Total Lifecycle Cost, Millions of $ (2014) | 8.9 (6.8-11) |
| Capital Cost per acre foot capture over entire lifetime, $/AF (2014) | 1080 (710-1,740) |
| O&M Cost per acre foot capture over entire lifetime, $/AF (2014) | 1,390 (920-2,250) |
| Total Lifecyle Cost per acre foot capture over entire lifetime, $/AF (2014) | 2,470 (1600-3,990) |
| **Ancillary Benefits** | |
| Acres treated for trash | 114 |
| Nitrate (lbs N) | 80 (60-90) |
| Total Copper (lbs) | 2 (1-2) |
| Total Lead (lbs) | 1 (0.8-1) |
| Total Zinc (lbs) | 7 (5-8) |
| Fecal Coliform (MPN*$10^{12}$) | 12 (9-15) |
| TSS (lbs) | 10,000 (9,300-10,000) |
| TKN (lbs) | 290 (220-340) |
| TP (lbs) | 40 (30-50) |
| Estimated Peak Flow Reduction (cu ft) | 3 (1-6) |
| Potential New Green Space (acres) | 0.7 (0.6-0.9) |

### 6.2.1 Implementation Area

Implementation area is the total area in the City or a subwatershed where a program type with a certain application or geophysical category is implemented. It is calculated as the implementation percentage multiplied by the opportunity area for each program type, subcategory, geophysical category, and subwatershed as explained in the opportunity area section above.

### 6.2.2 Capture Volume

For all program types except self-mitigating BMPs, the high, medium, and low capture efficiency is calculated using the selected BMP design storm depth with the high, medium, and low capture curves determined from the program type, subcategory, geophysical category, subwatershed, and BMP size. The high, medium, and low average annual captured stormwater volume is then calculated using high, medium, and low capture efficiency, the implementation area, and the total unit runoff volume from the unit BMP capture database. For self-mitigating BMPs, the capture efficiency is 90%, and the total captured volume is calculated from the implementation area and the average annual rainfall depth from the high, medium, and low rain gauges.

### 6.2.3 Total Costs and Cost per Capture Volume

The framework uses the total number of BMPs and the high, medium, and low program unit costs per BMP to determine the total capital cost, O&M cost, and total lifecycle cost for the chosen program implementation, as well as the cost per acre foot captured. In this calculation, the highest cost is combined with the lowest capture volume to determine the maximum cost per volume; and the lowest cost is combined with the highest capture volume to determine the minimum cost per volume.

### 6.2.4 Ancillary benefits

The range of pollutant load reductions are calculated using the EMCs for each pollutant and the range of total capture volumes. The peak flow reduction was calculated as the total BMP volume divided by the drawdown time for all program types except self-mitigating BMPs. For that program type, the peak flow rate is estimated as the footprint of the BMP multiplied by a range of infiltration rates typical of infiltrative soils where this pervious pavement would be likely to be placed (0.25, 0.4, and 0.5) to get the low, medium, and high peak reduction estimates. As stated previously, the green space area is the footprint for all BMPs within a program type that contribute green space. The range of footprints is calculated using the total BMP volume and the range of typical depths used in the unit cost development.

## 7. COMPARISON OF PROGRAM TYPES

As described above, the Framework can be used to evaluate the opportunity and benefit for individual programs at specific locations to provide insight on where programs should be prioritized throughout the City. This section describes the results of batch processing the Framework to determine the total costs and benefits of each program type applied throughout its entire opportunity area throughout the City, and discusses the insights these results offer for development of the programmatic element of the SCMP.

### 7.1 Methodology and Assumptions

Using the Framework, each program type/subcategory was run for all possible combinations of geophysical category, and subwatershed, which represents the entire opportunity area for the program type/subcategory. Implementation percentage was assumed to be 100%, across all program types. BMPs were assumed to be sized to capture runoff from the 85$^{th}$ percentile storm event for the representative medium gauge from each subwatershed. It should be noted that 100% implementation was assumed for the purposes of comparing all programs and, as discussed in TM2 of the SCMP, which is available as an appendix to the SCMP, 100% BMP implementation is not considered a realistic implementation goal. Additionally, the individual program types have overlapping opportunity areas, as illustrated in Figure 7, so the costs and benefits of the programs cannot be considered cumulative. Therefore, results are shown on a “per volume captured” or “per impervious area treated” basis, rather than total costs and capture volumes. Total capture volumes will be reported in Task 5 of the SCMP when specific implementation scenarios are explored. All the charts in this section show a range of values (represented by the bar) with the middle line representing the medium value.

### 7.2 Cost Per Unit Capture Volume

The first analysis done was to compare the cost per captured acre foot of water for each program type. This analysis gives an indication of which programs are generally most cost effective for the 85$^{th}$ percentile design storm. The total lifetime costs per acre foot of captured stormwater for the different program types are shown in Figure 9. While there is overlap between the ranges of costs per volume captured for all of the programs, the self-mitigating BMPs program has the highest low estimate and high estimate, much higher than any of the other programs. This is because this BMP area does not receive run-on from other areas, so it is limited to capturing only the rainfall falling on its footprint area. Consequently, it takes much greater BMP footprint to capture the same volume that the other programs would capture, greatly increasing the cost per unit capture.

Aside from the self-mitigating BMPs program, infiltration programs have a lower range of costs than direct use programs. This is partly due to the lower overall effectiveness of direct use programs due to long drawdown times. The long drawdown times decrease their capture efficiency of a given storage volume, increasing the cost per volume captured. However, it is also partly due to the fact that more infrastructures (storage tanks, pumps, piping, etc.) is generally required for most direct use BMPs than for infiltration BMPs. In addition, some direct use BMPs include costs for treatment (if needed). Infiltration BMPs only include costs associated with delivering the water into the aquifer. However, once water is infiltrated into an aquifer it then requires pumping, treatment, and a distribution network to arrive at the place of use, but since these processes are continuous, these costs were not included in infiltration programs.

Subregional infiltration programs have the lowest range of costs per unit volume captured. This is attributable to "economy of scale" of subregional BMPs. However, it should be noted that all programs except impervious replacement have costs at the low end of the range that is comparable to the subregional program. This indicates that there are conditions in which more distributed BMP types could have similar cost effectiveness to subregional BMPs – specifically when site conditions are favorable for simpler BMP implementation or where the cost of the distributed BMP implementation could be "shared" with a larger project (e.g. site redevelopment, utility work, and/or roadway maintenance/reconstruction).

It should be noted that while the relative efficiencies between the programs are true over the entire city, the most cost-effective option could vary by program type subcategory, subwatershed, geophysical category, or BMP size within each program type. Therefore, while one program type may appear to be less efficient than another program type overall, it may be more efficient under certain conditions. The best option for different areas will need to be reviewed on a case-by-case basis.

## 7.3 Capture Volume Per Unit Impervious Area Treated

The next analysis compared the stormwater volume captured for every acre of impervious area treated for each program type. This analysis gives an indication of which program types are most efficient at capturing stormwater in order to determine how to capture the most stormwater from a contributing area. The capture volume per impervious acre treated for each program is shown in Figure 11. The self-mitigating BMPs program type is assumed to capture 90% of the rainfall falling on it. This is a higher capture efficiency than most other BMPs which are sized to capture the 85$^{th}$ percentile storm event, which corresponds to its higher range of captured volume per area. However, because the captured area does not include run-on, it requires a large implementation area to capture that volume and has the lowest opportunity area of any program type (Figure 7). Infiltration program types have reasonably high unit capture rates at a BMP size of the 85$^{th}$ percentile storm depth. As a result, infiltration program types capture approximately 0.8 to 1.3 acre feet per impervious acre per year. They also have a slightly higher opportunity area than direct use programs (Figure 7), so they have a higher total opportunity capture volume. Direct use program types have a lower unit capture rate than infiltration program types due to their much longer drawdown times. Consequently, they capture only between 0.45 and 0.75 acre feet per impervious acre per year treated.

## 7.4 Ancillary Benefits Per Impervious Acre Treated

The third analysis compared the estimated pollutant removal, peak flow reduction, and green space benefits between the program types per impervious acre treated.

### 7.4.1 Pollutant Removal

The mass of pollutants removed by each program type per acre of impervious area treated are shown in Figures 12 through 19. The pollutant removal efficiency of a given program type is a function of both the EMCs of the contributing land uses and the capture volume per impervious treated acre. For TSS, TKN, nitrate, TP, TCu, and TPb, the aggregate EMCs calculated from all of the contributing land uses do not vary significantly across different opportunity areas so the primary driver for pollutant removal is the total capture volume. The figures showing removal of these pollutants (Figure 12 through 17) thus show a similar pattern to the capture volume per impervious acre (Figure 11), where impervious pavement has the highest unit reduction, followed by infiltration programs, followed by direct use programs. For pollutants with aggregate EMCs that vary greatly between different opportunity areas, the pattern differs from that observed in the capture volume; because programs that may have lower capture efficiency may still have high pollutant removal potential due to high EMCs. This is the case for fecal coliforms and TZn (Figure 18 and 19, respectively). For these pollutants, green streets are shown to be less effective at pollutant removal because the land uses contributing runoff to BMPs in green street programs (commercial and residential) have lower TZn and fecal coliform EMCs than land uses contributing runoff to BMPs in other programs.

### 7.4.2 Peak Flow

The estimated peak flow reduction provided by each program per impervious acre is shown in Figure 20. Using an approximation of 4 cfs per impervious acre as the peak flow production (based on a rainfall intensity of 4 to 5 inches per hour which is typical of a very large storm in the Los Angeles area), it is evident that the peak flow reduction provided by all of these programs is modest as the BMPs reach capacity early in the storm event. Self-mitigating BMPs have the highest peak flow rate reduction because they receive no run-on. Even at the highest estimate of soil infiltration rates, self-mitigating BMPs would only reduce the peak flow by approximately 10%. The other infiltration programs achieve less than 3% peak flow reduction, and the direct use programs have a negligible effect on peak flow due to their long drawdown times.

### 7.4.3 Green Space

The green space per acre of impervious treated area is shown Figure 21. Only infiltration programs include BMPs which provide green space. On-site infiltration and green street program types tend to provide significantly more green space than subregional BMPs. In other words, they typically have a higher footprint per treated impervious acre and a higher fraction of BMP types that include green space. The BMP distribution within each program used to estimate costs (Table 15) include more sub-surface storage BMPs in subregional infiltration program than in the on-site infiltration program.

### 7.4.4 Reduction in Potable Water Demand (Direct Use Only)

Stormwater capture for direct use can help property owners reduce their potable water demand, this providing cost savings on their water bill, and will relieve pressure from the municipal water supply system during rainy months. The expected reduction in potable water demand from stormwater capture and reuse at both the on-site and regional scales was not modeled.

### 7.4.5 Sensitivity of Comparisons

While each of these analyses compares the programs types as a whole, they do not include the variation in costs/benefits caused by varying subcategories, geophysical categories, subwatersheds, or the potential BMP sizes. Because the ranges of costs and benefits overlap for many of these programs, it is likely that while one program appears to be more efficient than another in the overall City, areas or applications exist in which another program may prove to be more cost effective. These variations will need to be considered to achieve the most effective implementation of programs throughout the City. While it is not possible to show results from the thousands of potential combinations in all locations and BMP sizes, some key trends are discussed below.

### 7.4.6 Program Type Subcategory and Geophysical Category

The results discussed above were summarized by program type. However, each program type subcategory has different contributing land use with different associated imperviousness values that affect the achievable capture rates. Additionally, each program type subcategory will utilize a different mix of BMPs and have different BMP drainage areas, affecting unit costs. Therefore, each program type subcategory will have different cost effectiveness compared to the program type as a whole.

The geophysical category affects the drawdown time which, in turn, affects unit capture rate. Higher unit capture rates make the same program type/subcategory more efficient in one geophysical category than another. Figure 22 shows the effects of program type subcategory and geophysical category on the total lifecycle cost per unit volume of stormwater captured for on-site infiltration and on-site direct use programs, as an example. As expected, geophysical category A offers the lowest cost per unit capture with geophysical category C the highest for all program type subcategories. The program type subcategory has only a modest effect for on-site infiltration programs in both geophysical categories A and B. The range of costs per capture volume is similar for each of the program type subcategories, although single-family residential subcategory has the highest cost per capture volume for this program type (Figure 22). The program type subcategory affects the range of cost per capture volume much more for the on-site direct use program type in geophysical category C than it does for the on-site infiltration program type in either geophysical category. Single-family residential has a much higher range than the other subcategories due to its smaller BMP drainage area, which decreases economy-of-scale.

### 7.4.7 Subwatershed

Each of the 15 subwatersheds within the City has a different land use distribution and geophysical category distribution, which affects the unit costs, unit capture rates, and opportunity areas for different program types. In addition, each has different rainfall patterns, which also affect the capture volumes. Therefore, subwatersheds should be examined individually to determine the effectiveness of different program types. Figure 23 shows the total lifecycle cost per unit volume of stormwater captured for each program type in three representative subwatersheds. The cost effectiveness of the programs is affected by the subwatershed. For example, the range of cost effectiveness of the self-mitigating BMP program type is lower in the Dominguez Channel subwatershed than in the Hansen Tujunga Spreading Ground subwatershed. This could be due to the different rainfall patterns in each subwatershed. The same area of permeable pavement constructed in subwatershed receiving more rainfall will provide more recharge than the same area of permeable pavement in a subwatershed receiving less rainfall. If the cost to construct the permeable pavement is the same in both areas, the permeable pavement in the subwatershed with the higher rainfall will have a lower cost per volume captured. Note that this analysis does not consider limited opportunity area for some programs in certain subwatersheds. Consequently, even if one program is more efficient than another in a subwatershed, it may have very limited opportunity area in that subwatershed, limiting its utility.

### 7.4.8 BMP Size

The typical BMP sizing parameters for each program affects the unit capture rate and total BMP storage volume (and therefore cost) of different programs. As shown in Figure 10, the unit capture rate increases with BMP size, but the rate of increase in capture rate decreases with every unit increase of BMP size (i.e., diminishing returns). The cost typically has an constant initial mobilization cost, then increases linearly with BMP size. Thus the capture rate decreases with BMP size, while the unit costs with BMP size (because the intitial costs become a smaller percentage of the total costs). This will affect the cost per unit capture for the same program type, subcategory, geophysical category, and subwatershed. To illustrate this, Figure 24 shows the total lifecycle cost per acre foot of water captured for all programs except self-mitigating BMPs at three different BMP sizes. The self-mitigating BMPs program has a constant capture rate, so it was not included in this comparison. The cost per unit of volume captured is very sensitive to the BMP size, as expected. However, the cost effectiveness does not show a constant change with BMP size. Because the capture rate and cost are changing at different rates, the cost effectiveness does not increase or decrease linearly with BMP volume. Furthermore, the typical drainage area between programs varies, such that the BMP volume from a given storm size varies, as well, placing the programs in different regions of cost effectiveness.

## 8. CONCLUSIONS

As part of Task 3, six stormwater capture program types were developed and the costs and benefits of each program were compared. The opportunity areas for each program type were calculated throughout the city, and the imperviousness and pollutant loads associated with each opportunity area were calculated. Unit costs (cost per cubic foot of BMP storage volume) were developed using a suite of BMPs for each program. Unit stormwater capture rates were developed as part of Task 2. Ancillary benefits such as pollutant load reduction, peak flow reduction, and green space were also quantified for each program. A framework was developed which incorporates the attributes of the opportunity areas, unit costs, unit capture rates, and ancillary benefits to allow the evaluation of numerous combinations of program types, subcategories, geophysical categories, subwatersheds, BMP sizes, and implementation extents. This Framework will be useful in comparison of different combinations of programs and implementation rates around the City in order to develop a plan that minimizes cost while maximizing stormwater capture volume and other benefits.

As an initial comparison between programs, the Framework was used to evaluate the City-wide costs and benefits associated with all combinations of program type, subcategory, geophysical category, and subwatershed using 100% implementation rates and BMPs sized to capture the 85th percentile storm event. Table 20 summarizes the comparison with key conclusions.

**Table 20. Programs Comparison Summary**

| Programs | Conclusions |
|---|---|
| Subregional programs | • Offer the most opportunity area for implementation |
| Self-mitigation BMPs | • Offer the least opportunity area for implementation<br>• Capture the most volume per acre treated, but it requires an extensive implementation area |
| Infiltration programs | • Offer the lowest cost per unit volume (especially subregional infiltration)<br>• Offer a higher capture volume per acre than direct use programs, primarily because the BMPs in direct use programs typically have longer drawdown times, which decrease their capture rate in comparison to infiltration programs. |
| Direct use programs | • Offer a relatively high cost per unit volume capture, partially due to the distribution and treatment requirements not shown for infiltration programs |
| Impervious pavement replacement | • Offer the highest cost per unit volume captured |

In all of these results, the relative efficacy of different programs may depend on location, program type subcategory, geophysical category, and BMP size; therefore, each combination must be considered separately. Furthermore, even if one program is more effective than another, the program in question may have limited opportunity area in some areas, limiting its use. The cost-effectiveness of all program types contains areas of overlap with other programs, suggesting that, even though subregional infiltration programs may appear to be the most cost effective overall, there are conditions in which each of the six program types will be favorable, and all offer cost effective solutions. These are the “low-hanging fruit” opportunities that can be implemented first. As a result, the final plan will likely contain a mix of all program types.

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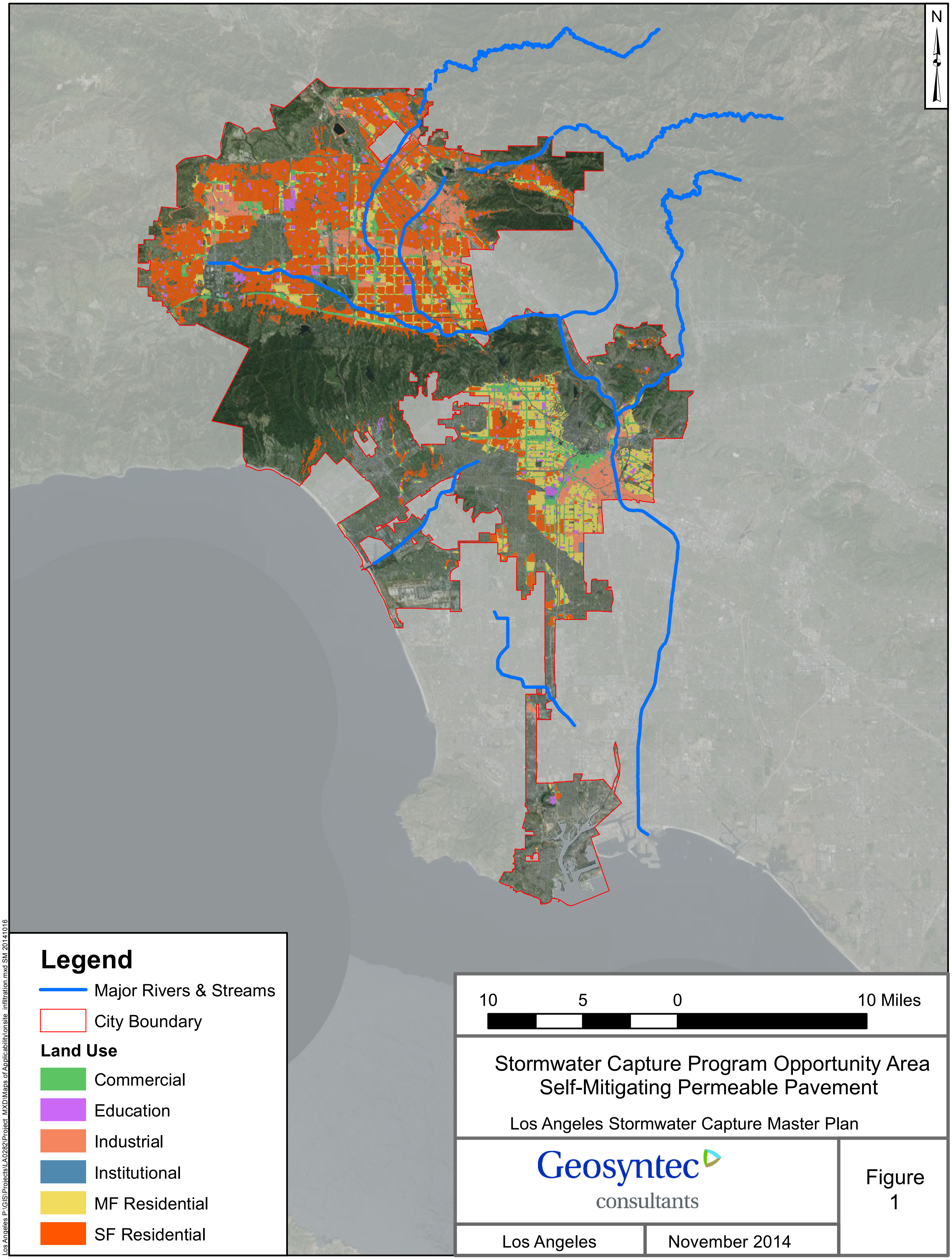
# Figures




Stormwater Capture Program Opportunity Area
Self-Mitigating Permeable Pavement

Los Angeles Stormwater Capture Master Plan

Geosyntec consultants

Figure 1

Los Angeles | November 2014

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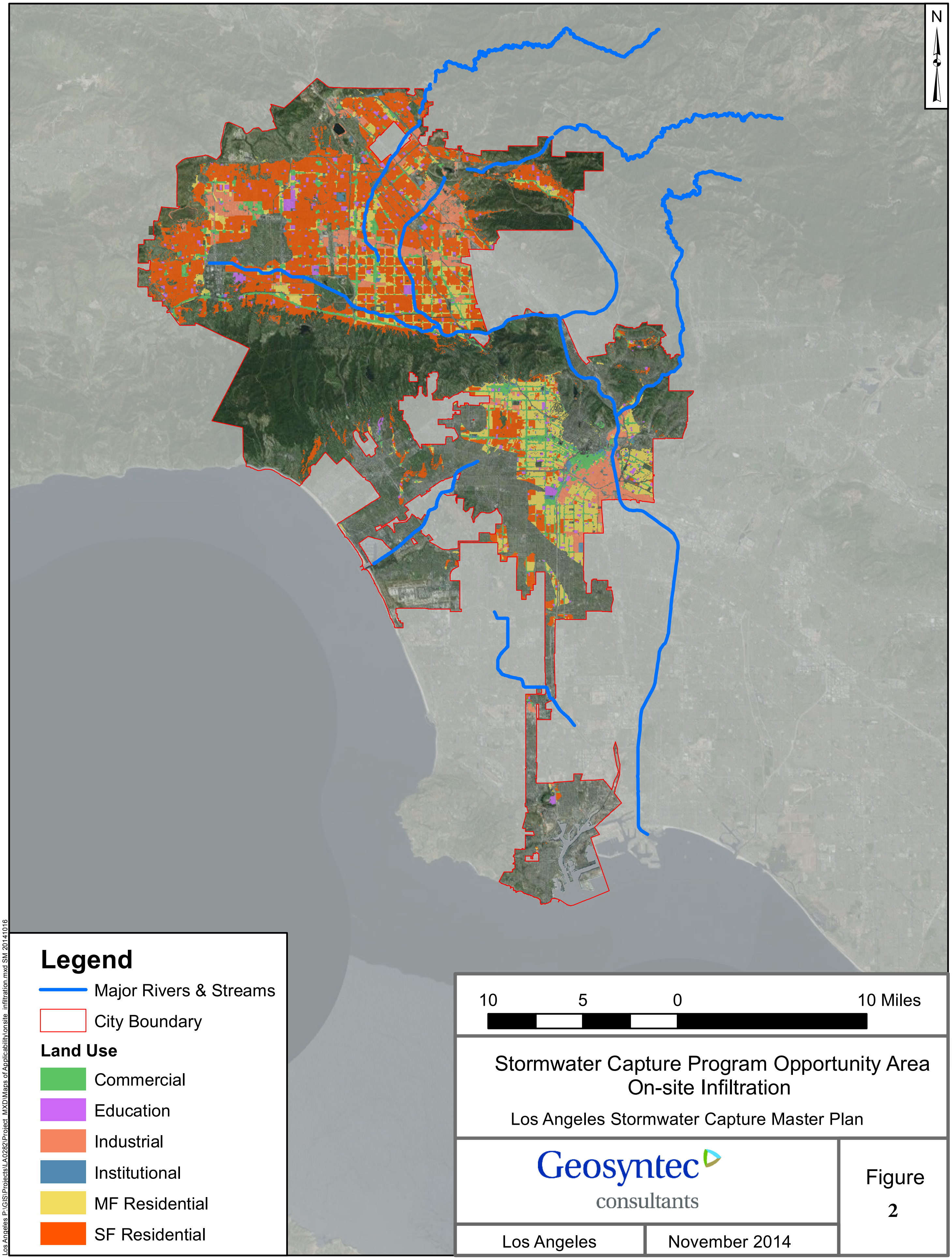
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Legend
Major Rivers & Streams
City Boundary
Land Use
Commercial
Education
Industrial
Institutional
MF Residential
SF Residential
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Stormwater Capture Program Opportunity Area
On-site Infiltration
Los Angeles Stormwater Capture Master Plan
Geosyntec consultants
Figure 2
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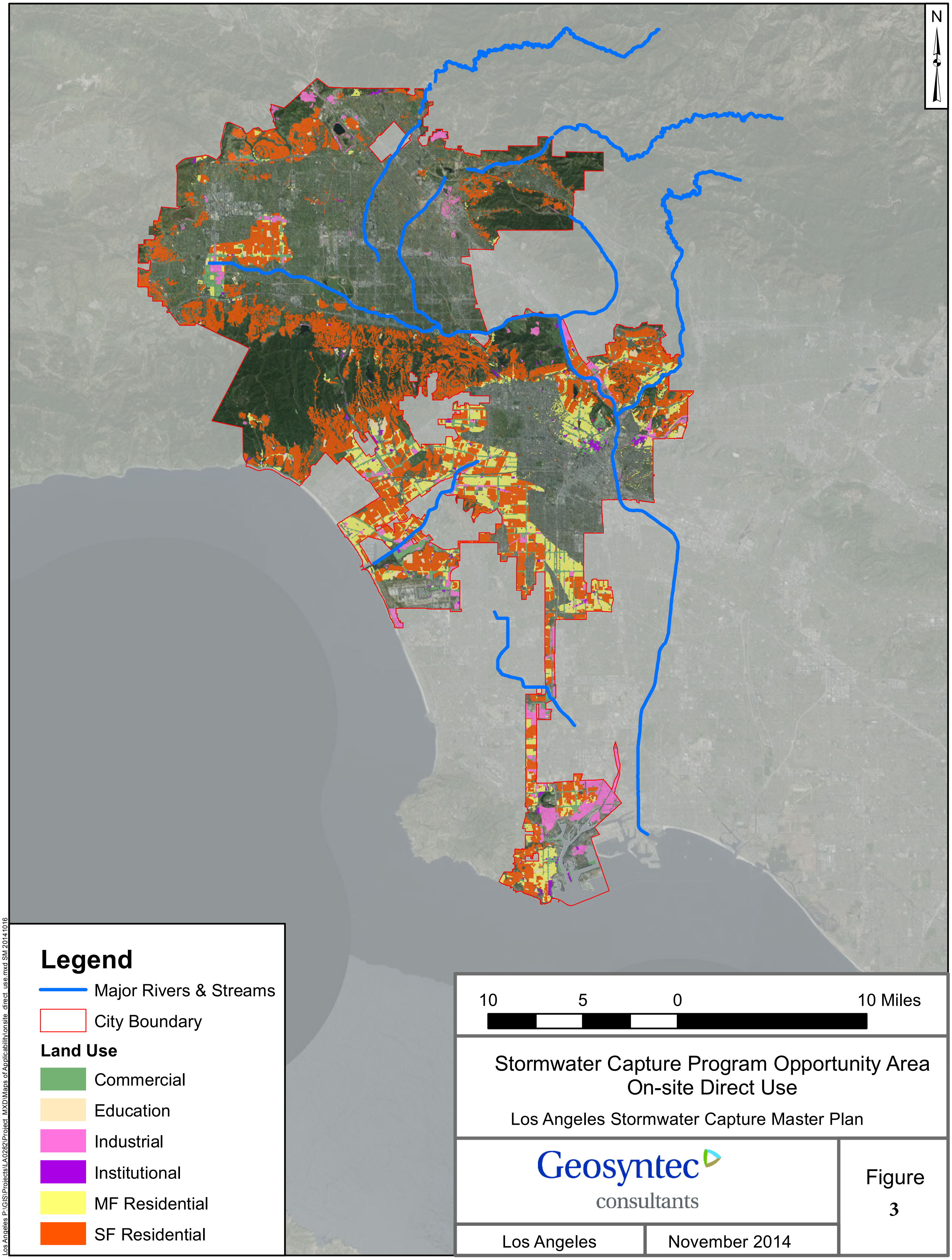
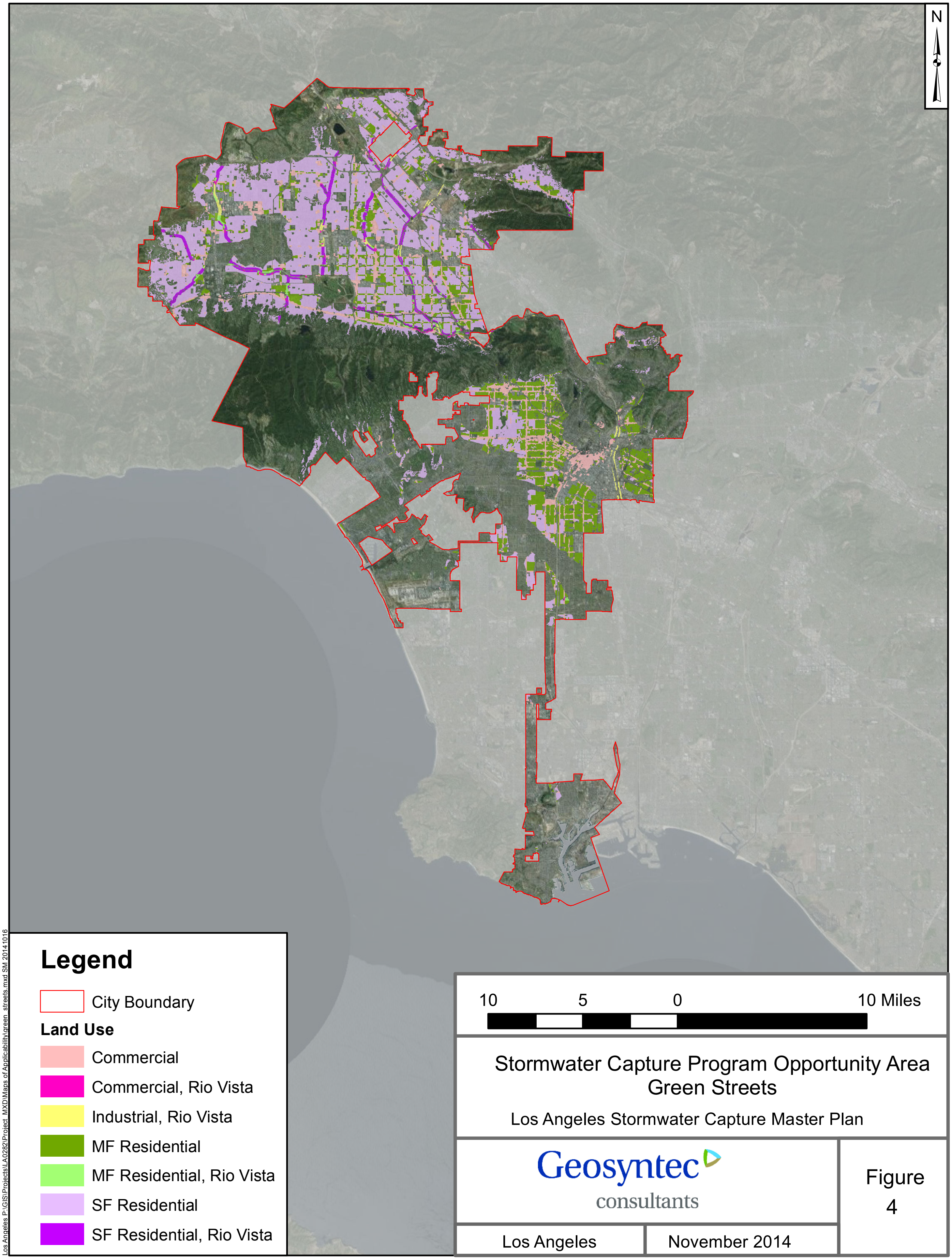

N
Legend
Major Rivers & Streams
City Boundary
Land Use
Commercial
Education
Industrial
Institutional
MF Residential
SF Residential
10
5
0
10 Miles
Stormwater Capture Program Opportunity Area
On-site Direct Use
Los Angeles Stormwater Capture Master Plan
Geosyntec
consultants
Figure
3
Los Angeles
November 2014




Stormwater Capture Program Opportunity Area
Green Streets

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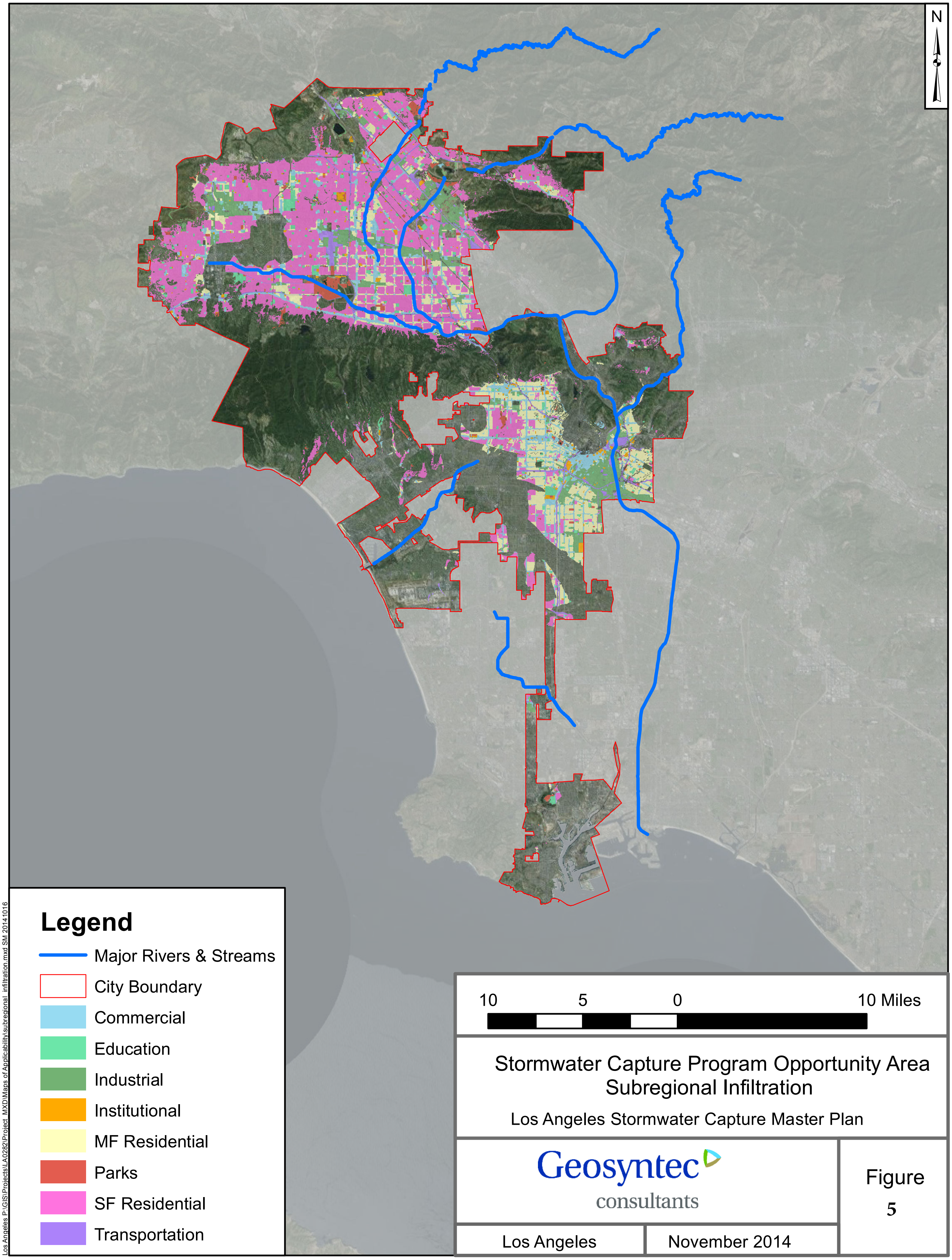
Figure 4

Los Angeles P:\GIS\Projects\LA0282\Project_MXD\Maps of Applicability\green_streets.mxd SM 20141016




Stormwater Capture Program Opportunity Area
Subregional Infiltration

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Figure 5

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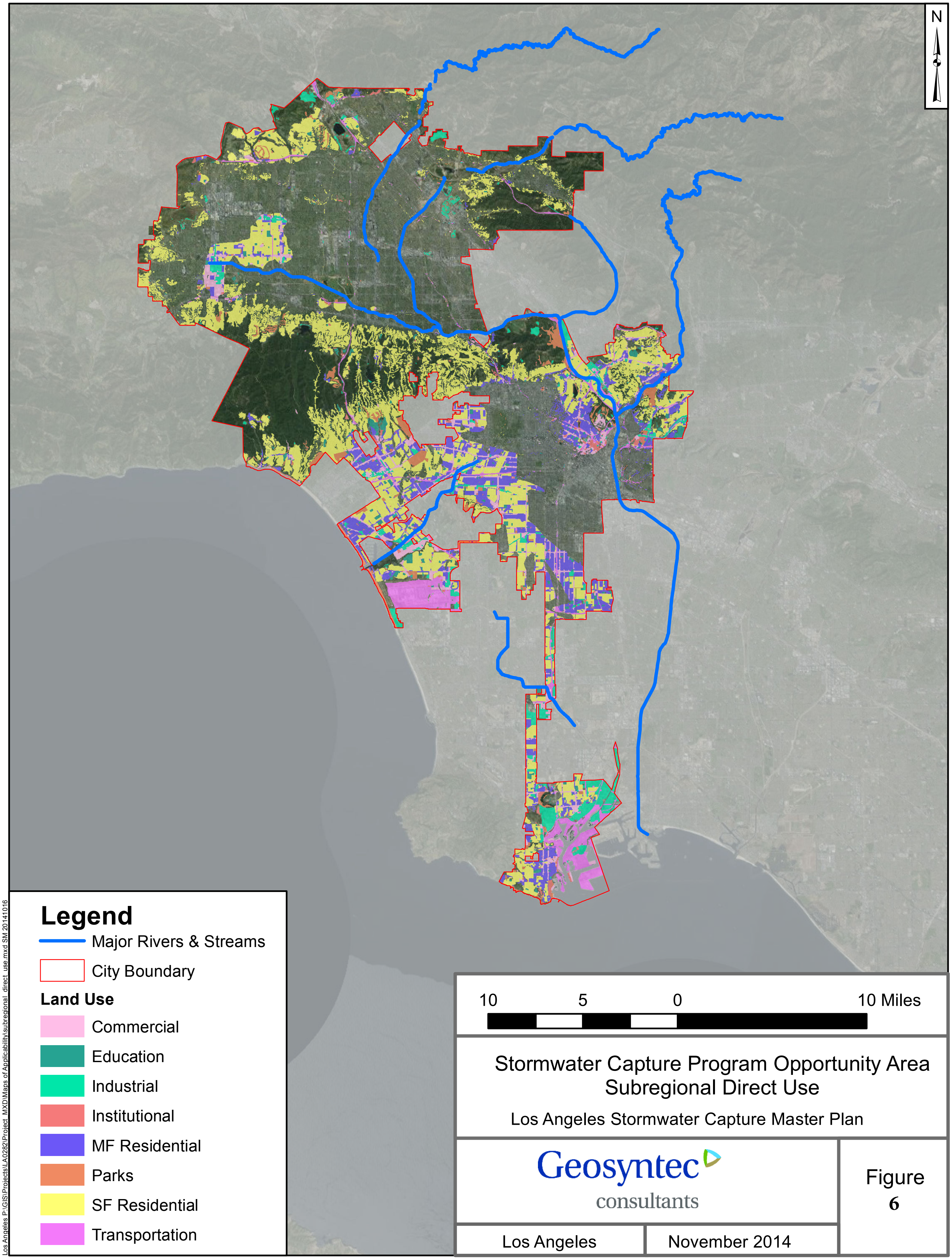
Los Angeles P:\GIS\Projects\LA0282\Project_MXD\Maps of Applicability\subregional_infiltration.mxd SM 20141016




Stormwater Capture Program Opportunity Area
Subregional Direct Use

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Figure 6

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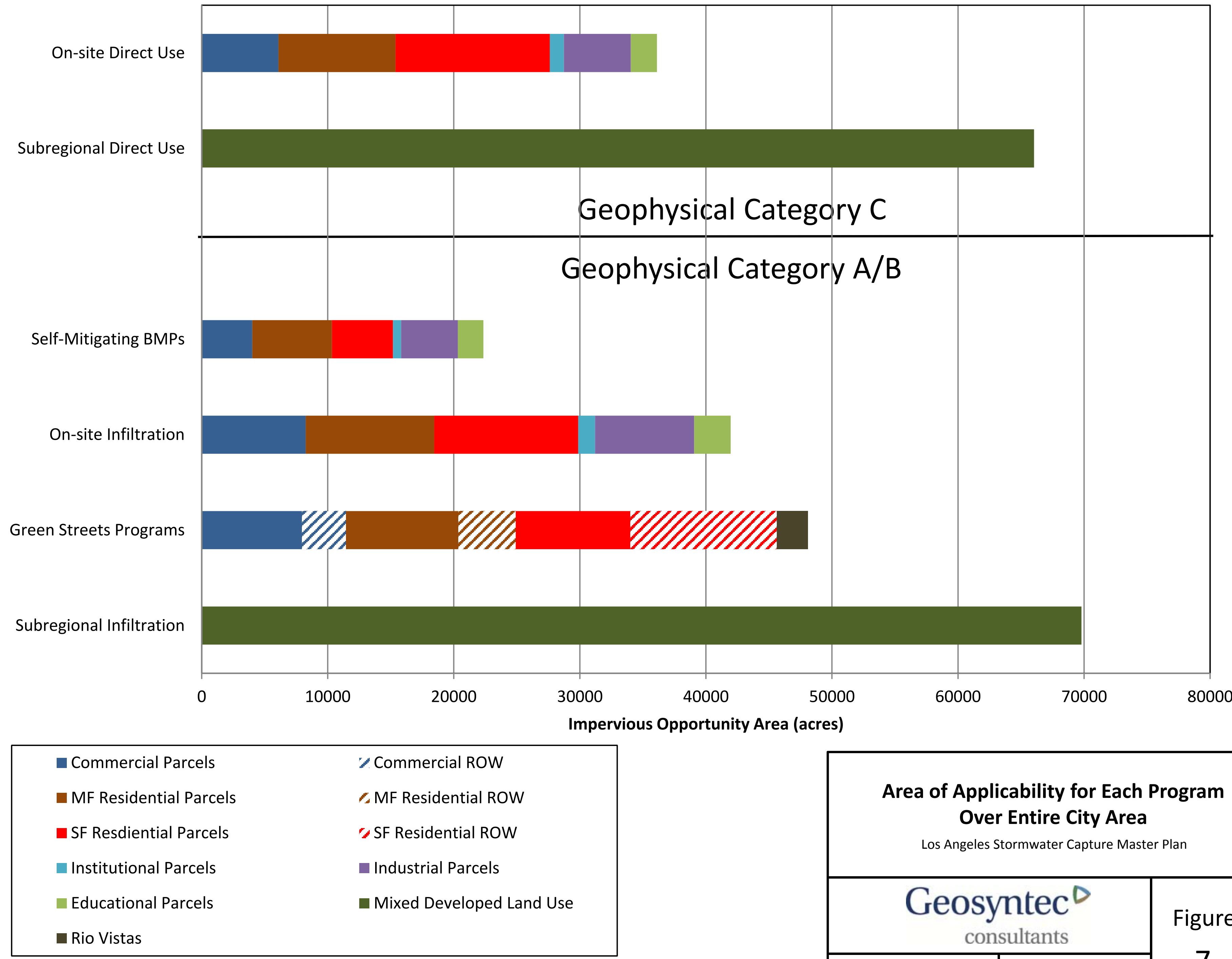


**Area of Applicability for Each Program Over Entire City Area**

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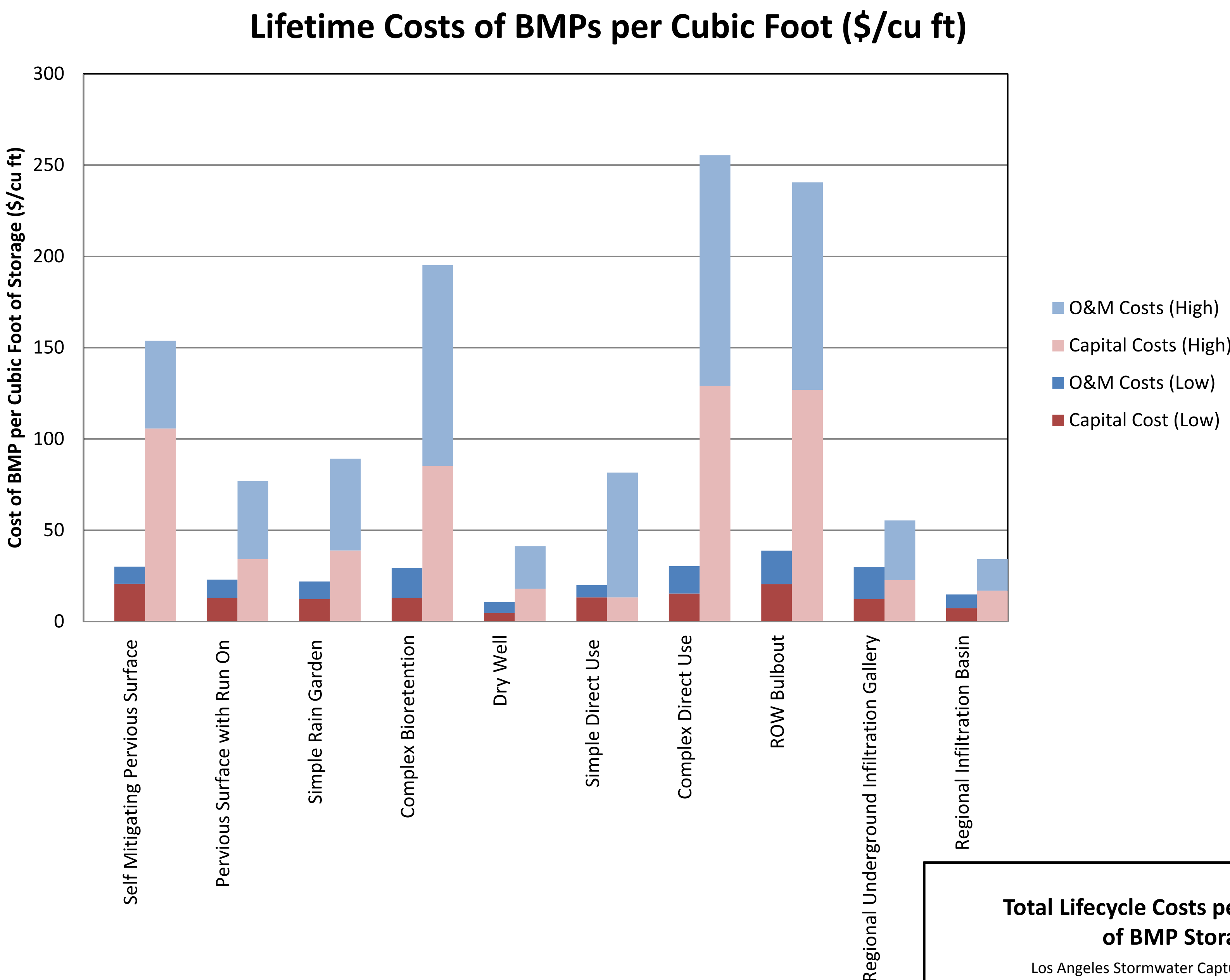
Figure 7




**Total Lifecycle Costs per Cubic Foot of BMP Storage**

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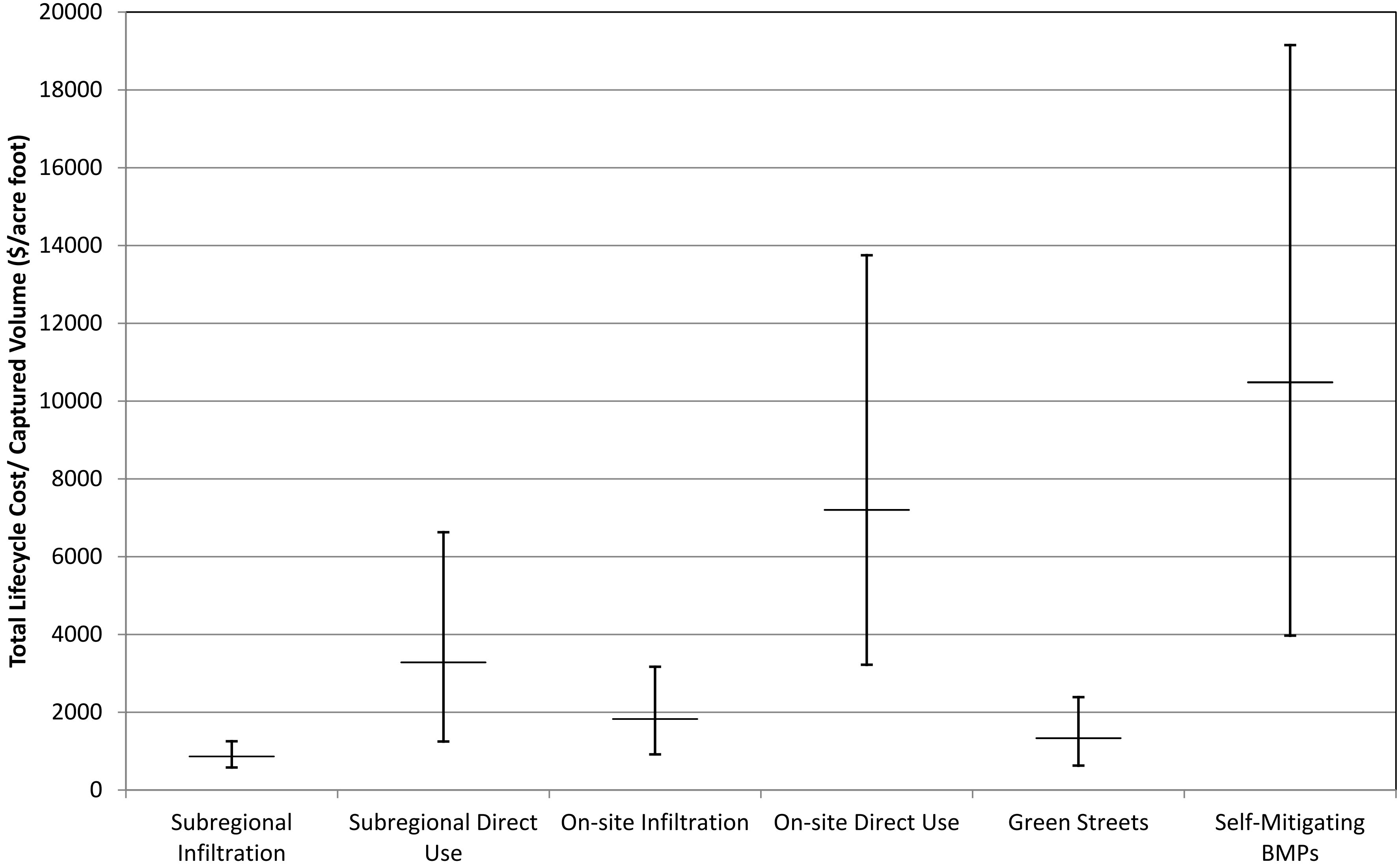
| Los Angeles | November 2014 | Figure 8 |
|---|---|---|




Middle line represents the medium cost estimate with the medium capture volume estimate. Error bars represent the highest cost estimate with the lowest capture volume estimate (upper) and lowest cost estimate with the highest capture volume estimate (lower).

**Total Lifecycle Costs per Acre Foot of Captured Stormwater for all Siting Opportunities within Entire City Area**

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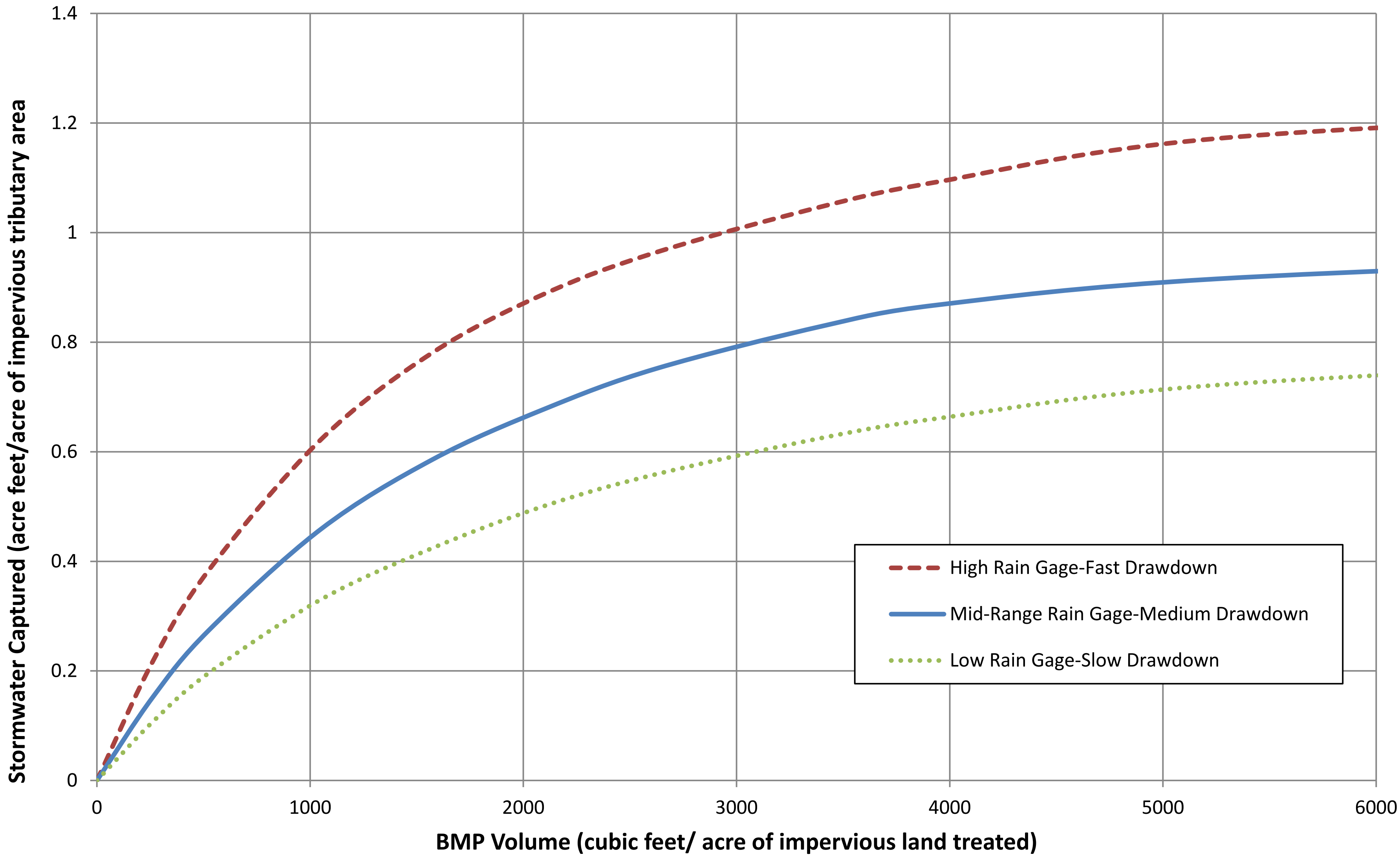
Figure 9




**These curves are the result of the following inputs to the framework:**

- **Program type: On-site Infiltration**
- **Siting Opportunities: MF Residential**
- **Geophysical Category: B**
- **Subwatershed: Northeast San Fernando Valley**

**Example of Unit Capture Nomograph from SCMP Framework**

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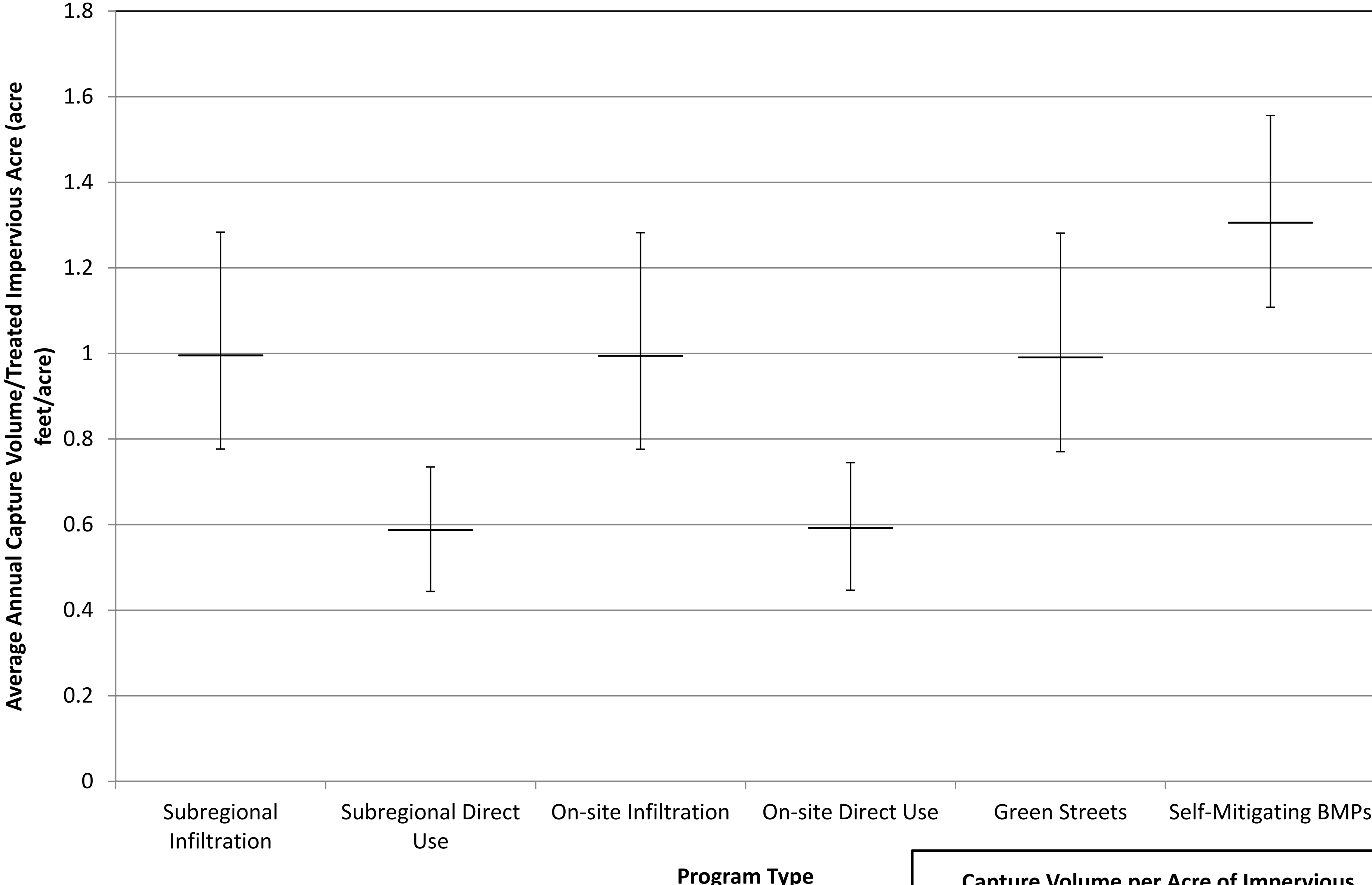
| Los Angeles | November 2014 | Figure 10 |
|---|---|---|




Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

**Capture Volume per Acre of Impervious Area Treated for Entire City Area**

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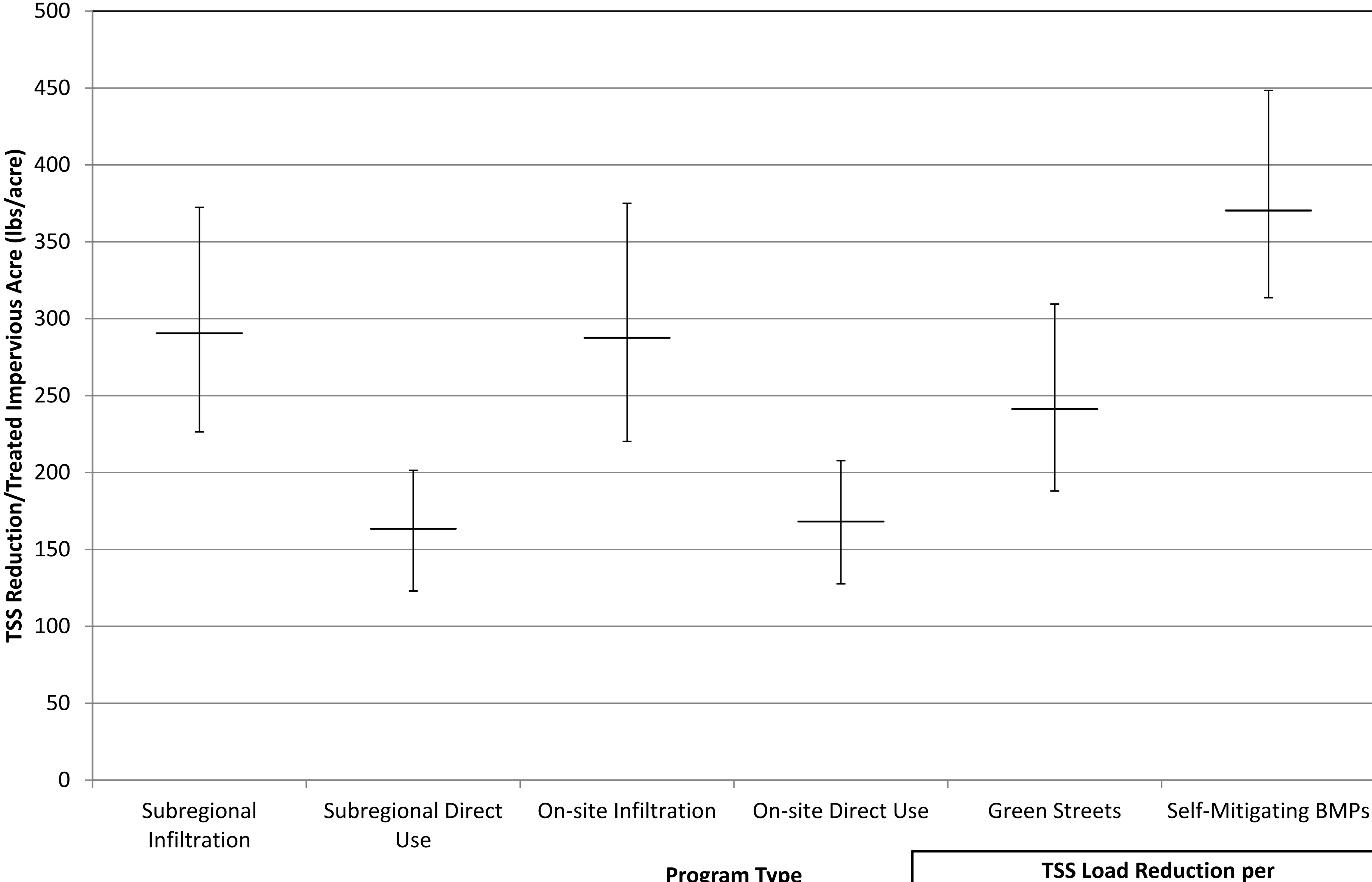
Figure 11




Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

Note: The estimated pollutant loads shown in these maps are intended to be used to evaluate the water quality benefits of specific suites of stormwater capture alternatives that are of interest to the development of the SCMP; estimates are based on assumptions and methods that were selected to be appropriate for the purpose of the SCMP. These estimates do not necessarily represent scenarios that are relevant for MS4 Permit-related watershed planning or compliance efforts; they are not intended to be interpreted for these purposes.

**TSS Load Reduction per Acre of Impervious Area Treated for Entire City Area**

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Figure 12

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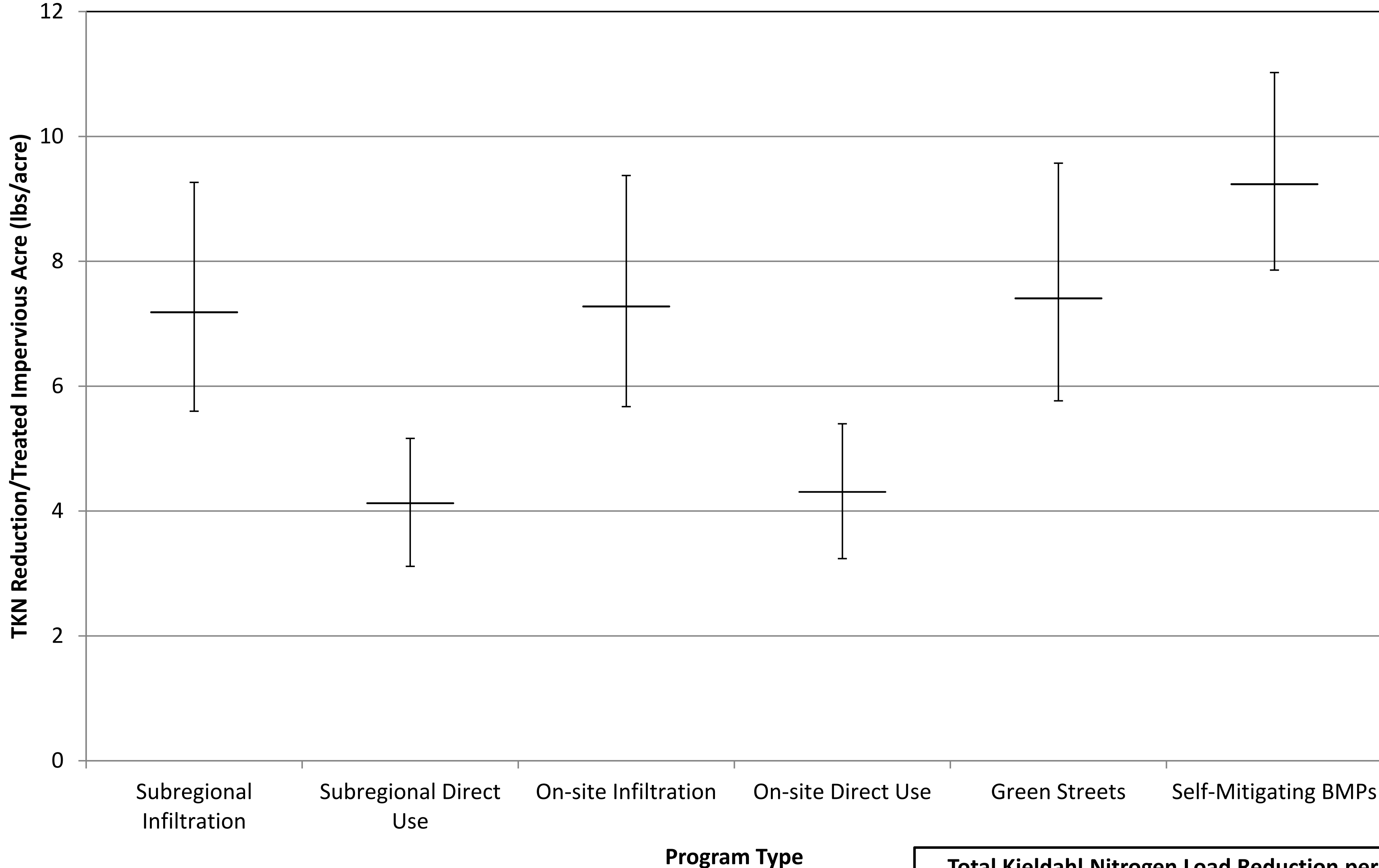


Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

Note: The estimated pollutant loads shown in these maps are intended to be used to evaluate the water quality benefits of specific suites of stormwater capture alternatives that are of interest to the development of the SCMP; estimates are based on assumptions and methods that were selected to be appropriate for the purpose of the SCMP. These estimates do not necessarily represent scenarios that are relevant for MS4 Permit-related watershed planning or compliance efforts; they are not intended to be interpreted for these purposes.

**Total Kjeldahl Nitrogen Load Reduction per Acre of Impervious Area Treated for Entire City Area**

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Figure 13

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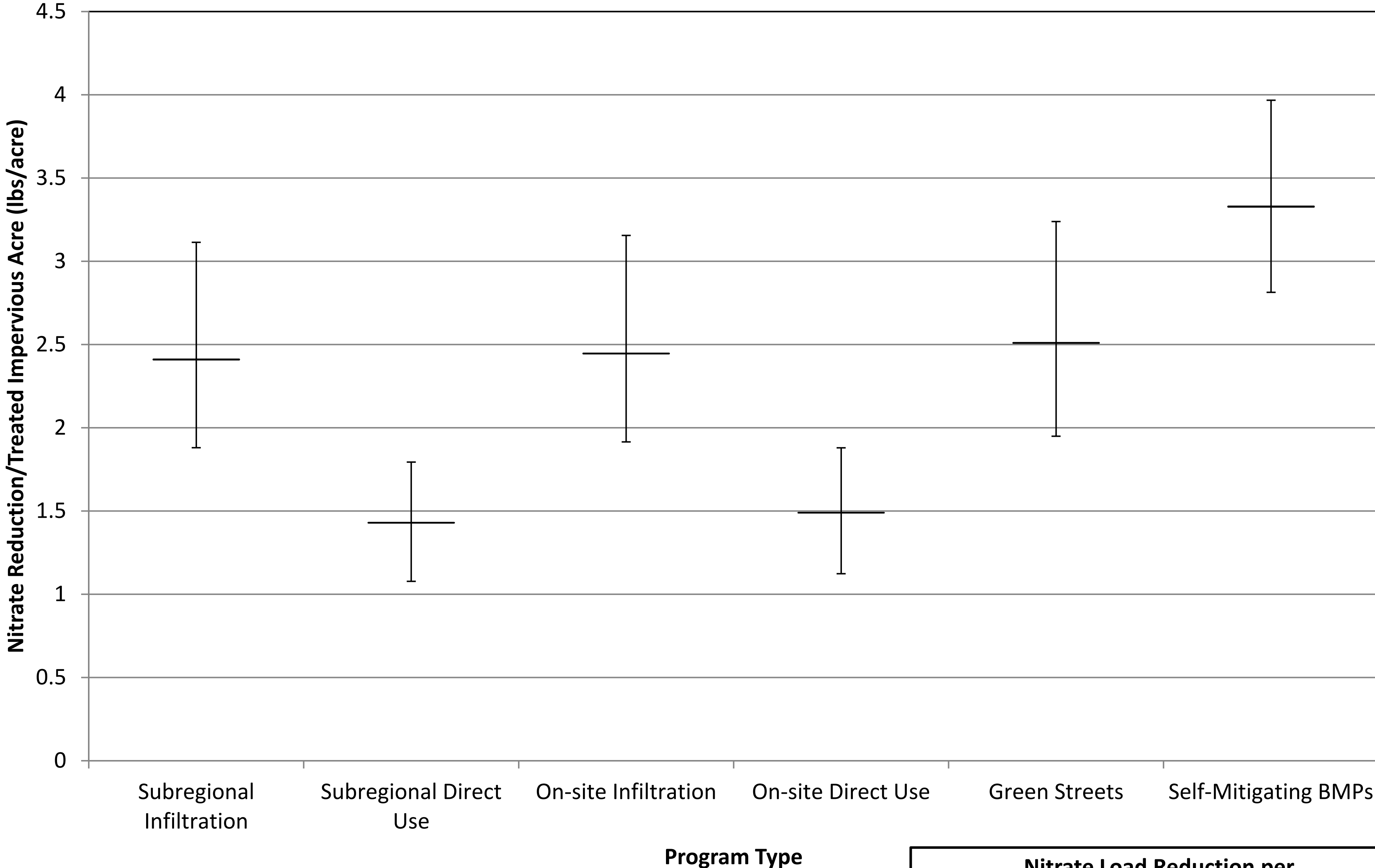
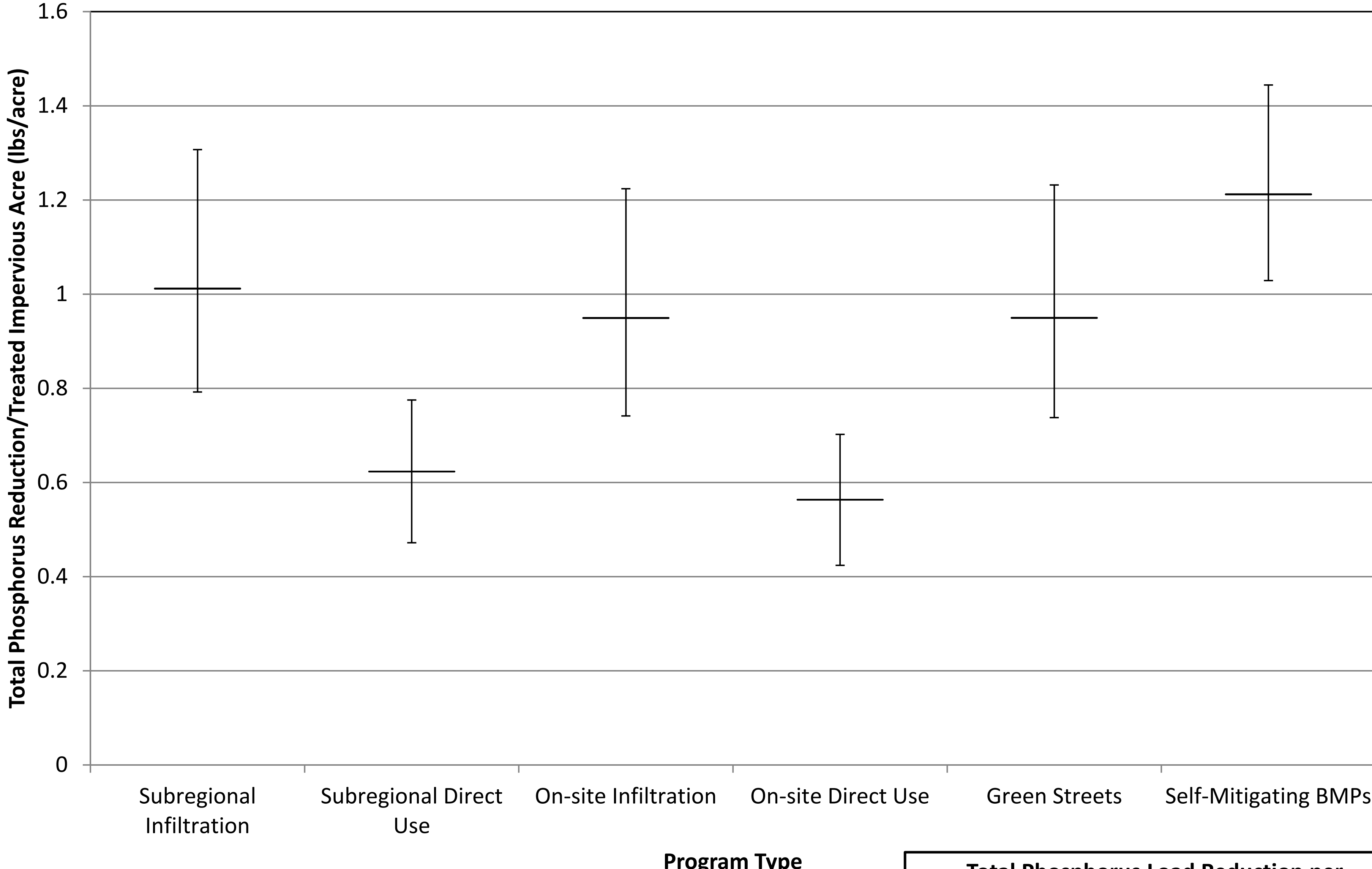



Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

Note: The estimated pollutant loads shown in these maps are intended to be used to evaluate the water quality benefits of specific suites of stormwater capture alternatives that are of interest to the development of the SCMP; estimates are based on assumptions and methods that were selected to be appropriate for the purpose of the SCMP. These estimates do not necessarily represent scenarios that are relevant for MS4 Permit-related watershed planning or compliance efforts; they are not intended to be interpreted for these purposes.

| | | |
|---|---|---|
| **Nitrate Load Reduction per Acre of Impervious Area Treated for Entire City Area**<br>Los Angeles Stormwater Capture Master Plan | | |
| Geosyntec consultants | | Figure 14 |
| Los Angeles | November 2014 | |




Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

Note: The estimated pollutant loads shown in these maps are intended to be used to evaluate the water quality benefits of specific suites of stormwater capture alternatives that are of interest to the development of the SCMP; estimates are based on assumptions and methods that were selected to be appropriate for the purpose of the SCMP. These estimates do not necessarily represent scenarios that are relevant for MS4 Permit-related watershed planning or compliance efforts; they are not intended to be interpreted for these purposes.

**Total Phosphorus Load Reduction per Acre of Impervious Area Treated for Entire City Area**

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Figure 15

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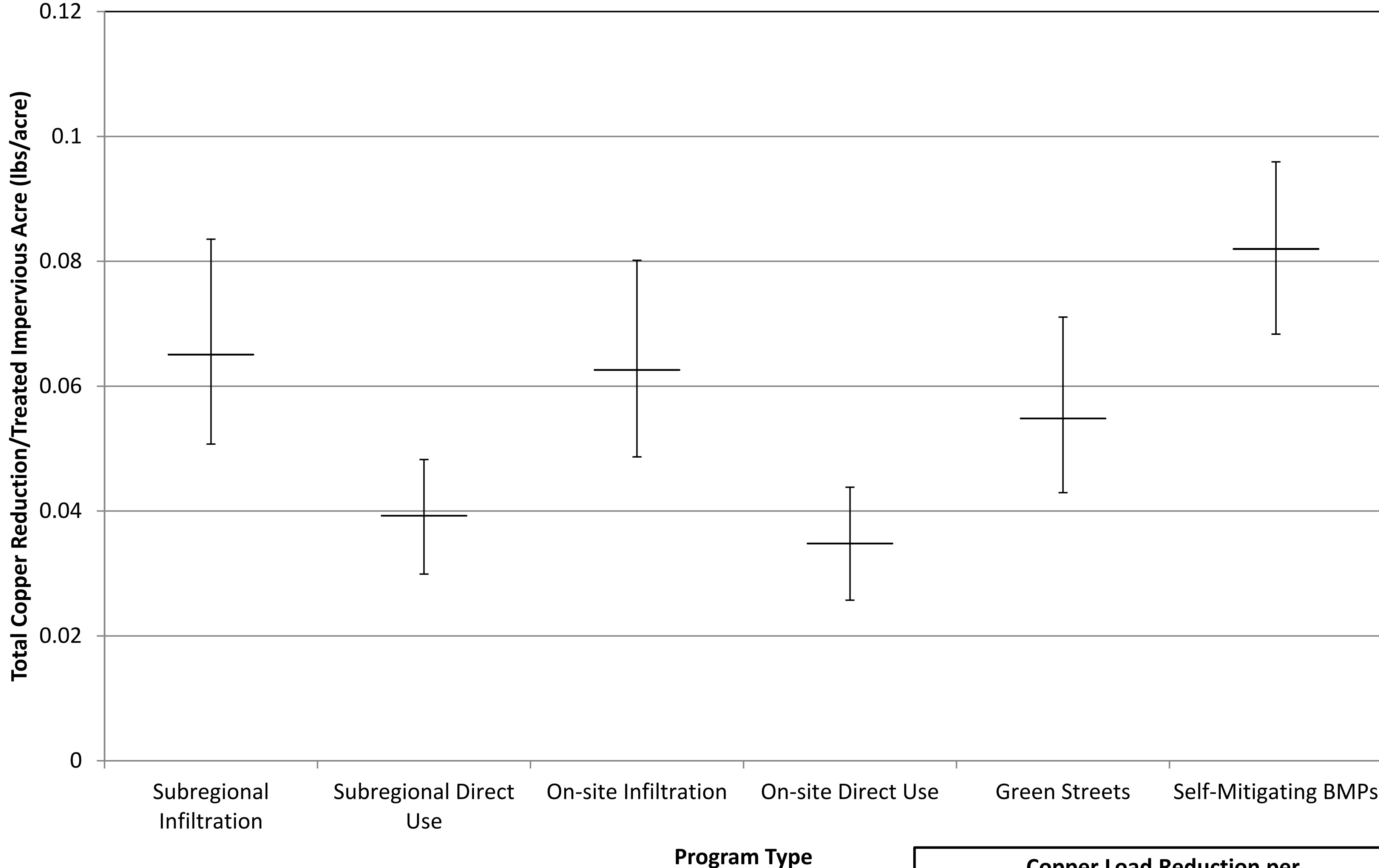


Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

Note: The estimated pollutant loads shown in these maps are intended to be used to evaluate the water quality benefits of specific suites of stormwater capture alternatives that are of interest to the development of the SCMP; estimates are based on assumptions and methods that were selected to be appropriate for the purpose of the SCMP. These estimates do not necessarily represent scenarios that are relevant for MS4 Permit-related watershed planning or compliance efforts; they are not intended to be interpreted for these purposes.

**Copper Load Reduction per Acre of Impervious Area Treated for Entire City Area**

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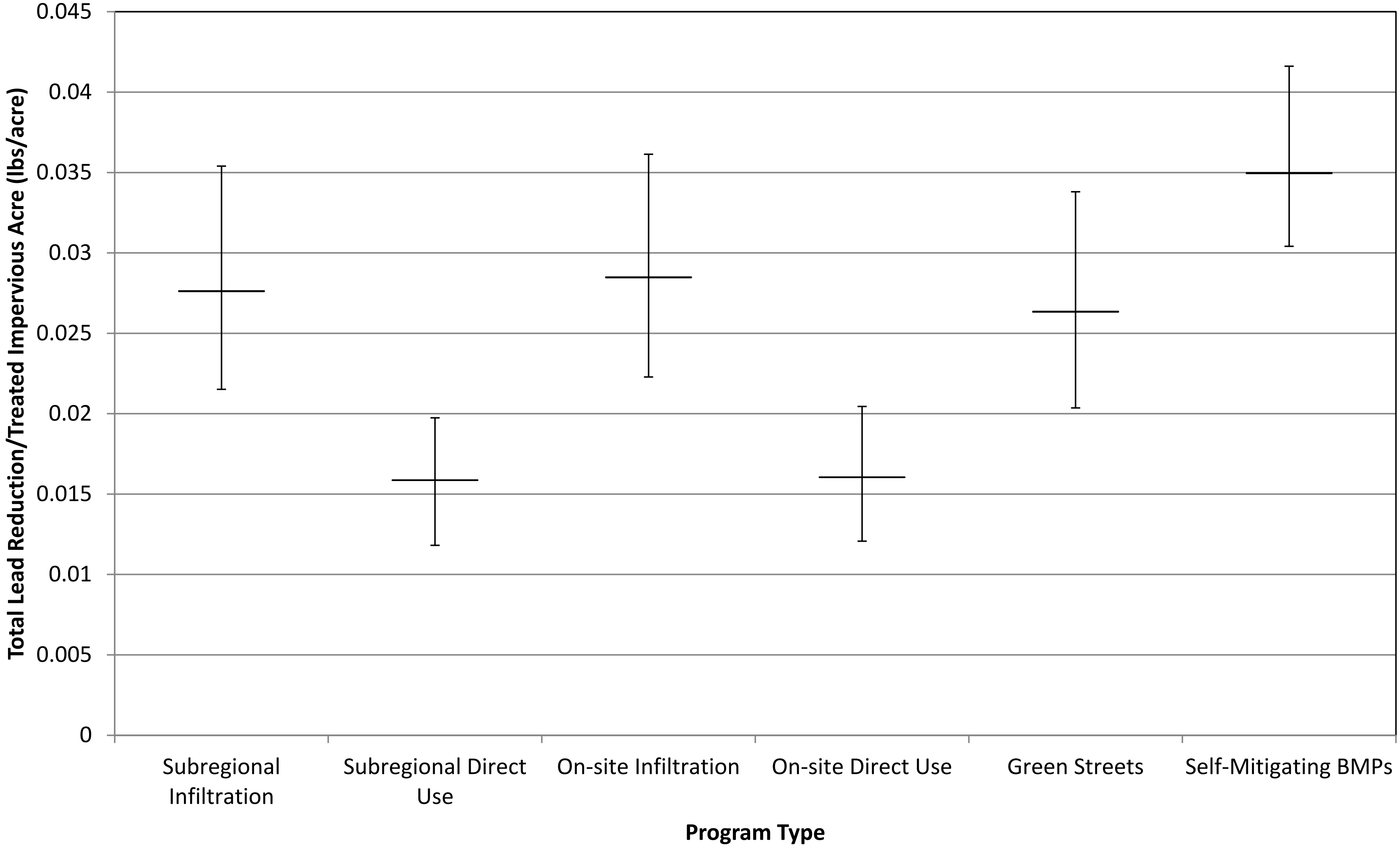
| | | |
|---|---|---|
| Los Angeles | November 2014 | Figure 16 |




Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

Note: The estimated pollutant loads shown in these maps are intended to be used to evaluate the water quality benefits of specific suites of stormwater capture alternatives that are of interest to the development of the SCMP; estimates are based on assumptions and methods that were selected to be appropriate for the purpose of the SCMP. These estimates do not necessarily represent scenarios that are relevant for MS4 Permit-related watershed planning or compliance efforts; they are not intended to be interpreted for these purposes.

**Lead Reduction per Acre of Impervious Area Treated for Entire City Area**

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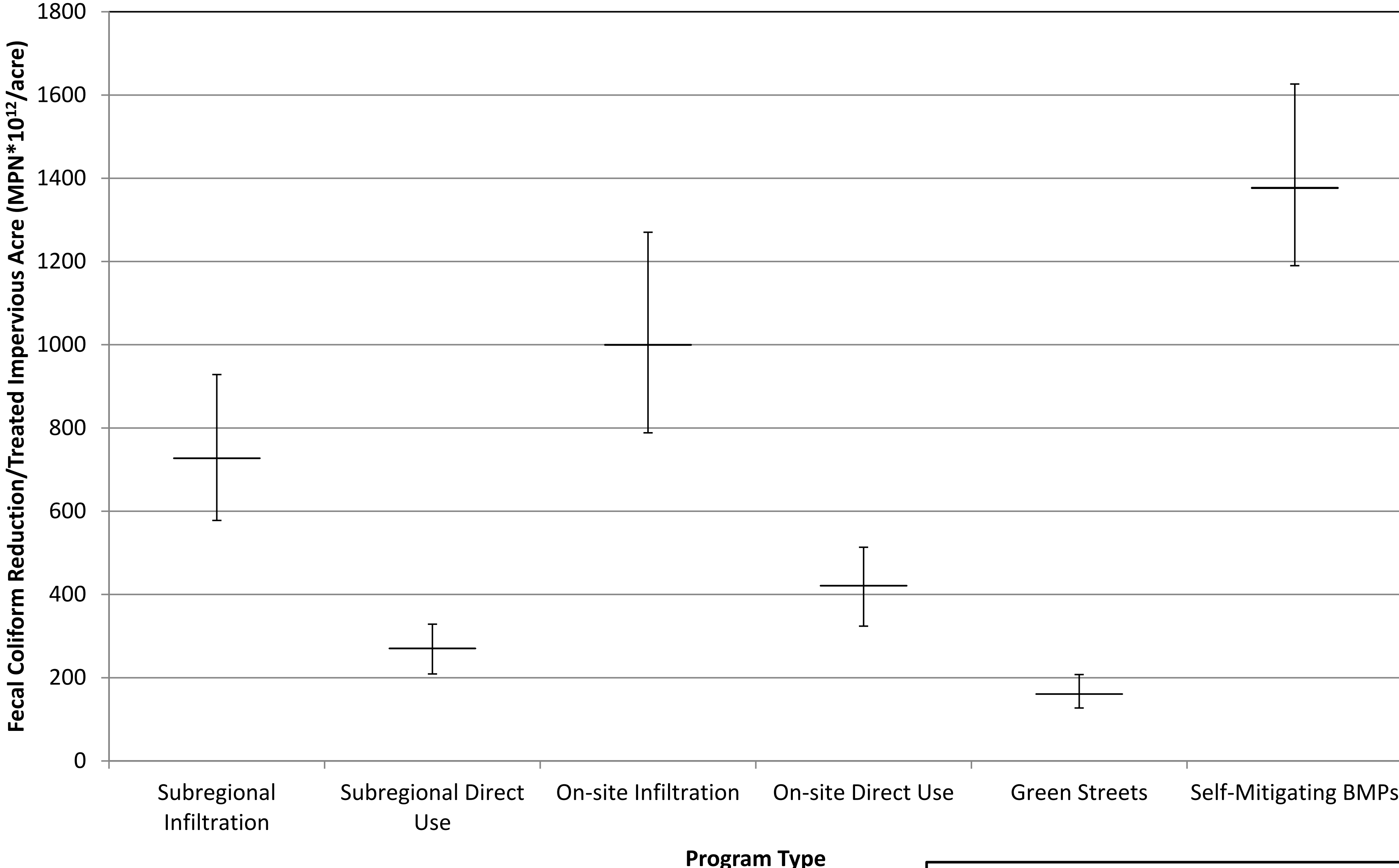
Figure 17




Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

Note: The estimated pollutant loads shown in these maps are intended to be used to evaluate the water quality benefits of specific suites of stormwater capture alternatives that are of interest to the development of the SCMP; estimates are based on assumptions and methods that were selected to be appropriate for the purpose of the SCMP. These estimates do not necessarily represent scenarios that are relevant for MS4 Permit-related watershed planning or compliance efforts; they are not intended to be interpreted for these purposes.

**Fecal Coliform Load Reduction per Acre of Impervious Area Treated for Entire City Area**

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Figure 18

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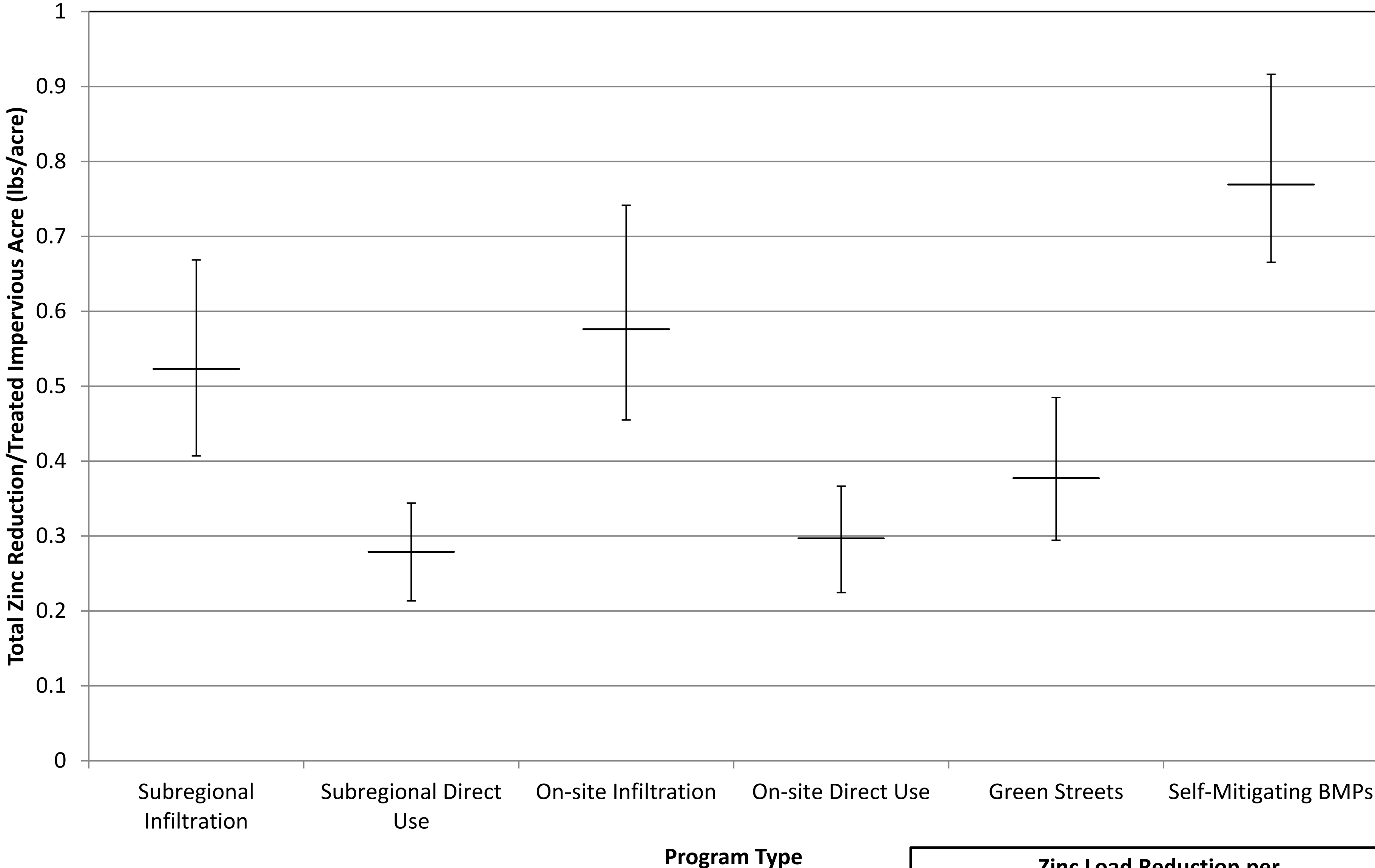


Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

Note: The estimated pollutant loads shown in these maps are intended to be used to evaluate the water quality benefits of specific suites of stormwater capture alternatives that are of interest to the development of the SCMP; estimates are based on assumptions and methods that were selected to be appropriate for the purpose of the SCMP. These estimates do not necessarily represent scenarios that are relevant for MS4 Permit-related watershed planning or compliance efforts; they are not intended to be interpreted for these purposes.

**Zinc Load Reduction per Acre of Impervious Area Treated for Entire City Area**

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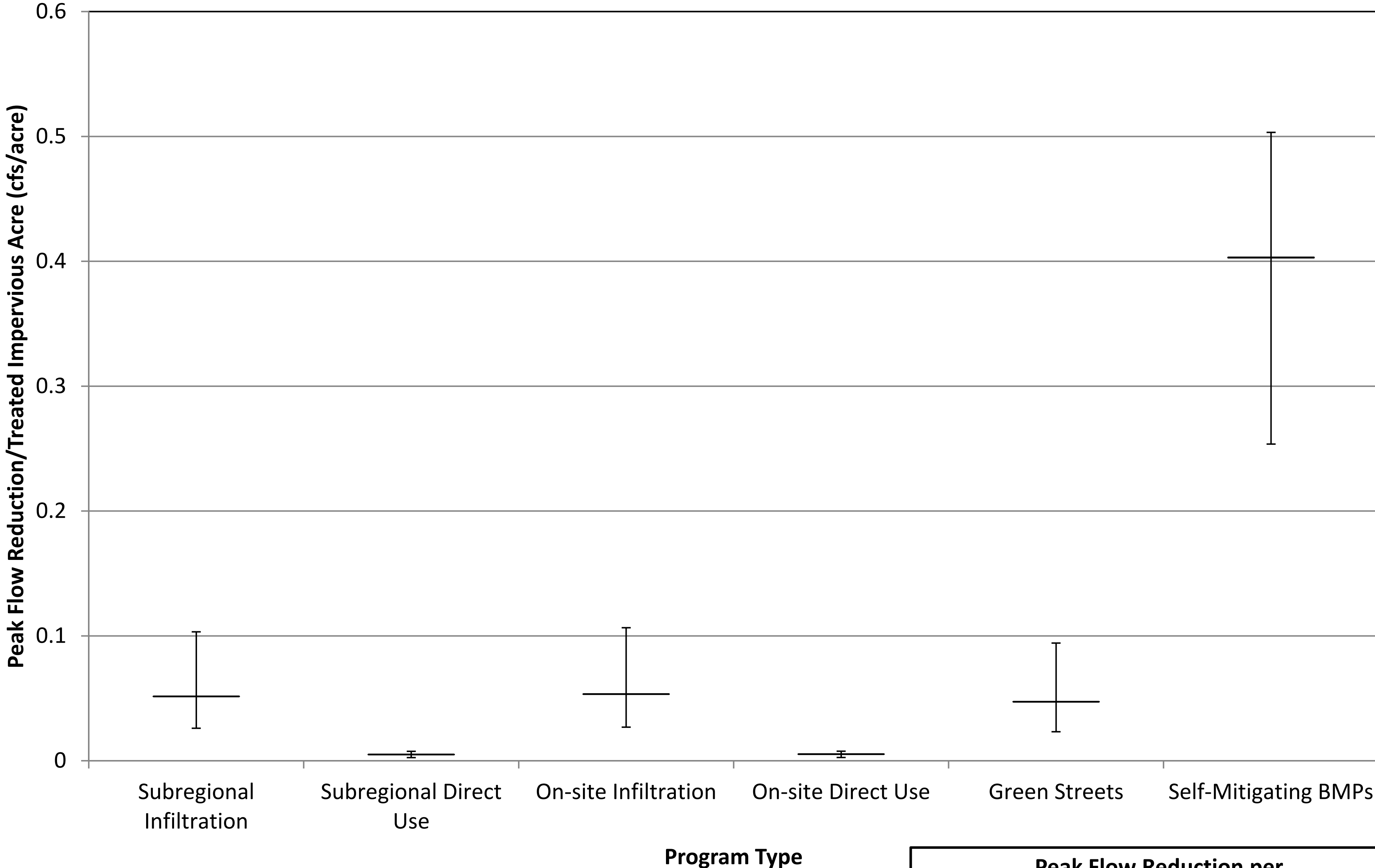
Figure 19




Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

**Peak Flow Reduction per Acre of Impervious Area Treated for Entire City Area**

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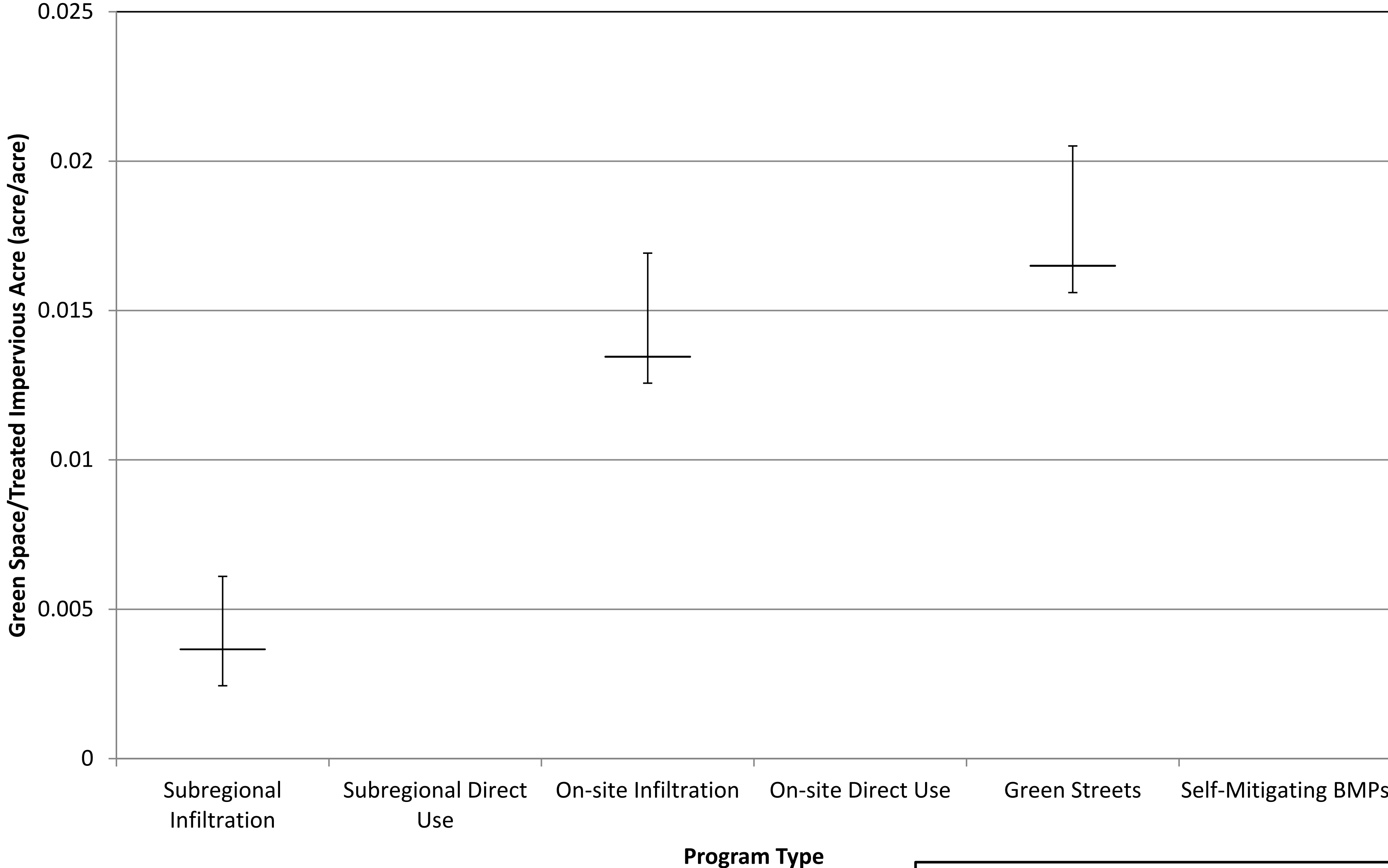
Figure 20




Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

**Green Space Area per Acre of Impervious Area Treated for Entire City Area**

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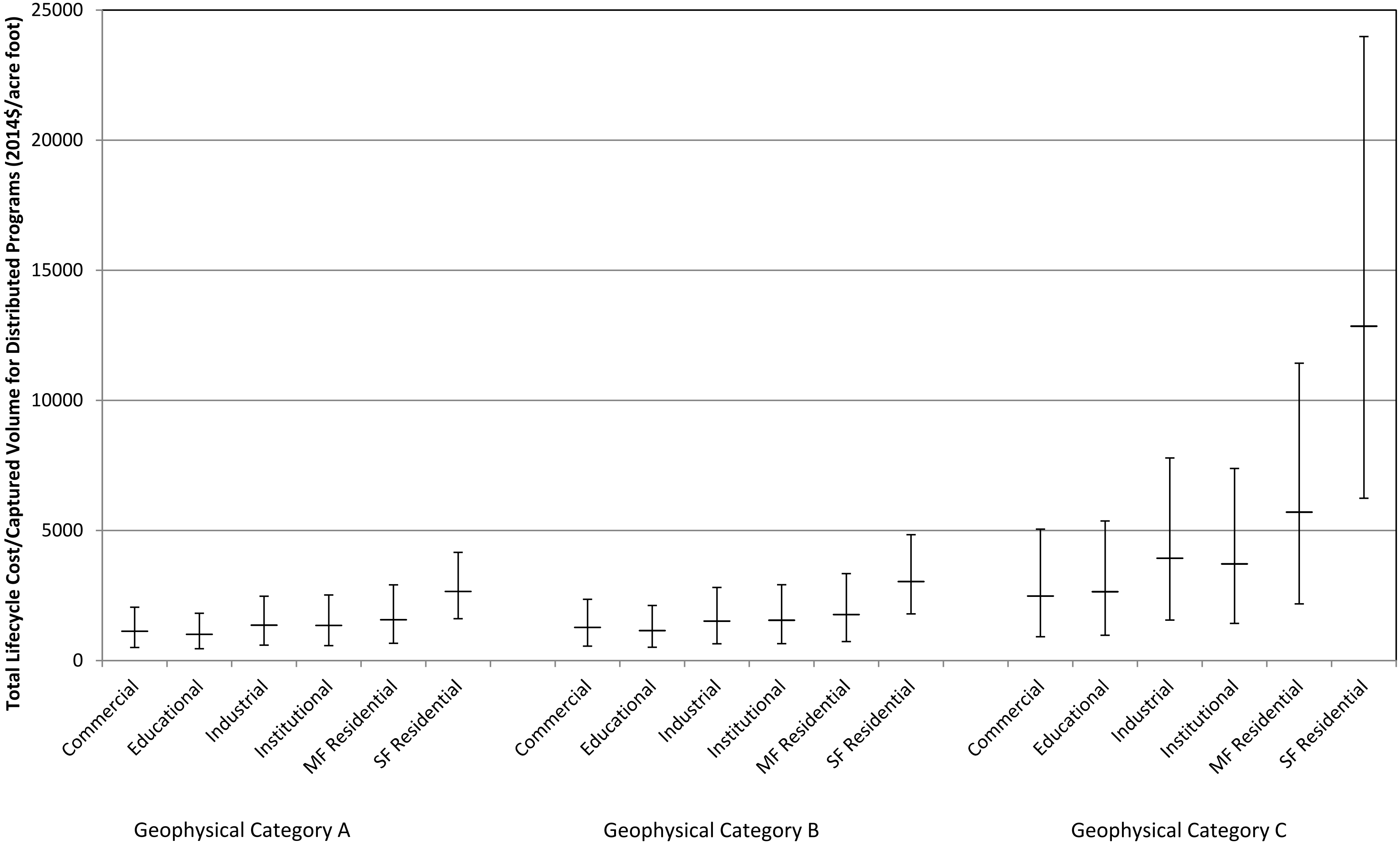
| | | |
|---|---|---|
| Los Angeles | November 2014 | Figure 21 |




Middle line represents the medium cost estimate with the medium capture volume estimate. Error bars represent the highest cost estimate with the lowest capture volume estimate (upper) and lowest cost estimate with the highest capture volume estimate (lower).

**Effect of Program Type Subcategory and Geophysical Category on the Cost per Volume Captured for On-Site Programs within the Entire City Area**

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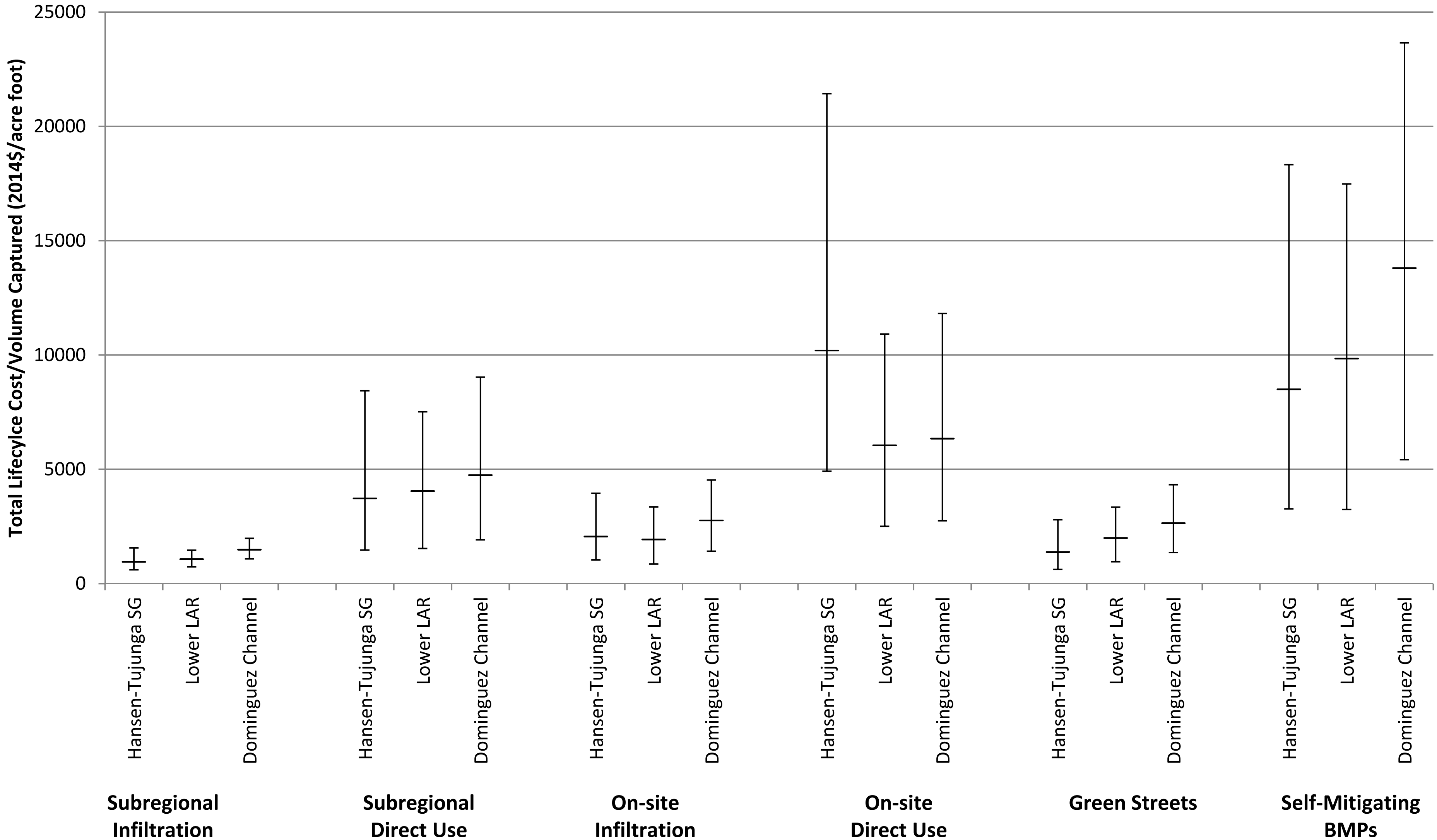
Figure 22




Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

**Effect of Subwatershed on the Cost per Volume Captured for each Program Type within the Entire City Area**

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Figure 23

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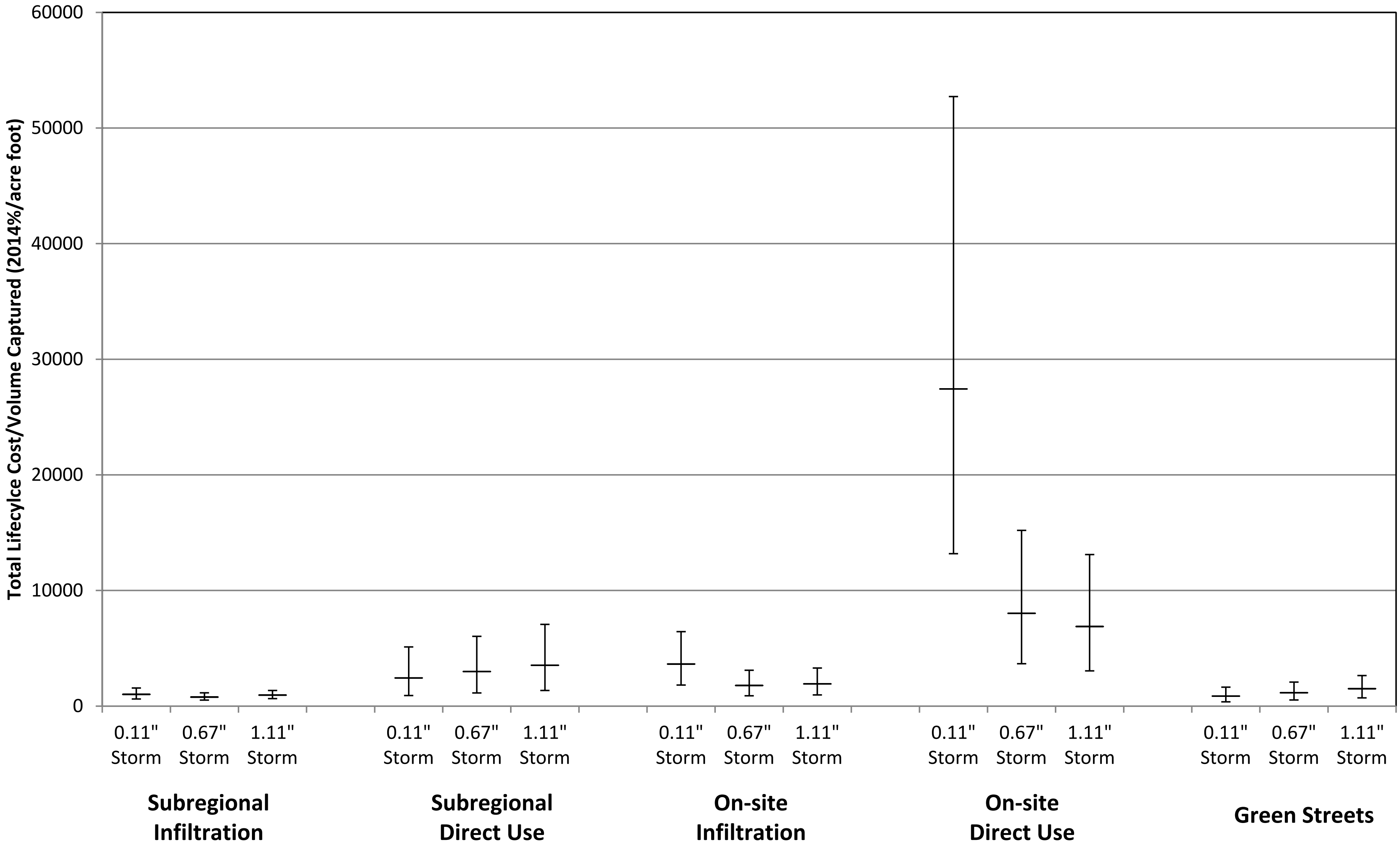


Middle line represents the medium estimate. Error bars represent the highest estimate and lowest estimate.

**Effect of BMP Size on the Cost per Volume Captured for each Program Type within the Entire City Area**

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Figure 24

# Appendix A: Program Fact Sheets

(See Appendix I of Stormwater Capture Master Plan)

# Appendix B: Drainage Delineations

Percent of Impervious Area Directly Connected to Street

**Multi-Family Housing - Average 91%**

Total Area: .758 acres

Total Impervious Area: .569

Impervious Area Draining to Street: .478 acres

Percent draining to street: 84%

Example #2:

Total Area: .551 acres

Total Impervious Area:  .5625 acres

Draining to street: 0.565

Percent impervious area draining to street: 100%

Example 3:
Total Parcel Area: 0.303 acres
Impervious Parcel Areas: .227acres
Area draining to street: .203 acres
Percent draining to street: 89%

**Single Family Housing – Ave 84%**

Example 1:

Total Area: 0.303 acres

Total Imp Area: .127 acres

Area draining to road: 0.114 acres

Percent connected to street: 90%

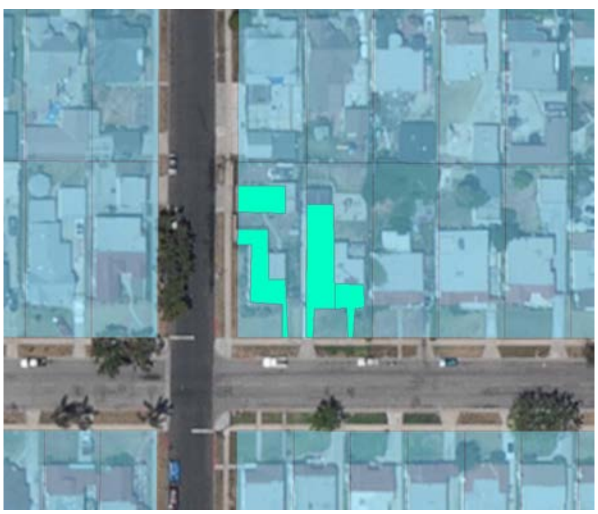
Example 2:

Total Area: .310 acres

Impervious Area: .130 acres

Area draining to street: .102 acres

Percent connected to street: 78%



Example 3:

Total Impervious Area: .049

Impervious area draining to street:  .041 acres

Percent connected to street: 84%

# Appendix C: Design Assumptions and Line Items

| **Design Assumptions**<br>Self-Mitigating Pervious Surface | | |
|---|---|---|
| | Low Cost Scenario | High Cost Scenario |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Grading Material and Criteria to be hauled | 0% | 20% |
| Materials | Porous asphalt | Interlocking pavers |
| Depth of Pavers/Asphalt surface (in) | 4 | 4 |
| Depth of bedding layer (in) | 0 | 2 |
| Depth of subbase (in) | 4 | 6 |
| Overflow | Overflow Edge | Overflow Edge |
| Soil decompaction depth (ft) | 0 | 1 |
| Pretreatment | No | No |
| Depth of asphalt to be demolished (in) | 0 | 6 |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |

| Design Assumptions<br>Pervious Surface with Run-on | | |
|---|---|---|
| | Low Cost Scenario | High Cost Scenario |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Percent excavated to be hauled | 20% | 80% |
| Utility constraints | No relocation | Some relocation |
| Materials | Porous asphalt | Interlocking pavers |
| Depth of Pavers/Asphalt surface (in) | 4 | 4 |
| Depth of bedding layer (in) | 2 | 4 |
| Depth of subbase (in) | 12 | 24 |
| Overflow pipe below permeable layer | Yes | Yes |
| Reservoir Depth for Storage Volume Calculations (in) | 6 | 6 |
| Overflow | Overflow Edge | 1 Drop inlet + per each 5000 sq ft of pavement |
| Connection to sewer | NA | 30' |
| Soil decompaction depth (in) | 0 | 12 |
| Depth of subbase required for traditional surface (ft) (avoided cost) | 1 | 1 |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |

| Design Assumptions<br>Simple Rain Garden | | |
|---|---|---|
| | Low Cost Scenario | High Cost Scenario |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Percent Excavation Hauled | 20% | 80% |
| Utility constraints | No relocation | No relocation |
| Side slopes above amended media surface (H:V) | 3:1 | 3:1 |
| Length:Width | 2:1 | 2:1 |
| Ponding Depth (in) | 12 | 6 |
| Mulch Depth (in) | 2 | 4 |
| Media Depth (in) | 12 | 24 |
| Porosity | 0.3 | 0.3 |
| Slopes Vegetation | Hydroseed | Hydroseed |
| Percent landscape costs incremental compared to baseline landscape requirements | 25% | 75% |
| Overflow | Sheet flow over grassed berm | Overflow riser |
| Inlet Protection Percent of Total Area | 5% | 5% |
| Inlet Protection Depth (in) | 6 | 6 |
| Hydroseed Percent to Total Area | 10% | 10% |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |
| | | |

| Design Assumptions<br>Complex Bioretention | | |
|---|---|---|
| | Low Cost Scenario | High Cost Scenario |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Percent excavation hauled | 20% | 80% |
| Side slopes above amended media surface (H:V) | 3:1 | 3:1 |
| Vertical Concrete Walls | No | Entire Perimeter |
| Pretreatment | Gravel Forebay | Gravel Forebay |
| Length: Width | 2:1 | 2:1 |
| Ponding Depth (in) | 8 | 6 |
| Mulch Depth (in) | 3 | 3 |
| Media Depth (in) | 12 | 24 |
| Storage Layer (in) | 6 | 8 |
| Porosity (#57) | 0.35 | 0.35 |
| Porosity (soil mix) | 0.3 | 0.3 |
| Bottom Surface Vegetation (# one gallon plants per 100 sq ft) | 15 Perennials | 30 Perennials and 4 Shrubs |
| Percent landscape installation and maintenance costs incremental compared to baseline requirements | 25% | 75% |
| | | |
| Catch basin overflow | 1 | 1 |
| Rip rap for energy dissipation, 1ft depth , percent area | 5% | 10% |
| Shoring | No | Yes |
| Forebay ponding depth (ft) | 0.5 | 0.5 |
| Forebay gravel depth (ft) | 1 | 1 |
| Contingency + Local / Site Specific Design Requirements (%) | 20% | 20% |

| Design Assumptions<br>Dry Wells with Pretreatment | | |
|---|---|---|
| | Low Cost Scenario | High Cost Scenario |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Percent excavation to be hauled | 20% | 80% |
| Well Footprint (feet by feet) | 10 by 10 or 12 by 12 | 10 by 10 or 12 by 12 |
| Total Height of the well (feet) | Varies | Varies |
| Depth from Finish Surface to Top of Well | 2 | 4 |
| Effective Rock Porosity | 0.4 | 0.4 |
| Pretreatment | Gravel Forebay | CDS |
| Shoring, percent internal area, med and high only | 80% | 100% |
| Underdrain for observation well, 6" | Yes | Yes |
| Inlet Piping, 6" | 50 feet | 100 feet |
| Forebay ponding depth (ft) | 0.5 | 0.5 |
| Forebay gravel depth (ft) | 1 | 1 |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |

| Design Assumptions<br>Simple Direct Use | | |
|---|---|---|
| | Low Cost Scenario | High Cost Scenario |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| General System Description | Gravity flow to cistern; Above ground; gravity feed; Low reliability expectations | Gravity flow to cistern; Above ground cistern; municipal backup |
| Storage tank foundation depth, concrete, (inches) | 6 | 12 |
| Storage Tank Foundation Size (SY) | 1.5 | 3 |
| Storage tank material | Round Plastic | Slimline Plastic |
| Piping (ft) | 100ft/100cf | 100ft/100cf |
| Conveyance and Pretreatment | Simple first flush diversion-based pre-treatment; Coarse screen; Overflow routing and splash pad; | Proprietary downspout filter/diversion system; Coarse screen; Overflow routing and splash pad; |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |

| Design Assumptions<br>Complex Direct Use | | |
|---|---|---|
| | Low | High |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Excavated material to be hauled | NA | 100% |
| General System Description | Gravity flow to cistern; Above ground | Gravity flow to cistern; Buried in constrained conditions; filtration required; Extensive or complicated pumped distribution system with moderate elevation change |
| Storage tank foundation | 6", concrete | 12", concrete |
| Storage Tank Material | Plastic | Plastic |
| Conveyance and Pretreatment | Simple first flush diversion-based pre-treatment; Coarse screen; Overflow routing and splash pad; | Proprietary downspout filter/diversion system; Coarse screen; Overflow routing and splash pad; |
| Installation Costs (% of Material Costs) | 40 | 80 |
| Treatment for Outdoor Non-Potable Use | Proprietary Disinfection System | Proprietary Disinfection System |
| Pumps | Single pump | Duplicate pumps |
| Distribution and Irrigation System | Function of volume of cistern + pump size/#pumps TBD | Function of volume of cistern or pump size/#pumps TBD |
| Specialized Engineering and Planning (%) | 15 | 15 |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |

| **Design Assumptions**<br>Right-of-Way Bulb-Out | | |
|---|---|---|
| | Low Cost Scenario | High Cost Scenario |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Excavated material to be hauled | 20% | 80% |
| Utility constraints | Some relocation | Some relocation |
| Length: Width | 2:1 | 2:01 |
| | | |
| Freeboard (in) | 6 | 6 |
| Ponding Depth (in) | 12 | 6 |
| Mulch Depth (in) | 2 | 2 |
| Media Depth (in) | 12 | 18 |
| Storage Layer (in) | 6 | 12 |
| Trench Drain (ft) | 0 | 30 |
| Distance to Storm Drain (ft) | NA | 30 |
| Porosity | 0.3 | 0.3 |
| Standard width (ft) | 15 | 15 |
| Retaining wall | None | Perimeter |
| Shoring | None | Yes, half of perimeter |
| Percent landscape installation and maintenance costs incremental compared to baseline requirements | 50% | 75% |
| Rip rap for energy dissipation, 1ft depth , percent area | 5% | 10% |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |

| Design Assumptions<br>Underground Vault/Gallery with Pretreatment | | |
|---|---|---|
| | Low | High |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Excavation to be hauled | 75% | 100% |
| Stone Reservoir (inches) | Varies | Varies |
| Volume pipe (cf) | Varies | Varies |
| Freeboard | 6 | 10 |
| Shoring (SF) | Yes | Yes |
| Effective Porosity of Stone Reservoir | 0.4 | 0.4 |
| Filter Bedding - Wash Sand/Pea Gravel layers (ft) | 0 | 2 |
| Distribution Lateral Size (inches) | 72 | 72 |
| Observation Wells per 1,000 sq-ft | 0.25 | 0.5 |
| Pretreatment | CDS | CDS |
| Overflow Pipe | Yes | Yes |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |

| Design Assumptions<br>Regional Infiltration Basin | | |
|---|---|---|
| | Low | High |
| Percent of Capital Cost for Planning, Engineering | 20% | 35% |
| Percent Demolition Costs | 0% | 100% |
| Excavated material hauled | 75% | 100% |
| Embankment Side Slopes | 3:01 | 3:01 |
| Basin Depth (ft) | 5 | 5 |
| CDS Unit | 1 | 1 |
| Forebay Volume | 20% total | 20% total |
| Pretreatment | CDS + forebay | CDS + forebay |
| Soil Amendments (ft) | 2 | 3 |
| Freeboard (ft) | 8 | 10 |
| Vegetation | Yes | Yes |
| Fence / Gate | Yes | Yes |
| Inlet/Energy Dissipation | 24" storm sewer diversion and quarry spall energy dissipation | 24" storm sewer diversion and quarry spall energy dissipation |
| Outlet | CMP riser with connection to storm sewer; Rip rap weir/overflow emergency spillway | CMP riser with connection to storm sewer; Rip rap weir/overflow emergency spillway |
| Utility Relocation | Yes | Yes |
| Percent landscape installation and maintenance costs incremental compared to baseline requirements | 100% | 100% |
| Contingency + Local / Site Specific Design Requirements (%) | 20 | 20 |

**Costs for line items were obtained from past projects, RS Means, and vendors:**

| Category | Cost Item | Description | Units | Cost Source | Unit Price |
|---|---|---|---|---|---|
| Demo, Disposal, and Earthwork | Demolish and remove existing asphalt or concrete | Pavement removal, 3" to 6" deep, bituminous roads | SY | Broadway Cost Estimate | $6.75 |
| Demo, Disposal, and Earthwork | Excavation, 5 to 50 CY | Small scale excavations to 3 to 6 ft depth; curb bulb-outs, planter strips, etc. | CY | RS Means with multiplier applied | $32.51 |
| Demo, Disposal, and Earthwork | Excavation, 50 to 250 CY | Small scale excavations to 3 to 6 ft depth; larger curb bulb-outs, planter strips, etc. | CY | RS Means with multiplier applied | $20.66 |
| Demo, Disposal, and Earthwork | Excavation, 250 to 2500 CY | Larger scale excavations to 3 to 8 ft depth; sub-regional detention facilities, etc. | CY | RS Means | $14.45 |
| Demo, Disposal, and Earthwork | Excavation,, 2500 CY to 10,000 CY | | CY | RS Means | $5.93 |
| Demo, Disposal, and Earthwork | Excavation,10,000 CY to 100,000 CY | | CY | RS Means | $3.93 |
| Demo, Disposal, and Earthwork | Excavation, 100,000CY | | CY | RS Means | $3.09 |
| Demo, Disposal, and Earthwork | Hauling, 10 CY truck, 10 miles RT | 8 CY truck, 15 MPH ave, 6 mile cycle, 20 minute wait | CY | Broadway Cost Estimate | $9.00 |
| Demo, Disposal, and Earthwork | Finish Grading | Topsoil placement and grading, up to 200' radius, remove and stockpile on site, spread from pile to rough grade by hand | CY | RS Means | $33.83 |
| Demo, Disposal, and Earthwork | Decompaction of Soil to 12 inches depth; average 500 to 1000 sf area | Tilling or ripping to restore surface infiltration rates and improve plant growth | SY | RS Means | $16.00 |

| Category | Cost Item | Description | Units | Cost Source | Unit Price |
|---|---|---|---|---|---|
| Asphalt, Curbing, and Concrete | Traditional Asphalt Subgrade and Base Course | Plant mixed asphaltic base courses for roadways and large paved areas | CY | RS Means | $78.35 |
| Demo, Disposal, and Earthwork | Finsh grading subgrade for pavement, large parking lots | | SY | RS Means | $1.16 |
| Demo, Disposal, and Earthwork | Permeable Asphalt Top Course | | SY | www.lid-stormwater.net/permpaver_costs.htm | $9.00 |
| Asphalt, Curbing, and Concrete | Concrete, Slab on grade, 6" | | SY | RS Means | $32.46 |
| Asphalt, Curbing, and Concrete | Concrete, Slab on grade, more than 6" | | SY | RS Means | $57.78 |
| Asphalt, Curbing, and Concrete | Traditional Asphalt Top Course | Wearing course, plant mix asphalt, less than 300 tons | SY | RS Means | $17.31 |
| Asphalt, Curbing, and Concrete | CIP concrete curb and gutter | radius steel forms, 6" high, 6" thick, 30" wide, inclues concrete | LF | RS Means | $15.45 |
| Asphalt, Curbing, and Concrete | Cast In Place, Reinforced Concrete Retaining Wall, | 4' high, $418.65/cu yd, assume 6" thick, | LF | RS Means | $93.03 |
| Asphalt, Curbing, and Concrete | Cast in Place concrete curb and gutter, machine formed, | Radius, 6" x 18", includes concrete | LF | RS Means | $8.65 |
| Asphalt, Curbing, and Concrete | Permeable Paver Surface | Assume permeable interlocking concrete pavers - top course only; 50 to 2000 sq-ft applications | SF | Ernest Maier | $7.00 |

| Category | Cost Item | Description | Units | Cost Source | Unit Price |
|---|---|---|---|---|---|
| Structures and Piping | Utility area drain, catch basins or manholes | curb inlet frame, grate and curb box, large, 24"x36" | EA | RS Mean s | $1,572 |
| Shoring | Shoring System | | SF | Broadway Cost Estimate | $37 |
| Structures and Piping | 12" Storm Drain (Public ROW) - fully installed; all costs; avg 4 to 6 ft depth | Including asphalt cutting, trenching, bedding, pipe placement, backfill, and re-paving. Whatever pipe material is most common in City. | LF | City of Austin | $76.00 |
| Structures and Piping | 18" Storm Drain (Public ROW) - fully installed; all costs; avg 4 to 6 ft depth | Including asphalt cutting, trenching, bedding, pipe placement, backfill, and re-paving. | LF | City of Austin | $130.00 |
| Structures and Piping | Trench Drain, polyester polymer concrete with heavy duty galvanized grater; 12 inches deep; 12 inches wide | | LF | RS Means | $175.92 |
| Structures and Piping | PVC Vent/Cleanout/ Observation Wells - 6 inch dia; | | EA | RS Means Line | $141.37 |
| Structures and Piping | Underdrain piping associated with observation wells | 6" pvc | LF | RS Means | $8.00 |

| Category | Cost Item | Description | Units | Cost Source | Unit Price |
|---|---|---|---|---|---|
| | Diversion Structure | Infiltration Basin | EA | Broadway Cost Estimate | $40,000 |
| Structures and Piping | 72" corrugated steel, perforated pipe, 16 gauge | Infiltration gallery | LF | RS Means | $27.72 |
| Storage/ Infiltration | Cistern (plastic) | More than 1000 gallons | Gal | www.tank-depot.com | $0.90 |
| Storage/ Infiltration | Cistern (Plastic, slimline) | 1321 gallons (177 cu ft) | Gal | http://tankulator.ata.org.au/tank-materials-price-comparision.php#note-3 | $1.51 |
| Storage/ Infiltration | Cistern (Plastic, slimline) | 2642 gallons (353 cu ft) | Gal | http://tankulator.ata.org.au/tank-materials-price-comparision.php#note-4 | $1.51 |
| Storage/ Infiltration | Cistern (Plastic, slimline) | 5283gallons (706 cubic feet) | Gal | http://tankulator.ata.org.au/tank-materials-price-comparision.php#note-5 | $1.51 |
| Storage/ Infiltration | Cistern (Plastic, round) | 1321 gallons (177 cu ft) | Gal | http://tankulator.ata.org.au/tank-materials-price-comparision.php#note-6 | 0.82 |
| Storage/ Infiltration | Cistern (Plastic, round) | 2642 gallons (353 cu ft) | Gal | http://tankulator.ata.org.au/tank-materials-price-comparision.php#note-3 | 0.61 |

| Category | Cost Item | Description | Units | Cost Source | Unit Price |
|---|---|---|---|---|---|
| Storage/ Infiltration | Cistern (Plastic,round) | 5283gallons (706 cubic feet) | Gal | http://tankulator.ata.org.au/tank-materials-price-comparision.php#note-4 | 0.43 |
| Storage/ Infiltration | Pump | | EA | www.rainharvestingsupplies.com | $2,135.00 |
| Storage/ Infiltration | Irrigation Tubing (1/2") | Subsurface drip irrigation, looped grid, pressure compensating, preinserted emitter, trenching and backfill | LF | RS Means Line | $1.38 |
| Structures and Piping | Splash Block | | EA | Home Depot | $10.00 |
| Pretreatment | Vortex Filter | Vortex Fine Filter, WISY Model WFF 100 | EA | www.rainharvestingsupplies.com | $595.00 |
| Pretreatment | First Flush Diverter | 4" downspout | EA | www.rainharvest.com | $40.00 |
| Disinfection/Treatment | UV System | | EA | http://water.epa.gov/infrastructure/septic/upload/disinfection_small.pdf | $2,500.00 |
| Manhole | Access Manholes, 8' | | EA | Broadway Cost Estimate | $1,000 |
| Pretreatment | CDS | Less than 4 acres tributary area | EA | Contech | $25,000 |
| Pretreatment | CDS | More than 4 acres tributary area | EA | Broadway Cost Estimate | $60,000 |
| Demo, Disposal, and Earthwork | Trench, excavation | | CY | Green Streets Bid Tabulation | $75.00 |

| Category | Cost Item | Description | Units | Cost Source | Unit Price |
|---|---|---|---|---|---|
| Aggregates and Media | Rip Rap at Inlet or Outlet for Energy Dissipation | Riprap and Rock Lining, mortared 6 feet high, 30 feet wide, 15 feet deep | CY | RS Means | $125.00 |
| Surface Treatments/ Finishing | Hydroseed | For restoring adjacent areas | SF | RS Means | $0.80 |
| Surface Treatments/ Finishing | Mulch | Aged bark, hand spread 3" deep | SY | RS Means | $8.56 |
| Surface Treatments /Finishing | Soil preparation | Topsoil placement and grading, top dress by hand, 6 inch depth | CY | RS Means | $69.00 |

# APPENDIX K.
# CENTRALIZED PROJECT DESCRIPTIONS

Within the context of the SCMP, centralized projects are projects that have the potential to increase the water supply portfolio by 500 AF per year or more, and are singular in nature (i.e. one specific concept for one specific location). In some cases a single project's circumstances, as in the case of the Silver Lake stormwater capture project, can cause a project with less than 500 AF per year to be included in this list.

Below is a list with a brief description of the 44 centralized projects compiled and considered as part of the SCMP.

- Arundo Donax Removal Project - Phases I and II

  Arundo is an invasive water intensive species of plant. According to the National Forrest Foundation (NFF), an acre of Arundo removed would yield an additional 20 AF per year of water through incidental recharge through the soft bottom waterways and/or through capture and recharge at the downstream spreading basins. Phase I of this project conceptualizes the removal of 5 acres of Arundo, thereby freeing up a potential 100 AF per year. Phase II of this project conceptualizes the removal of 95 acres of Arundo, thereby freeing up a potential 1,900 AF per year.

- Big Tujunga & Pacoima Dam to LA Filtration Plant

  Big Tujunga and Pacoima Dams capture and store water during and following precipitation events for flood protection and for storing stormwater that can later be released for recharge through incidental infiltration and through active surface spreading in downstream spreading grounds. This concept builds upon this existing infrastructure and proposes to directly withdraw 5,000 AF per year from the two reservoirs and pump it into the LA Filtration plan where it can be treated and distributed as potable supply.

- Big Tujunga Dam Sediment Removal

  There is an estimated 2.3 million to 4.4 million cubic yards of sediment within the Big Tujunga Reservoir. The sediment impacts the operation of the valves and reduces storage capacity for water conservation and flood control. Sediment removal is necessary to maintain the operability of the dam and protect the communities and environment downstream of the dam. It is estimated that an additional 500 AF per year of water can be captured and released for recharge through incidental infiltration and through active surface spreading in downstream spreading grounds.

- Big Tujunga Dam Seismic Retrofit

  The Big Tujunga Dam was seismically retrofitted by the Los Angeles County Flood Control District re-establishing its storage capacity back to 6,000 AF. This represents an increase of 4,500 from its restricted level of 1,500 AF. This project was completed in 2012.

- Boulevard Pit Multiuse

  The Boulevard pit is an active aggregate mine operated by Vulcan Materials Company which Vulcan estimates will be in service through 2020. The site is approximately 140 acres and has been mined to a depth of more than 250 feet below ground surface at its deepest point. The average annual groundwater recharge benefit from converting the Boulevard Pit into a stormwater detention facility is 9,760 AF per year.

- Branford Spreading Basin Upgrade

  The Branford Spreading Basin recharges an average of about 500 AF per year. To enhance recharge at this facility the concept will pump out any standing water, completely clean and deepen the basin, and remove clogged sediment layers thereby increasing storage and recharge capacity. This project is expected to increase recharge by approximately 500 AF per year bringing the total to 1,000 AF per year.

- Bull Creek Pipeline

  This project includes design and construction of an inflatable rubber dam to divert low flows from Bull Creek, through a pipeline, to the Pacoima Spreading Grounds. It will allow for stored and captured stormwater to be conveyed to the Pacoima Spreading Grounds and other downstream spreading facilities via the Pacoima Diversion Channel for recharge into the San Fernando Groundwater Basin.

- Cal Mat Pit

  The Cal Mat pit was a prior gravel mine which has been converted into an active inert landfill. The site is approximately 115 acres and is currently about 50 feet deep. It was mined to a depth of more than 250 feet below ground surface at its deepest point. The average annual groundwater recharge benefit from converting the Cal Mat pit into a stormwater detention facility is approximately 500 AF per year.

- Canterbury Power Line Easement

  LADWP's Canterbury Power Line Easement, a corridor approximately 12,800 feet long and 150 feet wide along Canterbury Avenue from the Pacoima Spreading Grounds to the Tujunga Wash Channel, is proposed to be be graded into approximately 24 infiltration basins. Stormwater will enter the system through local catch basins as well as from an inlet structure to be constructed within the Pacoima Spreading Grounds. An overflow structure will be constructed at the downstream end where excess water will be released into the Tujunga Wash Channel. The Project may also incorporate open space enhancements including walking and biking trails, educational signage, and native vegetation. The groundwater recharge is estimated at 1,500 acre-feet per year.

- Debris Basin Retrofit #1 (pilot), #2, and #3.

  There are multiple debris basins in the foothills surrounding the urbanized valley floors within and around the City of Los Angeles. Debris basins are an important component in Los Angeles' flood control system. Most debris basins are owned and operated by the Los Angeles County Department of Public Works. These debris basins range in size from several acre feet to more than 100 AF in capacity. Some debris basins are located upstream of several spreading facilities. Certain debris basins can be retrofitted with control outflow works so runoff from rainfall tributary to the debris basins could be stored for a short period of time, then metered out to be captured in downstream spreading facilities. Careful analysis is necessary to understand which debris basins could become candidates for a retrofit of this type. Is it estimated that each of these projects (#1, #2, and #3) could provide between 100 and 1,000 AFY of recharge benefit

- East Valley Baseball Park (Park Retrofit #2 and #3)

  The East Valley Baseball Park is located at a park site west of the Rory M. Shaw Wetlands Park. The Project will excavate three infiltration basins with a surface area of approximately 10.5 acres to provide additional storage and infiltration. The basins will be 5 to 10 feet deep and will accept runoff from the Tujunga Spreading Grounds and a nearby storm drain. The connection to the Tujunga Spreading Grounds allows it to receive large flows to supplement surface drainage such as releases from the Big Tujunga and Hansen Dams. The groundwater recharge is estimated at 500 to 1,000 AF per year.

- Hansen Dam Water Conservation Project

  The Hansen Dam is owned and operated by the USACE. The Hansen Dam Water Conservation and Supply Feasibility Study (Feasibility Study) investigates creating a water conservation pool behind Hansen Dam to allow for stormwater capture and storage. The stored water would allow for additional dam releases to downstream spreading grounds where the water would percolate into the groundwater basin. The Feasibility Study was completed in 1999. Due to the increased need to capture local stormwater, the study will be updated. The groundwater recharge facilities would be either the Hansen Spreading Grounds, owned by Los Angeles County Flood Control District (LACFCD), or the Tujunga Spreading Grounds, owned by LADWP, depending on capacity and availability. This project could yield an average recharge amount of 3,400 AF per year.

- Hansen Spreading Grounds Upgrade

  The Hansen Spreading Grounds is a 120 acre parcel located adjacent to the Tujunga Wash Channel downstream from the Hansen Dam. The site is utilized for recharging the groundwater basin for the City of Los Angeles' use. The Los Angeles County Flood Control District and the City of Los Angeles Department of Water and Power modernized the facility in 2013.

- LA Forebay Recharge System (LAR Pilot, LAR Full Scale, and Upper Ballona)

  The Los Angeles River and Ballona Creek flow from downtown towards the Pacific Ocean. The Los Angeles River flows generally southward towards Long Beach while Ballona Creek flows generally westward towards the Santa Monica Bay. Near downtown Los Angeles the region directly overlays the Los Angeles Forebay, a geologic feature that allows infiltrated water to reach beneath confining soil layers and into the Central Basin. Concepts include the capture, treatment, and recharge of flows from the LA River and Ballona Creek for recharge. It is estimated that approximately 4,600 AF per year could be recharged depending on site design.

- Lakeside Reservoir (Options A and B)

  The Lakeside Retention Basin is an existing debris basin owned by LADWP. Its original purpose was to retain sediment and debris before storm flows entered the Van Norman Complex, but urbanization upstream of the facility has rendered this unnecessary. Lakeside Retention Basin Option A assumes that a park is built on part of the site and that retention facilities will be constructed on the remaining portion of the site. Lakeside Retention Basin Option B assumes that the entire site will be utilized to retain stormwater and that it will be excavated to maximize storage at the site. Modifications to the outlet structure, including a slide gate, would need to be made to retain stormwater and regulate flow from the basin.

- Lopez Spreading Grounds Upgrade

  The Lopez Spreading Grounds Improvement Project consolidates the six existing spreading basins into two deeper basins that would increase storage capacity from 24 acre-feet to a total of 175 acre-feet. Flow would be diverted from Pacoima Wash to the reconfigured basins using a new rubber dam diversion. The rubber dam would be 100 feet wide; the west side of the channel would be improved with slide gates capable of diverting a maximum flow of 100 cfs to the spreading grounds. An inter-basin gate structure will be constructed to move water from the new upper basin to the new lower basin. An outlet pipe will be constructed to gravity drain from the lower basin back to Pacoima Wash. This project would yield an annual recharge benefit of approximately 480 acre-feet above the baseline condition.

- North Hollywood Power Line Easement

  This Project will retrofit approximately one mile of the LADWP Whitnall Highway Power Line easement, starting from the intersection of Tujunga Avenue and Kittridge Street in the northwest to Oxnard Street and Riverton Avenue in the southeast. It is envisioned that up to nine infiltration basins would be constructed and connected to local stormdrains for inlet and overflow works. The estimated recharge from this project is 770 AF per year.

- Old Pacoima Wash

  The Old Pacoima Wash is owned and operated by the LA County Flood Control District. Stormwater will enter the system from an inlet structure within the Pacoima Spreading Grounds. The Old Pacoima Wash runs southwest from the Pacoima Spreading Grounds and was once the main drainage channel that is now used to collect local runoff, with upstream flows either percolating into the aquifer or bypassing the system to the Tujunga Wash. By diverting more water into and through the Pacoima Spreading Grounds, water can overflow into the Old Pacoima Wash and create an in-stream infiltration system by installing rubber dams on existing drop structures. Inflatable dams will be utilized after storm events to store up to 12.2 acre-feet of stormwater for infiltration. Expected recharge is 1,000 to 1,500 acre-feet per year.

- Pacoima Dam Sediment Removal

The Pacoima Dam Sediment Removal Project will remove accumulated sediment and restore reservoir capacity to 6,060 acre-feet for continued flood control and water conservation operations. This project will remove a minimum of 2.4 million cubic yards of accumulated sediment and allow for an additional 700 AF per year of recharge in downstream spreading grounds.

- Pacoima Spreading Grounds Upgrade

  The District and LADWP propose to upgrade the facility to better capture stormwater increasing recharge by approximately 2,000 acre-feet per year. To accomplish the goals of the project, a phased approach is being proposed. Phase 1 will relocate and automate the intake structure, enhance infiltration rates, and reconfigure the spreading basins. Phase 2 will develop other compatible uses, such as passive recreation and native habitat improvements.

- Rory M Shaw Wetlands Park Project (Strathern)

  This Project consists of constructing stormwater capture and treatment facilities within the bounds of a 46-acre site formerly used as a gravel pit. This project will construct detention ponds and wetlands to store and treat stormwater runoff. The treated flows will then be pumped to the adjacent Sun Valley Park for infiltration in the underground basins. In addition to increased groundwater recharge, flood protection, and water quality improvements, the project will include habitat restoration and recreational opportunities. Expected recharge is estimated at 590 AF per year.

- San Fernando Road Swales

  This Project will create a depressed parkway running along San Fernando Road from Pierce Street to the Tujunga Wash to accept surface runoff flows from the surrounding neighborhood to help recharge the groundwater table. The Project proposes to capture surface runoff from approximately 260 acres that currently runs along street gutters to storm drains, through the Los Angeles River and into the Pacific Ocean. The Project will direct the flows through pre-treatment devices and into a vegetated swale that will run alongside 1.75 miles of San Fernando Road. Expected recharge is approximately 130 AF per year.

- Sepulveda Basin - Hansen SG Pipe Line 54"

  The Sepulveda Basin and Sepulveda Dam, located on the Los Angeles River, are owned and operated by the United States Army Corps of Engineers. This facility is a critical component to Los Angeles' flood control system. The basin has a storage capacity of 18,129 AF at the top of the spillway. When storm flows coming from the 152 square mile tributary area begin to subside, gates could be closed to impound water behind the dam to conserve it before it is lost to downstream reaches of the Los Angeles River and the Pacific Ocean. Using a new pump station, and potentially installing a smaller pipe within the East Valley pipeline which runs from Sepulveda Basin to the Hansen Spreading Grounds, stormwater captured behind the Sepulveda Dam could be used to recharge the San Fernando Groundwater Basin aquifer. This project requires longer-term planning because the USACE needs to develop a feasibility study and the ultimate decision belongs with the federal government. It is estimated that this project could provide upwards of 3,000 AFY of recharge benefit.

- Sheldon Pit Multiuse

  The Sheldon Pit is located immediately adjacent to the Los Angeles County Flood Control District's Tujunga Wash Channel on the south east bank. The pit was an active aggregate mine and is now operated by Vulcan Materials for fine sediment placement. Presently Vulcan has no plans to cease operations. The site is approximately 138 acres and has been mined to a depth of approximately 250 feet below ground surface at its deepest point. If acquired and enhanced with stormwater capture facilities along with multi-use attributes, the available capacity of storage of stormwater is approximately 6,000 acre-feet and an annual average recharge of 1,500 AF per year is expected.

- Sheldon-Arleta Gas Management System

  The spreading of water for groundwater recharge by LADWP at its Tujunga Spreading Grounds adjacent to the Sheldon-Arleta Landfill has caused unintended landfill methane gas migration to offsite locations. The Tujunga Spreading Grounds is one of the major spreading grounds utilized to recharge the San Fernando Groundwater Basin, a major source of groundwater supply for Los Angeles. Due to unintended landfill gas migration, the spreading capacity of this facility has been reduced by up to 80 percent since the 1990s in order to minimize the gas migration problem. This project is complete.

- Silver Lake Stormwater Capture Project

  This project as proposed will involve diverting stormwater runoff away from existing storm drains, from the surrounding watershed, and into Silver Lake and Ivanhoe Reservoirs. Silver Lake Reservoir and Ivanhoe Reservoir will be removed from service within the potable water distribution system upon completion of the Silver Lake Reservoir Complex Storage Replacement Project (SLRC SRP). As a condition of the Environmental Impact Report (EIR) for the SLRC SRP, the reservoirs will be maintained at historic operating levels for aesthetic purposes. Silver Lake and Ivanhoe Reservoirs lose an estimated 418 acre-feet per year due to evaporation, which will initially be replenished using potable water. The Silver Lake Reservoir Stormwater Capture Project could reduce the potable water demand at the Silver Lake Reservoir Complex by an average of 117 acre-feet per year.

- Spreading Grounds Optimization

  This project is a partnership between LADWP and the Los Angeles County Flood Control District (LACFCD) to improve the co-operation and maintenance of the San Fernando Valley groundwater recharge facilities. It is estimated that through coordinated operation of the large storage facilities (including the Big Tujunga Dam and the Pacoima Dam) and the spreading grounds

(Hansen, Tujunga, Pacoima, and Lopez) the system could be 2.5% to 5% more efficient than at present. This represents an increase in recharge by 650 to 1,300 AF per year.

- Storm Drain Mining (Treat and Inject / Treat and Directly Use)

  Storm drain mining is defined as diverting dry and wet weather flows out of storm drains and channels for treatment and beneficial use. An example is a project being developed by the City of Los Angeles Bureau of Sanitation in the Ballona Creek Watershed called the North Outfall Treatment Facility (NOTF). The NOTF project proposes to retrofit a decommissioned sewage outfall treatment facility into urban runoff water quality improvement project to improve water quality in Ballona Creek, the Estuary, and downstream beaches while providing much needed reclaimed water for local irrigation and other non-potable uses in the area. Should sufficient demands not be identified, treated flows could be injected into the potable groundwater aquifer. It is estimated that a system such as this could contribute 1,500 AF per year to the City's water supply portfolio. This is a concept that could be replicated across the City where sufficient flow is available and where non-potable demands, or potable aquifers, exist.

- Tujunga Spreading Grounds Upgrade

  LADWP and the Los Angeles County Flood Control District are cooperatively working to enhance the 150-acre Tujunga Spreading Grounds. Enhancements include; deepening and consolidating the existing 20 basins into 9 large spreading basins, installing two high flow intakes with 60-foot inflatable rubber dams, and modifying the existing intake to improve water quality and remove sediments. This project is designed and funded and environmental clearances have been obtained. Once constructed it is expected that this project will contribute an additional 4,200 AF per year to the San Fernando Basin.

- Valley Generating Station Stormwater Capture (Phases I and II)

  The Valley Generating Station is a power generating facility owned and operated by LADWP. This is one of several stormwater capture projects located in the Sun Valley Watershed in the San Fernando Valley and it is designed to help alleviate localized flooding, recharge the groundwater basin, and improve downstream quality in the San Fernando Valley. Phase I of this project entail the diversion of on-site stormwater runoff through a series of recharge basins, swales and overflow culverts to strategic points on-site. The expected recharge from Phase I is approximately 118 AF per year. Phase II includes the upgrade of the existing gravel pit for use as a storage for later recharge in downstream spreading grounds. Expected recharge from Phase II is 700 AF per year.

- Van Norman Stormwater Capture

  This project will involve an outlet modification and cleanout of the Lower San Fernando Dam to allow for stormwater capture. Operational changes will be made to allow for controlled dam releases. This will allow for stormwater that is stored and captured at Van Norman Complex to run into the future Bull Creek Stormwater Capture Project pipeline and eventually infiltrate in Pacoima Spreading Grounds.

- Van Nuys Airport

  The Van Nuys Airport Project as proposed could consist of a series of bioswales and infiltration areas at the runway/taxiway area similar to existing stormwater capture facilities at LAX. Option A consists of a runway/taxiway area swale with single tank underground detention and infiltration. Option B consists of a similar bioswale at the runway/taxiway area with detention tanks and a tank extension for clay conditions. Option C consists of a similar bioswale at the runway/taxiway area with subsurface irrigation and infiltration. These stormwater capture facilities would be used to target the 85% storm and could contribute approximately 300 AF per year to the City's water supply portfolio.

- Whiteman Airport

  Whiteman Airport is a 157 acre general aviation airport owned by the County of Los Angeles. The airport is located in the Pacoima region of Los Angeles and is bounded by Pierce Street, San Fernando Road, Airpark Way, De Foe Avenue, and Osborne Street. The airport has an estimated 127 acres of asphalt cover making the airport very conducive to runoff flow. Runoff at Whiteman Airport drains to various locations. Two large storm drains run underneath the airport and drain the northeastern portion of the property as well as portions of the Jessup Park hill. These storm drains discharge into the Branford Channel. In order to capture and infiltrate this water, stormwater diversions would be required to convey the water to the southern portion of the property where soils are conducive to infiltration. It is estimated that 80 AF per year could be recharged into the San Fernando Basin.

- Whitnall Hwy Power Line Easement

  The Power Line Easement is located along Whitnall Highway from Vineland Avenue to Cahuenga Boulevard. This project is one of various stormwater capture projects and studies in the San Fernando Valley that will contribute to recharge the San Fernando Groundwater Basin, improve downstream surface water and groundwater quality in the city of Los Angeles, as well as reduce local flooding. A recharge of approximately 110 AF per year could be achieved. In order to accomplish the goals of the project, stormwater runoff will be captured at several locations along the easement and then directed into a network of swales, culverts, hydrodynamic separators and infiltration basins for pre-treatment and infiltration. Currently a 34.5 kV underground distribution line runs through the easement and may need to be relocated for construction of infiltration basins.

- Whitsett Sports Fields Park Retrofit

  The Whitsett Sport Fields are located near the 170 Freeway at the intersection of Whitsett Avenue and Vanowen Street. Water will be routed from existing storm drains in the area. A hydrodynamic separator such as a CDS unit will be installed to remove trash from the inflowing water. The project concept for this project includes wetlands for treatment of low flows combined with infiltration basins. Subterranean infiltration galleries are a potential option as well. Trails around the basins will be provided for walking/bike riding. The fields that are currently utilizing this piece of open space can be moved across the freeway to the other portion of the park. This project has a land area of approximately 22 acres and a 225 AF storage capacity. Is it estimated that this project could provide between 500 and 1,000 AFY of recharge benefit.

Geosyntec consultants