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LA DWP

STORMWATER CAPTURE MASTER PLAN

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

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ACRONYMS AND ABBREVIATIONS

ADA	Americans with Disabilities Act
af	Acre-foot
amsl	Above mean sea level
BMP	Best Management Practice
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDPH	California Department of Public Health
cfs	Cubic feet per second
City	City of Los Angeles
CFCC	California Financing Coordinating Committee
COAC	City of Los Angeles Proposition O Citizens Oversight and Advisory Committee
CWSRF	Clean Water State Revolving Fund
Department	Los Angeles Department of Water and Power
DTSC	Department of Toxic Substances Control
EE	Energy efficiency
EIFDs	Enhanced Infrastructure Financing Districts
EMC	Event Mean Concentrations
EPA	U.S. Environmental Protection Agency
EWMP	Enhanced Watershed Management Program
FC	Fecal Coliforms
FRS	Facility Registry Services
GIS	Geographic Information System
GO	General Obligation
GWAM	Ground Water Augmentation Model
HRU	Hydrologic Response Unit
IBank	California Infrastructure and Economic Development Bank
IRWMP	Integrated Regional Watershed Management Program
ISRF	Infrastructure State Revolving Fund
JPAs	Joint Power Authorities

LABOE	Los Angeles Bureau of Engineering
LABSS	Los Angeles Bureau of Street Services
LACDPW	Los Angeles County Department of Public Works
LACFCD	Los Angeles County Flood Control District
LADBS	Los Angeles Department of Building and Safety
LADWP	Los Angeles Department of Water and Power
LASAN	Los Angeles Bureau of Sanitation
LID	Low Impact Development
LRP	Local Resource Program
LSPC	Load Simulation Program in C++
MS4	Municipal Separate Storm Sewer System
MWD	Metropolitan Water District of Southern California
PACE	Property Assessed Clean Energy
P3	Public-Private-Partnerships
POP	Public Outreach Plan
PRP	Potentially responsible party
PSG	Pacoima Spreading Grounds
RCRA	Resource Conservation and Recovery Act
RCP	Reinforced concrete pipe
RE	Renewable energy
RFO	Request for Offer
RFP	Request for Proposal
ROW	Right of Way
RWQCB	Regional Water Quality Control Board
SCAG	Southern California Association of Governments
SCMP	Stormwater Capture Master Plan
SOW	Scope of Work
SWRCB	California State Water Resources Control Board
TAT	Technical Advisory Team
TCu	Total Copper
TKN	Total Kjeldahl Nitrogen
TM	Technical Memorandum
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TPb	Total Lead

TSS	Total Suspended Solids
TZn	Total Zinc
TSG	Tujunga Spreading Grounds
ULARA	Upper Los Angeles River Area
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
UWMP	Urban Watershed Management Plan
WAS-TAC	Water Augmentation Study-Technical Advisory Committee
WRD	Water Replenishment District

GLOSSARY

Stormwater Capture	Stormwater that is either infiltrated into the ground or stored and used in place of water supplied by LADWP.
Stormwater Recharge	Captured stormwater that is infiltrated into the ground, most often into water supply aquifers.
Direct Use Stormwater	Captured stormwater that is used in place of water supplied by LADWP.
Centralized Capture Projects	Large infrastructure projects capable of infiltrating over 100 acre-feet per year, in general, on an annual average basis.
Distributed Capture Projects	Small projects distributed throughout the City. Individual projects have small average annual capture potential (less than 100 acre-feet per year, in general), but when implemented in large numbers, total capture volume can be significant.
Baseline/Existing Capture	Stormwater that is currently being captured through existing centralized stormwater capture infrastructure and incidental distributed capture.
Incidental (Passive) Distributed Capture	Stormwater that is passively captured via infiltration into pervious surfaces throughout the City with minimal implementation of distributed capture projects.
Stormwater Capture Project	An individual physical structure designed to capture stormwater.
Stormwater Capture Program	A coordinated effort to implement many similar distributed projects throughout the City, or area within the City.
Best Management Practice	A small distributed capture project that can be implemented programmatically.

Subregional Capture	Distributed stormwater capture program consisting of projects designed to capture runoff from multiple properties (approximately 50 acre tributary area). These projects are referred to as "regional projects" in the Los Angeles EWMPs.
On-Site Capture	Distributed stormwater capture program consisting of projects designed to capture runoff generated from a single property.
Green Street	Distributed stormwater capture program consisting of projects constructed in the street right of way that capture street runoff as well as some runoff from adjacent properties.
Self-Mitigating Pervious Pavement	Distributed stormwater capture program consisting of pervious pavement projects designed to capture only the precipitation that falls directly on their footprint. Distinct from pervious pavement projects that are designed to capture runoff from an entire property, which would be considered part of the Onsite Capture Program.
Implementation Rate	Measure of the extent of implementation of a given program. Calculated as the percent of the area available for implementation of a given program that is being treated by stormwater capture projects.

EXECUTIVE SUMMARY

The City of Los Angeles Department of Water and Power (LADWP) is responsible for providing the City of Los Angeles (City) with a safe and reliable supply of water for residential, commercial, governmental, industrial, and institutional uses. Since the early 1900s, the City has supplied water from a variety of sources. Today, the City's water comes from the Owens Valley via the Los Angeles Aqueduct; purchased water from the Metropolitan Water District of Southern California (MWD) imported from Northern California via the California Aqueduct and the Colorado River via the Colorado River Aqueduct; and several local water sources including groundwater, recycled water, and conservation.

Future water supplies from distant sources are becoming more restricted and less reliable. Environmental commitments, periods of dry years, low snow pack, and judicial decisions have all contributed toward significant cuts in imported supplies. These threats and the need for action were recently highlighted in the Mayoral Directive Number 5 which calls for a 20% reduction in the City's fresh water use by 2017 and a 50% reduction in LADWP's purchase of imported potable water by 2024. To ensure a safe and reliable water supply for future generations of Angelenos, one of the City's key strategies is to increase the local water supply and decrease the need to purchase imported water. However, in large part due to urbanization, the majority of precipitation that falls onto the City flows into storm drains and out to the ocean. In light of these conditions, stormwater is an increasingly viable supply.

Capturing and using stormwater on-site can offset potable water demand. Capturing and

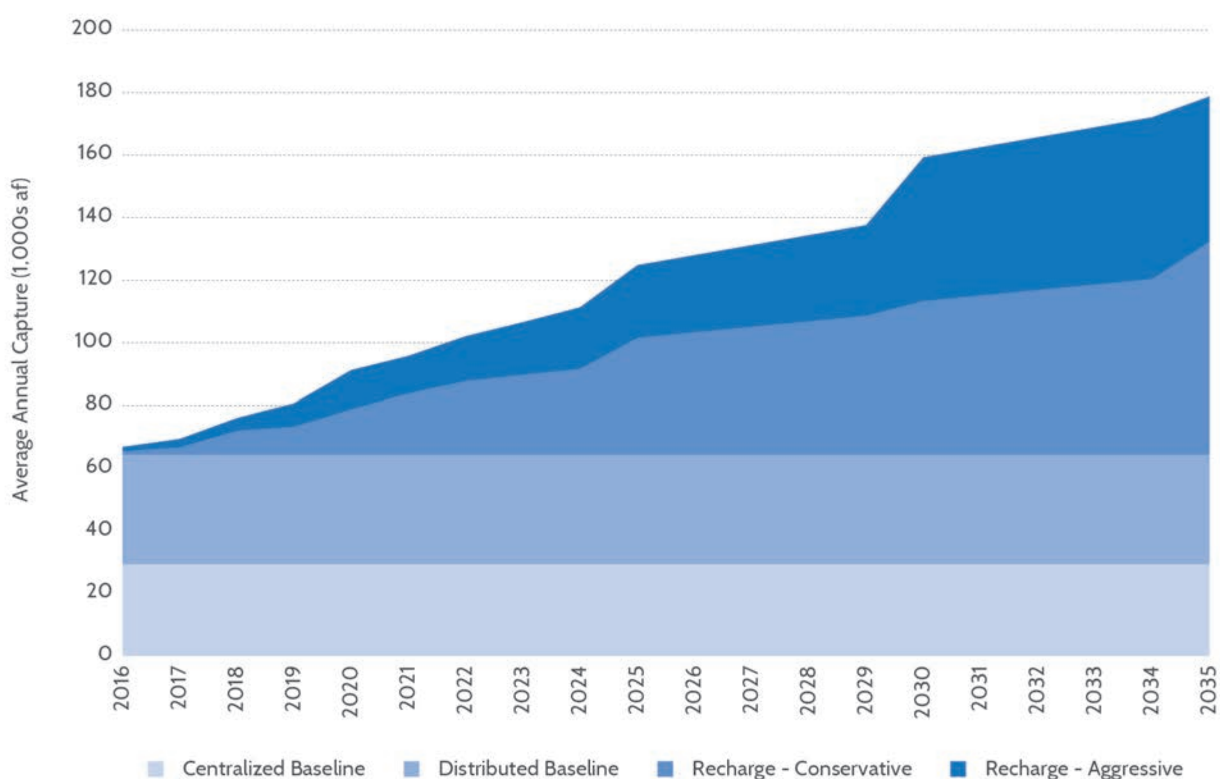

Figure ES-1. Baseline and Potential Stormwater Capture Within the City of Los Angeles infiltrating stormwater into subsurface groundwater aquifers increases local groundwater reserves. Both infiltration and capture for direct use enhance the reliability of the City's water supply. Projects to capture and conserve stormwater runoff comprise an important component of the City's water supply portfolio. The City is a part of a complex multi-jurisdictional region. As such, implementing effective and comprehensive local stormwater capture projects involves a collaborative effort between several agencies including LADWP, the Los Angeles County Flood Control District (LACFCD), the Los Angeles Bureau of Sanitation (LASAN), the Los Angeles Bureau of Street Services (LABSS), the Los Angeles Bureau of Engineering (LABOE), and the US Army Corps of Engineers (USACE). Additionally, LADWP partners with many community-based organizations to leverage their relationships with the residents of the City. Working together on projects that have multi-benefits for multiple agencies allows for the opportunity to cost-share and reduces the financial burden.

Currently LADWP and its partners actively capture and recharge approximately 29,000 acre-feet per year of stormwater, along with another 35,000 acre-feet per year infiltrating into the potable aquifers through incidental recharge. This water source represents approximately 10% of the City's annual water demand. Through the work on LADWP's Stormwater Capture Master Plan (SCMP), it has been demonstrated that an additional 68,000 to 114,000 acre-feet per year could be realistically captured through a suite of projects, programs, and policies over the next 20 years (Figure ES-1). Potential projects and programs to capture additional stormwater are particularly important to consider, not only because of the increasing economic value of this water supply but also because stormwater projects address a host of other challenges faced by the City. Some of these challenges include reducing dependence on imported water, meeting federal water quality mandates, providing enhanced flood protection, reducing peak flows in the region's waterways, providing green space for habitat and recreation, and providing climate mitigation and adaptation opportunities. Through the process of developing the SCMP, LADWP and the SCMP Team, including Geosyntec Consultants and TreePeople[1], evaluated and characterized the role that increased centralized and distributed stormwater capture can play in the City's water supply portfolio, while also providing ancillary benefits to help meet some of these other important challenges faced by the City.

CONTEXT

LADWP's Water System's mission is to provide its customers with safe, reliable, high quality, and reasonably priced water service in a transparent and environmentally responsible manner. LADWP currently meets over 85 percent of annual water demand from sources hundreds of miles away through the Los Angeles Aqueducts and water purchased from MWD that originates in the watersheds of the Bay Delta and the Colorado River. Flows from the Bay Delta and the Los Angeles Aqueduct are currently at or near historic lows and all of these sources face significant challenges going into the future, including:

- Allocations and pumping restrictions threaten supplies from the Bay Delta and Colorado River;
- Owens Lake dust mitigation reduces supply from the Los Angeles Aqueduct;
- Climate change threatens to reduce supplies from all water sources due to changes in precipitation patterns and

1. TreePeople has been a core partner and pro bono adviser on the SCMP since its inception, helping to launch the Plan and working collaboratively with LADWP and Geosyntec to guide the process.

increased evapotranspiration caused by rising temperatures; and

- The energy needed to transport water from such distances is expected to become increasingly costly and the resulting carbon footprint of such energy use is a significant concern.

LADWP's long term goal is to be drought and climate resilient and it understands that in order to maintain reliability, actions must be taken before these threats are fully realized. Imported water threats, combined with anticipated regional population growth, demonstrate a clear need for the development of local water supplies to maintain water supply reliability.

LADWP has already begun to reduce imported water use through aggressive water conservation programs and is developing new local water resources by increasing recycled water usage, initiating clean-up of local groundwater resources, and working to increase stormwater capture. LADWP's 2010 Urban Water Management Plan (UWMP) outlines a general strategy for reducing reliance on MWD water by nearly 50% by 2035, by increasing these local supplies. Stormwater capture is a critical piece of this strategy.

THE MASTER PLANNING PROCESS

The SCMP is a document that outlines LADWP's strategies over the next 20 years to implement stormwater projects and programs, and to cooperate with others on projects in the City that will contribute to more reliable and sustainable local water supplies. The SCMP is a planning document. Projects and programs recommended in the SCMP require approval by the LADWP Board of Commissioners on a case–by–case basis. Similarly, the recommendations of the SCMP are part of a broad input to decision-makers regarding future courses of action.

The goals of the SCMP are to quantify stormwater capture potential and identify new projects, programs, and policies to significantly increase stormwater capture for water supply within the 20-year planning period. Projects and programs were prioritized based on water supply criteria, though other benefits of stormwater capture and partnership opportunities were considered as part of the development process. The SCMP also presents costs and benefits for proposed projects, programs, and policies, while defining timing and key milestones. The SCMP was developed in close coordination with the LACFCD/United States Bureau of Reclamation (USBR) Basin Study, and LASAN's Enhanced Watershed Management Plans (EWMPs) as both efforts are closely related, and offer important opportunities to leverage the resources of each agency.

PUBLIC OUTREACH

Public participation was an important part of the development of the SCMP to ensure that the plan has the support of key stakeholders and is integrated with other regional stormwater management efforts. Investing in public awareness and approval of the SCMP during its development facilitates its future implementation and broad acceptance as an essential part of ensuring a sustainable local water supply. As such, public outreach activities were ongoing throughout the SCMP development process, and included outreach with local and state elected officials, regulators, entities involved in research or implementation programs related to stormwater capture, the Technical Advisory Team (TAT)–composed of internal LADWP and City staff as well as representatives from other government agencies with planning-level interests that overlap with the SCMP planning process–key regional stakeholders (including leaders of environmental, neighborhood, civic, and community organizations), and the general public. Table ES-1 summarizes public outreach events conducted over the course of the SCMP development. Figure ES-2 depicts the significant public participation enjoyed throughout the planning process.

Table ES-1. Public Outreach Events Conducted Throughout the SCMP Development Process

Public Outreach Event	Topic	Date(s)
TAT #1	Stormwater capture potential modeling approach	9.16.2013
Key Stakeholder Meeting #1 – All Key Stakeholders	Introduction to SCMP	10.21.2013
TAT #2	Stormwater capture potential	2.24.2014
General Public #1	Introduction to SCMP, potential for stormwater capture, and solicitation of project/program ideas	3.26.2014
Key Stakeholder Meeting #2 – GreenLA	Stormwater capture potential preliminary results and solicitation of project/program ideas	3.26.2014
Key Stakeholder Meeting #3 – Prop O Citizens Oversight and Advisory Committee (COAC)	Introduction to SCMP and preliminary modeling results	5.19.2014
Key Stakeholder Meeting #4 - UCLA	Coordination between SCMP and UCLA/Colorado School of Mines	7.22.2014
TAT #3/Key Stakeholder Meeting #5	Distributed stormwater capture program unit response curves	10.9.2014
General Public Meeting #2a	Presentation of interim report	1.22.2015
General Public Meeting #2b	Presentation of interim report	1.29.2015
TAT Meeting #4/Key Stakeholder Meeting #6	Implementation strategies	3.25.2015
TAT/Key Stakeholder "Office Hours"	Implementation rates	6.1.2015, 6.4.2015
General Public Meeting #3	Presentation of final SCMP	6.25.2015
EWMP Coordination Meetings	Coordination between plans	Multiple
Basin Study Coordination Meetings	Coordination between plans	Multiple
Meeting with The River Project	Project update and collaboration	1.14.2014
Meeting with Arid Lands Institute	Project update and collaboration	3.21.2014
Presentation at H2O Conference	Informational presentation	5.28.2014
Presentation to Studio City Residents Association	Project update	7.8.2014
Presentation to National Research Council	Informational presentation and project update	7.31.2014

Table ES-1. Public Outreach Events Conducted Throughout the SCMP Development Process

Public Outreach Event	Topic	Date(s)
Meetings with LAUSD	Project update	10.2.2014, 10.15.2014
Presentation at IRWMP Leadership Committee Meeting	Informational presentation and project update	10.22.2014
Presentation at the Westchester Rotary Club	Project update	12.17.2014
Presentation to Upper LA River Area IRWMP Group	Informational presentation and project update	1.21.2015
Presentation at Southern California Water Committee Meeting	Informational presentation and project update	1.22.2012, 6.25.2014
Presentation to LA Neighborhood Council Coalition	Project update	2.7.2015
Presentation at American Water Resources Association Conference	Informational presentation	3.30.2015
Briefings with City Council Members, EPA Region 9 Administrator, RWQCB, and SWRCB	Informational presentation and project update	Multiple

Figure ES-2. Public Outreach Event "General Public #1"

CURRENT CAPTURE

Los Angeles has a long history of managing stormwater runoff. For most of its history, the primary objective of "stormwater management" has been to control catastrophic flooding. To this end, a regional flood control system was developed consisting of conveyances, impoundments, spreading grounds, flood control basins, and debris basins.

Over the past few decades, as imported water has become more expensive, less reliable, and more susceptible to limitations, stormwater flowing to the ocean has been recognized as an increasingly valuable resource for the region. As a result, existing flood control facilities and individual parcels have been and continue to be retrofitted, and new large-scale facilities are being developed to infiltrate stormwater for groundwater recharge. In the past 40 years, stormwater capture in centralized facilities has increased 50 percent (Figure ES-3). Modeling conducted as part of this study showed that on average, the centralized facilities that exist today capture nearly 30,000 acre-feet of stormwater annually. LADWP has several new centralized projects funded and underway, and many more identified that will significantly increase this capture potential.

In tandem with the development of centralized capture facilities, LADWP is also contributing to the implementation of distributed capture projects. LADWP understands that the opportunities for centralized capture projects are limited due to their space requirements, and acknowledges the important benefits provided by distributed capture projects. While there are many examples of distributed projects both planned and in service, their contribution toward total aquifer recharge is

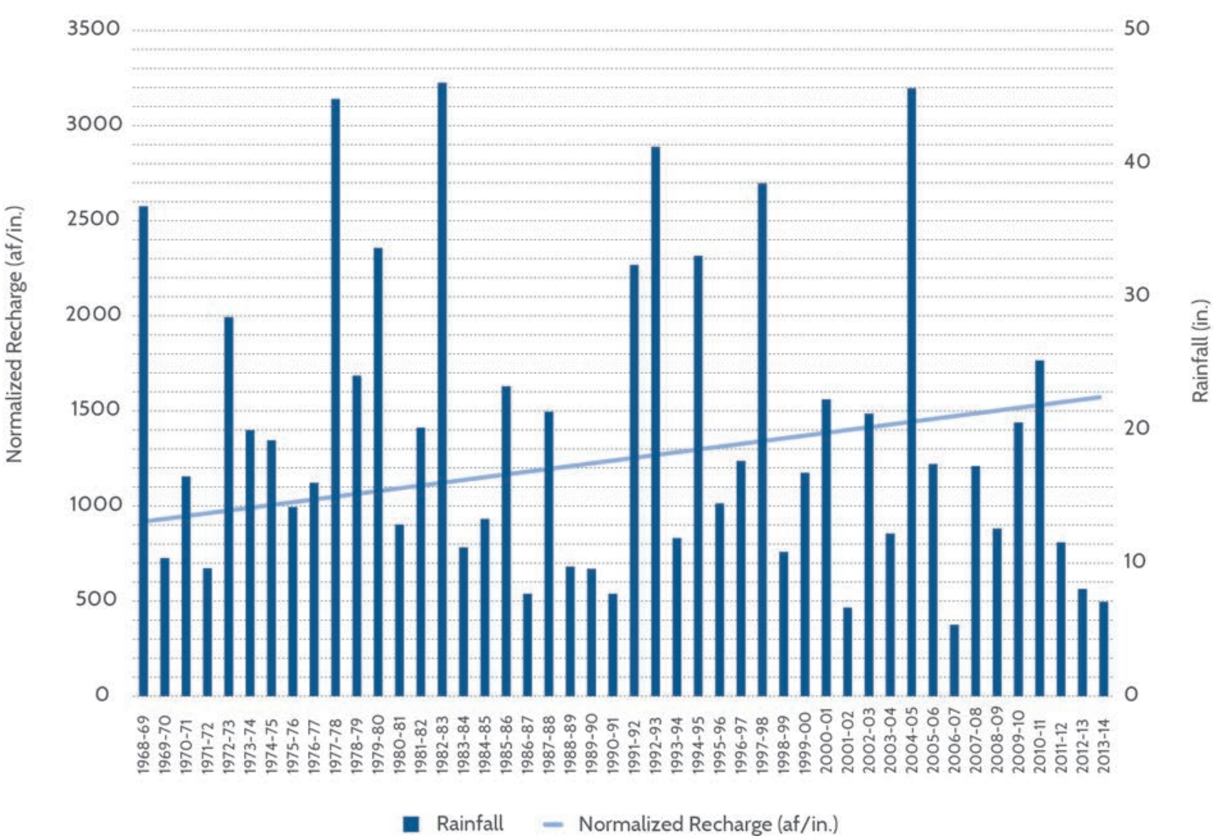

Figure ES-3. Increased Efficiencies in Centralized Facility Capture Over the Past Four Decades relatively minor due to the limited capture capacity of each individual project. For distributed projects to make a more significant contribution to groundwater recharge, these groundbreaking pilot projects can be implemented on a programmatic basis across the City.

While distributed capture projects do not currently provide significant recharge volumes, continuous simulation modeling performed for the SCMP showed that 63,000 acre-feet per year of distributed infiltration is currently occurring incidentally via pervious surfaces throughout the City. However, only 35,000 acre-feet per year of this infiltrated water is being recharged into water supply aquifers. The remaining 28,000 acre-feet per year is infiltrating into soils above confined aquifers. Water currently being infiltrated incidentally above confined aquifers does not constitute an existing supply, though it could potentially contribute to LADWP's water supply portfolio if LADWP established pumping, treatment, and distribution in the future.

FUTURE SCENARIOS

In developing the SCMP, two scenarios–Conservative and Aggressive–were considered to create an "envelope" of the range of potential future outcomes (Figure ES-4). These two scenarios reflect broader conditions outside the direct control of LADWP that could impede or accelerate stormwater capture. Regardless, swift, significant, and sustained action on the part of LADWP and its partners is a significant part of realizing either scenario.

LONG-TERM STORMWATER CAPTURE POTENTIAL

Prior to developing targets for the SCMP, the long–term stormwater capture potential was estimated to refine estimates developed in previous studies, and to better understand the realistic potential for stormwater capture and

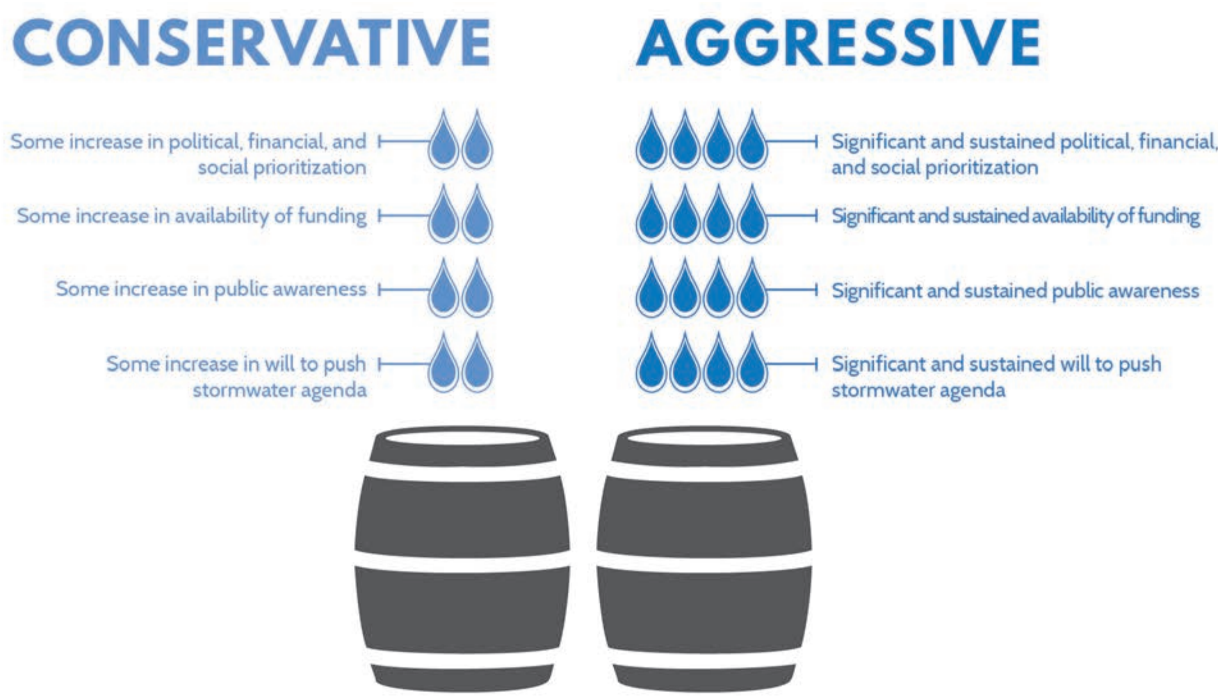

Figure ES-4. Aggressive Versus Conservative Scenario serve as a context for developing the SCMP. These stormwater capture estimates included both centralized and distributed capture that might be implemented by the year 2099 (Figure ES-5).

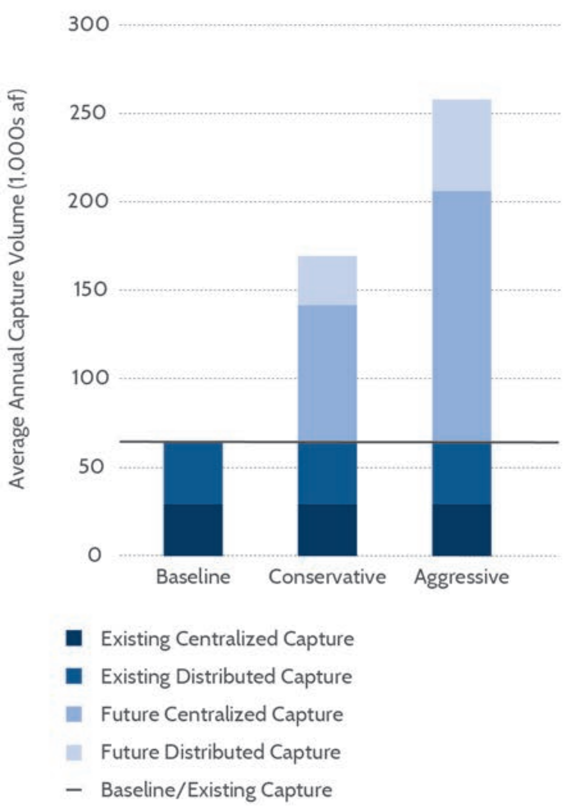

Figure ES-5. Potential Stormwater Capture by 2099

STORMWATER CAPTURE ALTERNATIVES

The SCMP considered both centralized and distributed stormwater capture projects. Centralized capture projects are those that capture generally more than 100 acre-feet per year and are unique to a specific location and opportunity. Distributed capture projects are smaller (less than 100 acre-feet per year) and have similar designs, allowing them to be implemented programmatically across the City.

For centralized projects, a comprehensive list was compiled from a review of previously implemented stormwater capture studies, LADWP's current list of centralized projects, new project concepts, and input from the TAT, key stakeholders, and the general public. These centralized stormwater capture alternatives were identified for potential inclusion in the final SCMP. Potentially feasible alternatives were evaluated and scored based on criteria developed by the SCMP Project Team, including water supply benefit, cost, ownership, compatible uses/partnership opportunities, and operating costs.

To identify distributed stormwater capture program opportunities and evaluate their costs and benefits, an emphasis was placed on flexibility such that the widest possible variety of programs could be evaluated based on their implementation in different areas throughout the City to guide development of the final SCMP implementation strategy. Table ES-2 lists stormwater capture programs grouped into program types.

Table ES-2. Distributed Program Alternatives

Project	Program
On-site Infiltration	Residential Rain Garden Program
Green Streets	Commercial Green Street Program
Subregional Infiltration	Neighborhood Recharge Facility Program
On-site Direct Use	Residential or Commercial Cistern Program
Subregional Direct Use	Park Subsurface Storage and Irrigation Program
Impervious Replacement	Impervious Surface Replacement Program

IMPLEMENTATION POTENTIAL

To determine the stormwater capture potential for the City, centralized and distributed projects and programs were identified, and implementation rates and schedules were established with extensive input from LADWP and SCMP stakeholders.

For centralized projects, implementation phasing was developed by analyzing the status of each project, understanding the technical complexity of each project, determining the level of permitting required, and assessing the individual project costs and partnership opportunities. For distributed capture programs, program type alternatives were developed by creating categories based on different combinations of project attributes, including tributary sources (either on-site or off-site areas), land use type (private property, public property right of way), and use of captured water (aquifer recharge or direct use). This categorization resulted in a total of five feasible program categories along with several subcategories (Table ES-3).

Table ES-3. Distributed Program Categories

Program Category	Subcategory
On-Site Infiltration/Direct Use	Single Family Residential
	Multi-Family Residential
	Commercial
	Industrial
	Educational
	Institutional
Green Street Programs	Commercial Streets
	Residential Streets (Parkway Retrofits)
	Street Ends at Rivers (Rio Vistas)
Subregional Infiltration	N/A
Subregional Direct Use	N/A

A detailed analysis was performed on these programs to determine their costs and potential benefits, including capture volume, pollutant reduction, increased green space, and peak flow reduction. Results from this analysis helped guide the establishment of potential implementation rates for each program over the SCMP planning period.

Using centralized and distributed implementation rates, stormwater capture potential (in acre-feet per year) was developed for the Conservative and Aggressive Scenarios, at 5, 10, 15, and 20 years—the years 2020, 2025, 2030, and 2035 (Table ES-4). This table indicates that LADWP could nearly double the existing capture in centralized facilities over the next 20 years, and through participation in programmatic implementation of distributed solutions, provide an even greater amount of new capture through distributed capture projects. In total, LADWP could potentially realize increased local water supply through all of the planned uses of stormwater by 68,000 to 114,000 acre-feet per year within 20 years.

Table ES-4. Stormwater Capture Potential at 5, 10, 15, and 20 Year Milestones

		Conservative				Aggressive			
		2020	2025	2030	2035	2020	2025	2030	2035
Recharge Baseline	Baseline–Incidental	35	35	35	35	35	35	35	35
	Baseline–Centralized	29	29	29	29	29	29	29	29
	Baseline Subtotal	64	64	64	64	64	64	64	64
Recharge Potential	Centralized Facilities	9	22	25	35	15	29	48	51
	Distributed Infiltration	5	14	22	31	11	27	41	56
	Recharge Subtotal	14	36	47	66	26	56	89	107
Direct Use Potential	Distributed Direct Use		1	1	2	1	4	6	7
	Baseline Subtotal	***64***	***64***	***64***	***64***	***64***	***64***	***64***	***64***
	Potential Subtotal	***14***	***37***	***48***	***68***	***27***	***60***	***95***	***114***
	Total	***78***	***101***	***112***	***132***	***91***	***124***	***159***	***178***

There are multiple combinations of projects and program types that can be implemented to capture the potential volumes described. However, depending on multiple factors, the cost-effectiveness (or life cycle cost, in dollars per acre-foot) of these projects and programs varies considerably. These factors include capture volume, tributary area, capital costs, operations and maintenance requirements, among others. Cost-effectiveness varies within and among the different projects and program types (Figure ES-6).

As shown, centralized projects can provide the greatest opportunities for the most cost-effective means of capturing stormwater for water supply. Often, this is because of unique project factors, such as land ownership, already in place. Subregional infiltration projects, as part of a programmatic implementation plan, also show great promise across a wide variety of conditions, and recharge water into the local aquifers in a tight range of costs per acre-foot. Green Streets, on-site infiltration, subregional direct use, and on-site direct use also provide water supply potential at a lower price range yet warrant partnering entities.

VALUE OF RECHARGED/DIRECT USE WATER

Implementation of the centralized facilities and distributed programs may require funding, at least in part, by LADWP. Any proposal to use ratepayer monies to fund stormwater projects must be carefully evaluated. It is important to consider that expenditures on these projects and programs result in the development of a resource that has economic value to LADWP. The value of captured water to LADWP consists of the avoided cost of purchased water and the value of

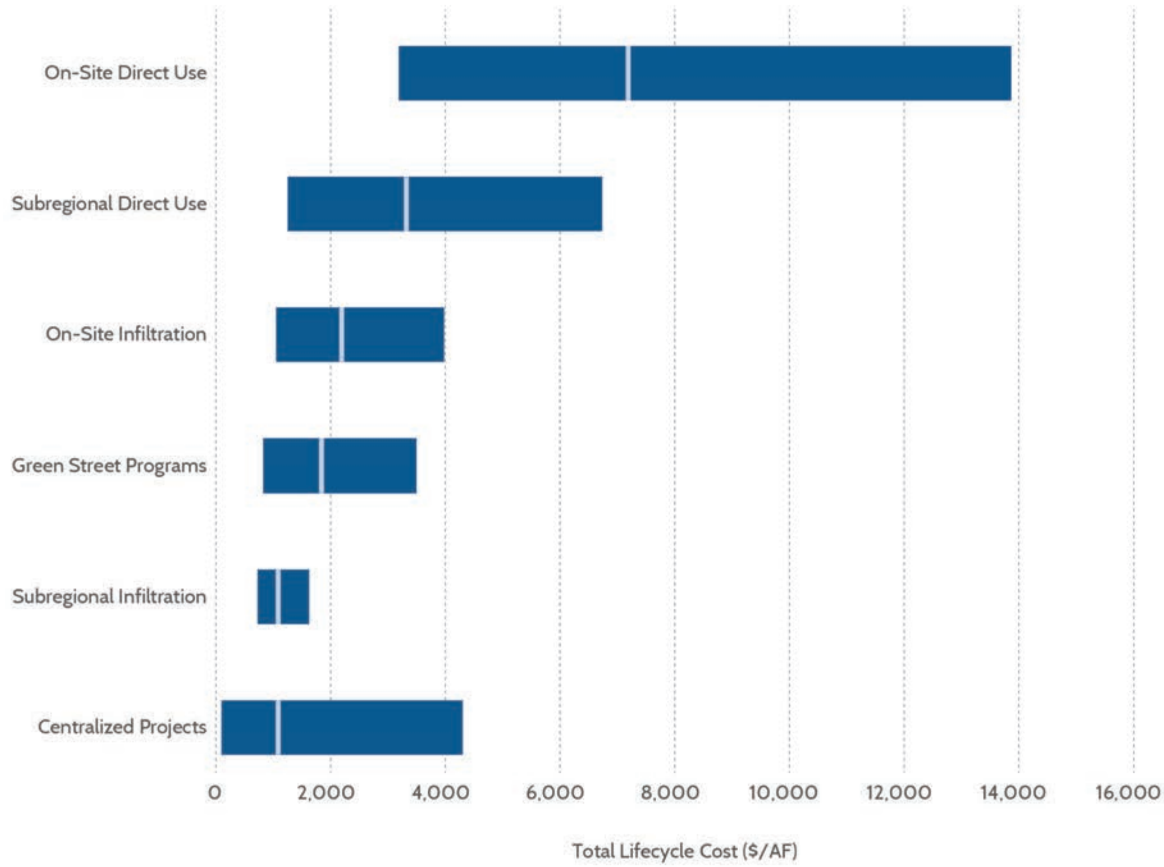

Figure ES-6. Cost-Efficiency of Projects and Program Types

increased water supply reliability resulting from development of local water resources. Analysis of MWD water costs and the value of local resources through its local resource program (LRP), including predicted escalation over time and using the value at the mid-point of the planning period, showed that stormwater projects that recharge water into groundwater aquifers, and thus avoid purchase of Metropolitan Water District (MWD) Tier 1 untreated water, can be considered to have a value of $1,100 per acre-foot of water generated over the life of the project (Figure ES-7).

Direct use projects, which can avoid the purchase of MWD Tier 1 treated water, can be considered to have a value of $1,550 per acre-foot (Figure ES-8).

If the cost of a project or program is less than the value of the captured water it provides, then implementation of this project would be considered "good business" and would be defensible to the ratepayer. Projects or programs that cost more than the value of the water they provide may still be worth implementing when other project benefits are considered and other beneficiaries contribute to the cost of implementation.

Based on the analysis of identified project and program alternatives, each project/program category contains individual projects that could be implemented for a cost that is less than or equal to their value to LADWP (with the exception of the onsite direct use program). And each project/program category also contains projects with costs that exceed their value to LADWP in terms of water supply benefit where partnerships can close this

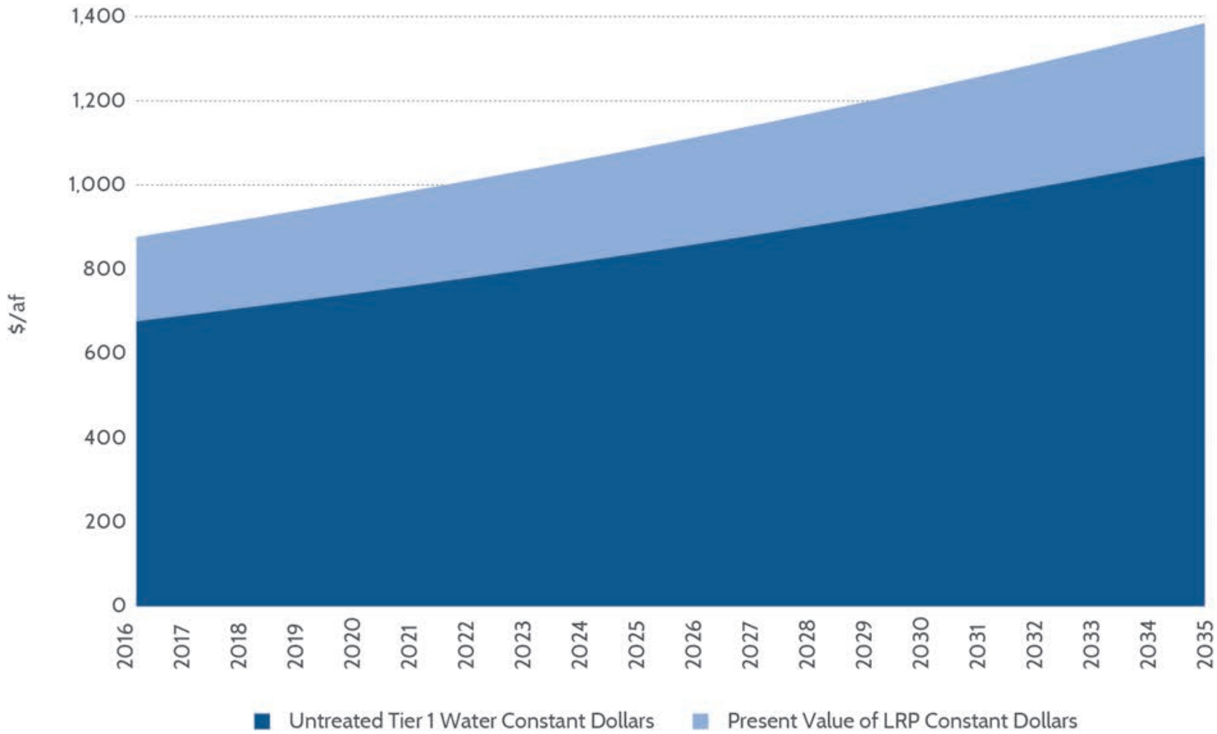

Figure ES-7. Value of Recharged Water to LADWP

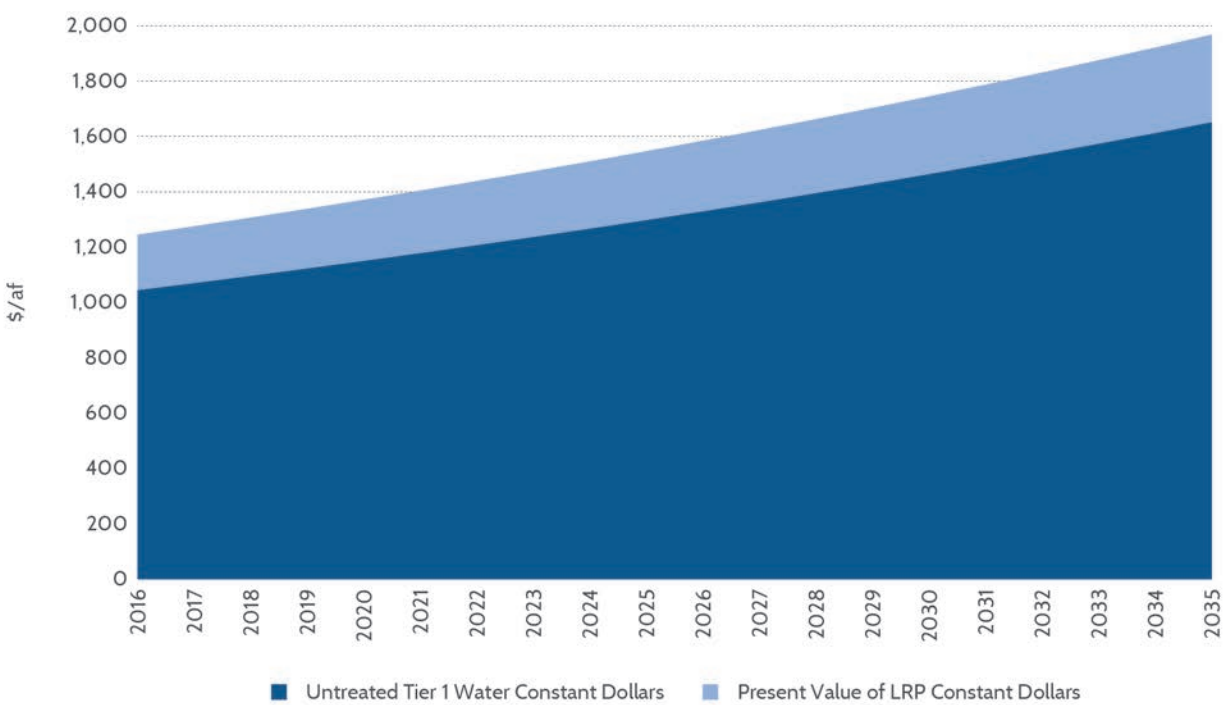

Figure ES-8. Value of Direct Use Water to LADWP funding gap. Though there is often a sound business case for LADWP to implement projects independently, their implementation approach should also include a strategy for coordination with other agencies to cost-effectively implement projects and programs.

FUNDING STRATEGIES

LADWP could contribute funds to projects in accordance with the water supply and local supply values described above. Recognizing the capital-intensive nature of many of these projects, a variety of strategies for debt financing could be employed. These strategies include issuance of debt by LADWP, but also debt issuances by other entities, including low interest loans from State and Federal sources, and cooperative pledges of LADWP funds toward repayment of debt issuances by other entities including public agencies, property owners and private sector entities. New forms of debt issuance may include formation of "Joint Powers of Authority" (JPA) or special assessment districts, in which LADWP funds could be combined with new sources of revenue to support new debt vehicles. In this regard, the SCMP includes a number of recommendations on how LADWP's avoided costs and the potential LRP subsidy from MWD can become significant sources of revenue pledged toward operating costs, capital costs, and debt repayment. It is also recommended that LADWP consider potential financing from Public Private Partnership opportunities.

LADWP can also serve as an important entity to receive grant monies for implementation of stormwater capture. Grants may include funds from the Water Quality, Supply and Infrastructure Improvement Act, and new sources of grant monies may become available. LADWP could help ensure that these grant opportunities are effectively realized over time. Optimizing grants and leveraging LADWP funding will require careful coordination with other entities including LACFCD, LASAN (through the EWMP process), and others.

For distributed projects, LADWP may also offer debt financing vehicles to projects that allow consumers to reduce their use of LADWP's water to encourage these projects without additional cost to other ratepayers. For distributed projects that would result in recharge benefit to LADWP, new incentive programs including grants, purchase agreements and financing would be offered. Also, LADWP would likely purchase water from a number of projects sponsored by other public agencies as a form of financial contribution to projects that are sponsored for other purposes.

IMPLEMENTATION RECOMMENDATIONS

Implementation of centralized and distributed projects and programs, and hence increased stormwater capture over the past several decades (Figure ES-3), is directly attributable to LADWP's growing focus on stormwater capture as a means of augmenting local water supplies. These increasing efforts toward identifying projects, welcoming project partnerships, and providing funding critical to the successful and timely implementation of projects is readily apparent in the increased role stormwater plays in the City's water supply portfolio. Even with LADWP's and their partners' sustained efforts, there remains significant untapped potential for additional capture from both centralized and distributed projects. Realizing this potential requires new strategies to allow projects and programs to be implemented at an accelerated pace.

GUIDING PRINCIPLES

The SCMP provides planning level guidance on the projects and programs that LADWP should implement or support to increase stormwater capture. However, as this plan gets implemented, additional decisions will need to be made to select and prioritize specific projects. To guide LADWP in making these decisions, specific attributes will be considered when evaluating individual projects. These are:

Sound Planning. LADWP is conservative in its approach to water supply planning, meaning that it errs on the side of more water and more storage. LADWP anticipates future regulations and policies, and how they may impact water supply planning. LADWP collaborated with the community and stakeholders throughout the development of the SCMP, and will continue to collaborate when proposing investments.

Appropriate Investment/Cost-Effectiveness. LADWP is committed to its ratepayers to ensure that it only implements projects that make good business sense. Investments must be based on clearly defined planning, reliability, environmental, and financial standards. However, while some projects may at first appear to have a high dollar per acre-foot price tag, by entering into partnerships with other agencies and co-investing in multi-benefit projects, LADWP may be able to reduce its share and make a defensible case for implementation of the project.

Reliable and Resilient Water Supply and Service. LADWP expects to continue to meet 100% of the demand 100% of the time. To accomplish this, LADWP needs to diversify its water supply portfolio in order to become drought and climate change resilient. While some individual projects may initially appear more costly, their additional expense in the near term may be warranted if they provide LADWP with a diversified water supply portfolio that is resilient in the face of anticipated threats to long-term water supply reliability.

Multiple Benefits. Though cost-effectiveness is an important metric to be used for evaluating a project, projects with multiple benefits have an advantage over projects that only provide water supply benefits, even though their total cost per acre-foot of captured water may be higher. LADWP looks to pursue multi-beneficial projects that address not only water supply, but water quality, localized flood protection, and open space. Multi-beneficial projects present the opportunity for collaboration and cost sharing, thus improving the cost-effectiveness of a project when viewed strictly as costs to LADWP.

Transparency and Collaboration. LADWP's goal is to provide easy-to-access information on policy decisions, outreach activities and follow-up, and governance. LADWP encourages dialogue with policy makers, community leaders, and the general public regarding LADWP standards. Not only does collaboration potentially reduce LADWP's share of project costs, collaboration among agencies also works toward different goals that improve the City's overall efficiency in meeting all of its goals, in that there is less redundancy and/or conflict between different agency projects.

Stormwater capture projects have the potential to provide non-water supply benefits (Table ES-5). Projects that include multiple additional benefits should be prioritized over those that provide few or no additional benefits. Collaboration should be a fundamental element of all work associated with implementation of the SCMP. LADWP should work closely with other City agencies to develop coordinated strategies for meeting overlapping goals.

Consistent with being multi-beneficial and collaborative, stormwater capture projects should also be prioritized opportunistically. While a given project may not be at the top of LADWP's priority list in a given moment, it may nevertheless be appropriate to implement if there are time-limited circumstances that would work in favor of said project. For instance, if a green street project has been identified for future implementation and that street is slated to be repaired before the green street project is implemented, it may be worthwhile to adjust the timeline of implementation to coincide with the street repair. This not only has the potential to reduce project costs and improve the environmental sustainability of the project, but could also reduce disruption to the neighborhood and increase public goodwill for the project.

Table ES-5. Potential Non-Water Supply Benefits of Stormwater Capture

Category	Potential Benefits of Stormwater Capture Project
Environmental	Flood protection
	Water Quality
	Habitat
	Heat island
	Climate adaptation/ mitigation
Infrastructure	Street repair
	Facility O&M
	River Revitalization
Social	Recreation
	Neighborhood revitalization
	Public health
Economic	Job creation

RECOMMENDED IMPLEMENTATION APPROACHES

The SCMP creates a vision for implementation of a wide variety of projects with multiple benefits. To implement all of the programs presented in the SCMP, a variety of approaches must be employed. Although LADWP will take the lead on implementation of projects and programs most beneficial from a water supply perspective, the projects and programs proposed in this plan are not expected to be implemented solely by LADWP. There are a variety of responsible parties who may direct and/or fund implementation, and there are different approaches for implementation that may be employed. Each project and/or program may be most suitably implemented through one or more of these approaches.

Four general approaches proposed for implementation of projects and programs described in this document are summarized below, including key recommendations for implementing these approaches.

1. LADWP-Led Implementation

For projects on land owned by LADWP that are highly cost-effective initiatives and contribute significantly to water supply, LADWP should accept leadership responsibilities and work to increase efficiency of implementation. For these projects the recommended approach focuses on maximizing participation by private-sector expertise in project development and implementation, but includes placing specific responsibilities on LADWP for stewardship of these new initiatives. Projects suitable for this approach include several of the centralized projects described in this document, as well as highly cost-effective subregional and green street projects.

- Projects that could be implemented by LADWP on properties and facilities owned by LADWP or partnering entities should employ performance specifications and design-build delivery to avoid delays of the conventional design-bid-build projects.
- LADWP should explore methods of employing private sector development expertise to implement some of the most cost-effective and developmentally complex centralized projects and sub-regional programs identified in the SCMP. This would include developing RFPs requesting information and proposals from the

private sector and public agencies to develop and implement the projects and programs identified.

- LADWP has already established a method for identifying and prioritizing centralized projects and key distributed projects. However, to achieve the implementation rates of distributed projects called for in this plan, LADWP must develop a systematic approach to identifying subregional projects cost-effective enough to warrant LADWP implementation. Analysis performed for the SCMP should be used to help focus in on areas likely to contain project opportunities.
- On all projects led by LADWP, LADWP should work to include project partners where appropriate.

2. Coordination with Other Agencies and Coordination with EWMPs

Considering the multi-benefit nature of stormwater capture projects, it is understood that many projects identified in this plan would be implemented by other agencies, and LADWP should participate in these projects wherever they provide cost-effective water supply benefits. Approaches for coordination with other agencies may include new forms of governance to facilitate funding and implementation. It is recommended that LADWP:

- Consider formation of a JPA or other form of cooperative governance with LACFCD to create a focused organization to speed implementation of cost-effective centralized projects.
- Develop standard terms for participation in projects sponsored by other public agencies to contribute to project costs consistent with the water supply benefits of the projects, and encourage other beneficiary agencies to do the same.
- Monitor the projects of other agencies to identify opportunistic stormwater capture projects in which they may participate.
- Offer grants, purchase agreements, and/or financing to projects that capture stormwater and groundwater recharge basins from which LADWP can recover the groundwater.
- Work with Los Angeles Unified School District (LAUSD) to develop a program to allow for the installation of subregional capture projects on their campuses where appropriate.
- Continue its participation in the City's EWMPs, including sharing data and maps to allow for comparison of prioritized project areas, thus facilitating identification of opportunities for project collaboration.
- Contribute funds to projects identified in the EWMPs that generate new water supplies consistent with the benefits of those projects.
- Work with other City agencies to explore the formation of an Enhanced Infrastructure Financing District (EIFD) to facilitate financing for City projects which have water supply and other benefits such as water quality improvements, open space, and flood protection.

3. Property Owner Implementation

The approach for private properties involves creating incentives to empower property owners to implement projects without over investment of ratepayer funds, by offering financing with cost recovery. It is recommended that LADWP:

- Offer grants, purchase agreements, and/or financing to on-site projects and subregional projects installed on private property that capture stormwater and recharge groundwater basins in which LADWP can recover the groundwater. Grant amounts should be based on the lifetime capture potential of a given project and the value of the recharged water.
- Offer loans to customers to help finance projects that would capture stormwater and beneficially use the water to reduce potable demands.

4. Regulated Implementation

Many projects will be implemented through development ordinances and statewide policies. LADWP should maximize the stormwater capture benefit obtained through these means by working with policy makers to advise on sound policy from a stormwater capture perspective. It is recommended that LADWP

- Work with policymakers to implement better enforcement of the LID ordinance and cooperate in the development of an improved LID ordinance and an improved Sustainable Streets Ordinance.
- Offer support for a retrofit ordinance that would require stormwater capture projects to be installed on existing properties or upon resale of a property.

ADDITIONAL RECOMMENDATIONS

Achieving the targets laid out in this plan requires a broad effort aimed at supporting the general landscape of stormwater capture. To this end, it is recommended that LADWP

- Work with the water-rights panel in the Central and West Coast Basins seeking to lead a regional effort to solicit projects and implement water augmentation projects within the Central and West Coast Basins and offer participation rights to water rights holders in the groundwater basins that contribute. These include efforts to recharge the Los Angeles Forebay with new stormwater sources.
- Ensure that the clean-up efforts in the San Fernando Basin proceed to continue and improve LADWP's cost-effective access to the water supply and storage resources of that groundwater basin.
- Continue engagement with the public to educate and solicit input on new programs to capture stormwater, including opportunities for individual property owners to implement on-site stormwater capture projects and programs.
- Develop a comprehensive program to receive the LRP from MWD for stormwater capture projects.
- Optimize existing grant sources and monitor potential new grant opportunities to maximize receipt of grant monies for stormwater capture projects.
- Develop procedures to measure new stormwater capture to help secure funding and realize benefits from stormwater capture in major groundwater basins.
- Help develop more refined maps of areas where stormwater recharge projects may have adverse impacts due to expansive/contractive soils or liquefaction potential and coordinate with the City of Los Angeles Department of Building and Safety (LADBS) on procedures to approve local projects to retain and recharge stormwater.
- Consider the development of a programmatic environmental document

to allow for a more streamlined approach to implementing the recommendations made above.

CONCLUSION

With increased pressure on traditional water resources, LADWP desires to augment its local water supply portfolio to further its mission of providing a safe, reliable, and environmentally sensitive water supply for the City of Los Angeles. Local stormwater has historically contributed a significant amount of water for the City. LADWP and its partners actively recharge the local groundwater aquifers with approximately 29,000 acre-feet per year, and another 35,000 acre-feet per year is recharged into those same aquifers by incidental infiltration through mountain front zones and unpaved surfaces. Now, with the SCMP development process complete, results show that through the sustained implementation of a suite of centralized projects and the adoption of distributed programmatic approaches, an additional 68,000 to 114,000 acre-feet per year of stormwater for water supply could be realized in the next 20 years. The approximate value of this water to LADWP over the same 20-year time period is $1,100 per acre-foot for recharged water and $1,550 per acre-foot for directly used water, which represents a sound investment in the City's future water supply portfolio.

To achieve these goals, sustained effort on behalf of LADWP and its partners, in particular LACFCD, LASAN, and other City agencies, is required. These efforts include diligent tracking of funding opportunities, increased integration of common functions between agencies with similar charges, and exploring creative new mechanisms of project implementation. As this plan to increase the capture of this valuable local water supply is realized, additional benefits to the City will be gained, including water quality improvements, improved green spaces for habitat and recreation, and reduced peak flows in the region's waterways.

1. INTRODUCTION

The City of Los Angeles Department of Water and Power (LADWP) is responsible for providing the City of Los Angeles (City) with a safe and reliable supply of water for residential, commercial, governmental, industrial, and institutional uses. Between 2010 and 2015, the City imported over 85% of its water from distant sources; only 12% of the City's water originated from local groundwater sources, which are replenished in most part by stormwater originating as precipitation in the mountains and the valley floors. Future water supply reliability will be challenged by changing regulations, environmental considerations, population growth, and climate change. To address these challenges, additional water resources will be required to assure sufficient supply to meet long-term growth demands. Increased stormwater capture can help assure a sufficient water supply for the City, as it is currently an underutilized, locally controlled water resource.

Increasing stormwater capture will enable the City to regulate and reduce its purchase of imported water and develop a more reliable water supply portfolio. LADWP evaluated and characterized the role that increased centralized and distributed stormwater capture can play in the City's water supply portfolio as set forth in this Stormwater Capture Master Plan (SCMP). Geosyntec Consultants (Geosyntec) and a team of subconsultants (Geosyntec Team) assisted LADWP to develop the SCMP to evaluate existing stormwater capture efforts, analyze the role of stormwater capture in the City's water supply portfolio, and provide recommendations for future stormwater capture opportunities. The Geosyntec Team was retained by LADWP under Agreement No. 47173-3. Work on the SCMP began July 5, 2013. The SCMP Project Team consists of LADWP, the Geosyntec Team, and TreePeople. TreePeople has been a core partner and pro bono adviser on the SCMP since its inception, helping to launch the SCMP and working collaboratively with LADWP and Geosyntec to guide the process

1.1. OBJECTIVE

The purpose of this document is to describe:

- The long-term potential of stormwater to contribute to the City of Los Angeles' water supply;
- Alternative projects and programs available to LADWP to increase stormwater capture for water supply;
- A range of project and program implementation rates at 5, 10, 15, and 20 years (in the years 2020, 2025, 2030, and 2035);
- A range of stormwater capture targets based on the implementation rates at 5, 10, 15, and 20 years;
- An estimate of the value of stormwater that is captured for recharge and/or for direct use, along with ancillary benefits;
- Potential funding strategies that could be used for program and project implementation; and
- An implementation strategy for LADWP to employ to meet projected targets, including both guiding principles and specific actions.

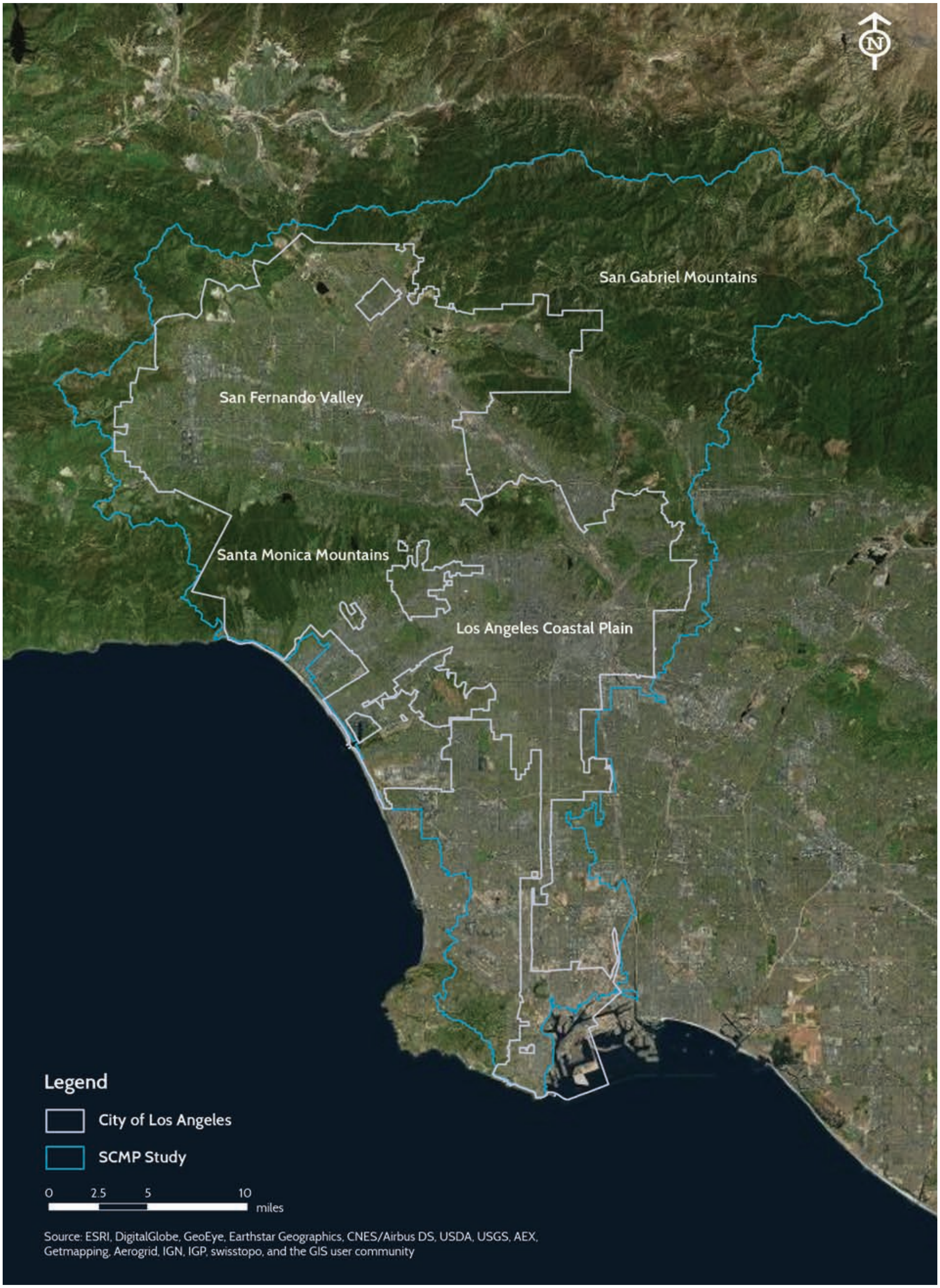

Figure 1. SCMP Study Area

1.2. STUDY AREA

The project study area consists of hydrologic areas within the City boundaries and all areas that drain to and through the City boundaries, hereby defined as the "SCMP Study Area" (Figure 1). Occupying the Los Angeles Coastal Plain, the SCMP Study Area rises uniformly from the ocean over a distance of 25 to 30 miles to an average elevation of about 2,000 feet above mean sea level (amsl) at the base of the San Gabriel Mountains, or roughly 80 feet per mile. From there, the mountains rise abruptly above the Coastal Plain to over 7,000 feet amsl in just one to three miles (~3,500 feet per mile). The regional climate is characterized as "Mediterranean" because the region experiences warm, dry summers and cool, wet winters. Annual rainfall patterns, and hence stormwater runoff characteristics, are quite variable. Although the average annual precipitation in downtown Los Angeles is 15.3 inches, it ranges from a low of 4.69 inches (2007) to a high of 30.6 (1998). The mountains that surround the coastal plain, and are tributary to the City, experience considerably more rainfall than downtown Los Angeles. For example, in Big Tujunga Canyon, annual rainfall ranged from 9.62 inches in 1989 to 53.93 in 1998.

Due to the relationship between stormwater capture and groundwater recharge, local groundwater basins are important to the project (Figure 2). The San Fernando Basin, the Central Basin, and the West Coast Basin are key to LADWP's efforts to capture and store stormwater for later use as these basins have clear mechanisms that would allow recovery of additional stormwater capture in a manner beneficial to LADWP. Other relevant groundwater basins include the Main San Gabriel, Hollywood, and Santa Monica groundwater basins. Significant capture and storage of stormwater is dependent upon greater and more efficient use of groundwater basins for storage.[1]

1. Appendix E provides a review of water rights as well as groundwater basin and storage information.

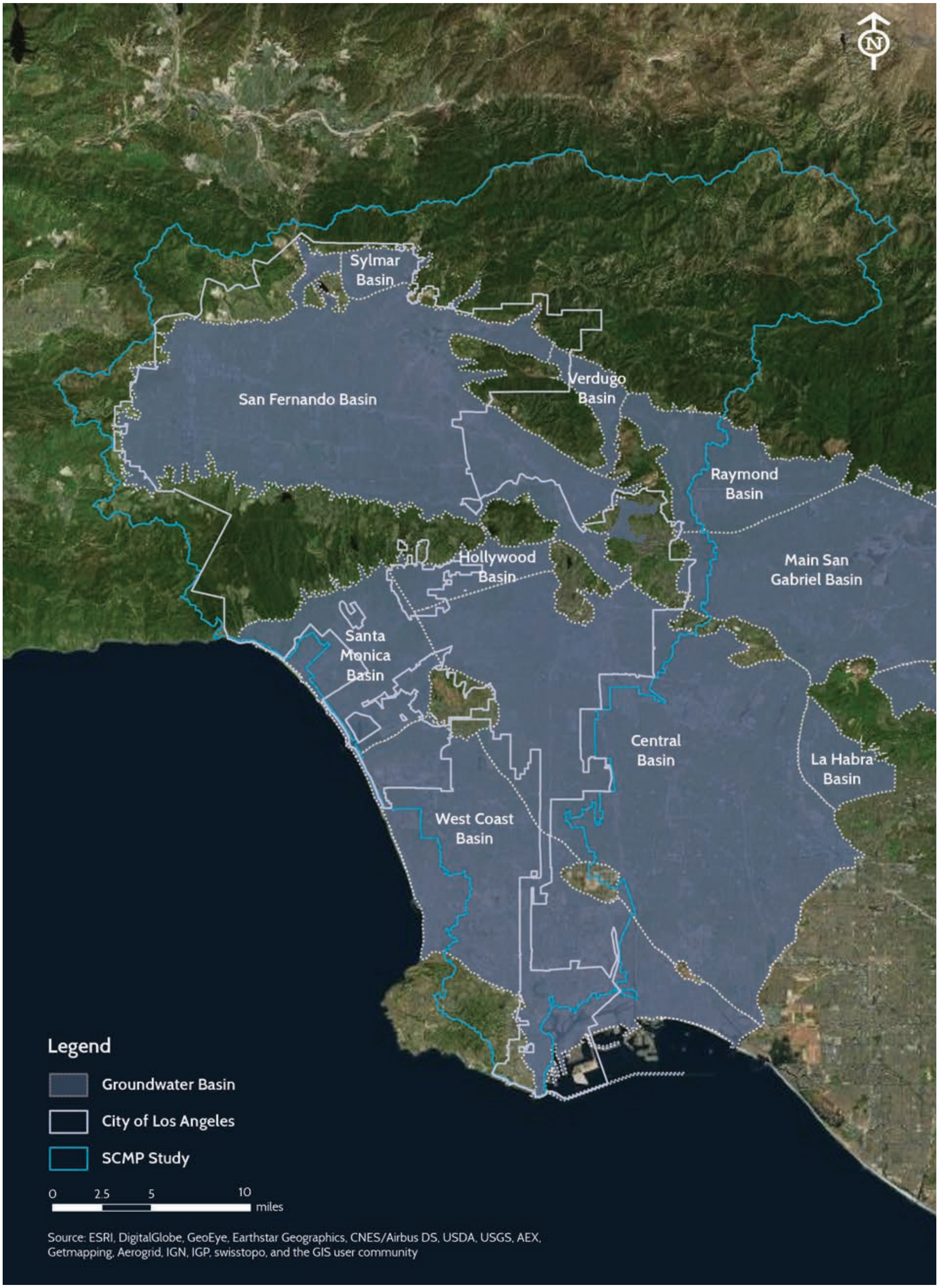

Figure 2. Groundwater Basins in Proximity to SCMP Study Area

2. THE STORMWATER MESSAGE

Public participation was an important part of the development of the SCMP in order to ensure that the plan had the support of key stakeholders and was fully integrated with other regional stormwater management efforts. Investing in public awareness and approval of the plan during its development will facilitate its future implementation and broad acceptance as an essential part of ensuring a sustainable local water supply. As such, public outreach activities were ongoing throughout the SCMP development process.

A Public Outreach Plan (POP) was the first deliverable of the SCMP development process to serve as a guide for public outreach activities to be conducted throughout SCMP development (Appendix A). The POP identified tactics to reach various target audiences and obtain ideas, suggestions, and feedback about the development of the SCMP.

The POP identified the overall objectives of SCMP public outreach:

- Increase awareness of local water supply elements;
- Inform the public about the SCMP;
- Solicit input on stormwater capture and use options;
- Obtain support for the SCMP and options;
- Inform and support other City initiatives such as Mayoral Executive Directive Number Five, which sets the goal to reduce potable water use by 20% by 2017 and reduce LADWP's purchase of imported water by 50% by 2024; and
- Raise awareness of existing opportunities for participation.

Strategies used in the SCMP outreach program included:

- Regular meetings and briefings with a subset of project partners known as the SCMP Technical Advisory Team, which was comprised of agency partners;
- Meetings and presentations with key stakeholder organizations;
- Public meetings;
- Print media;
- Focus groups;
- Development of collateral materials; and
- Development of an LADWP project website for the SCMP.

2.1. TARGET AUDIENCES

The SCMP's target audiences were grouped into four categories: (1) internal audience; (2) Technical Advisory Team; (3) key regional stakeholders; (4) the general public and the media.

2.1.1. INTERNAL AUDIENCE

The internal audience consisted of local and state elected officials, regulators, and entities involved in research or implementation programs related to stormwater capture. Groups included city, county, state, and federal departments, such as the Mayor and City Councilmembers, US Environmental Protection Agency (EPA) Region 9 Administrator, Regional

Water Quality Control Board (RWQCB) members, and the State Water Resources Control Board (SWRCB).

2.1.2. TECHNICAL ADVISORY TEAM

The Technical Advisory Team (TAT) consisted of internal LADWP and City staff, as well as representatives from other government agencies with planning-level interests that overlap with LADWP's master planning process. The Project Team met on a regular basis with the TAT to seek input and counsel on the technical development of the SCMP.

2.1.3. KEY REGIONAL STAKEHOLDERS

Key regional stakeholders included critical 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. Meetings or presentations were regularly held with key stakeholder organizations to inform these groups about the SCMP, solicit their input on the project and the development of the SCMP, and request their assistance in participating in the public meetings.

2.1.4. GENERAL PUBLIC

The general public included the citywide audience, constituents of key stakeholders, and the media. The general public was targeted through citywide public meetings.

2.2. PUBLIC OUTREACH MEETINGS

Table 1 summarizes the SCMP public outreach events held during the development of the SCMP. The public outreach strategy was an ongoing effort. The messages and the desired outcomes were refined at each stage of implementation, and public and stakeholder support was built and reinforced on a continuous basis. More detailed descriptions of each meeting can be found in Appendix A.

Table 1. SCMP Public Outreach Events

Public Outreach Event	Topic	Date(s)
EWMP Coordination Meetings	Coordination between plans	Multiple
Basin Study Coordination Meetings	Coordination between plans	Multiple
Briefings with City Council Members, EPA Region 9 Administrator, RWQCB, and SWRCB	Informational presentation and project update	Multiple
Presentation at Southern California Water Committee Meeting	Informational presentation and project update	1.22.2012, 6.25.2014
TAT #1	Stormwater capture potential modeling approach	9.16.2013
Key Stakeholder Meeting #1 – All Key Stakeholders	Introduction to SCMP	10.21.2013
Meeting with The River Project	Project update and collaboration	1.14.2014

Table 1. SCMP Public Outreach Events

Public Outreach Event	Topic	Date(s)
TAT #2	Stormwater capture potential	2.24.2014
Meeting with Arid Lands Institute	Project update and collaboration	3.21.2014
General Public #1	Introduction to SCMP, potential for stormwater capture, and solicitation of project/program ideas	3.26.2014
Key Stakeholder Meeting #2 – GreenLA	Stormwater capture potential preliminary results and solicitation of project/program ideas	3.26.2014
Key Stakeholder Meeting #3 – Prop O Citizens Oversight and Advisory Committee (COAC)	Introduction to SCMP and preliminary modeling results	5.19.2014
Presentation at H2O Conference	Informational presentation	5.28.2014
Presentation to Studio City Residents Association	Project update	7.8.2014
Key Stakeholder Meeting #4 – UCLA	Coordination between SCMP and UCLA/Colorado School of Mines	7.22.2014
Presentation to National Research Council	Informational presentation and project update	7.31.2014
TAT #3/Key Stakeholder Meeting #5	Distributed stormwater capture program unit response curves	10.9.2014
Meetings with LAUSD	Project update	10.2.2014, 10.15.2014
Presentation at IRWMP Leadership Committee Meeting	Informational presentation and project update	10.22.2014
Presentation at the Westchester Rotary Club	Project update	12.17.2014
Presentation to Upper LA River Area IRWMP Group	Informational presentation and project update	1.21.2015
General Public Meeting #2a	Presentation of interim report	1.22.2015
General Public Meeting #2b	Presentation of interim report	1.29.2015
Presentation to LA Neighborhood Council Coalition	Project update	2.7.2015
Presentation at American Water Resources Association Conference	Informational presentation	3.30.2015
TAT Meeting #4/Key Stakeholder Meeting #6	Implementation strategies	3.25.2015
TAT/Key Stakeholder "Office Hours"	Implementation rates	6.1.2015, 6.4.2015
General Public Meeting #3	Presentation of final SCMP	6.25.2015

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3. BACKGROUND & EXISTING CONDITIONS

This section summarizes work conducted under the project coordination, data collection, and existing conditions analysis completed as part of the SCMP, wherein the primary focus was to research and compile background and existing conditions as well as information pertinent to development of the SCMP. The following sections summarize the information reviewed and compiled.

3.1. EXISTING DATA

Baseline conditions related to stormwater capture were documented by gathering and reviewing background information. This included datasets necessary to analyze existing and potential stormwater capture, including those that relate to both opportunities and constraints for stormwater capture approaches and data necessary for stormwater modeling using the Load Simulation Program in C++ (LSPC) and Ground Water Augmentation Model (GWAM). Results of this work are summarized below and fully documented in Appendix B. Datasets used are described below.

Surface Hydrology and Hydrologic Features. Types of hydrologic data collected included: (1) precipitation and evapotranspiration data; (2) information on sub-basins and drainage systems; (3) existing and proposed stormwater capture facilities; and (4) flow and water quality monitoring data. Much of this data was utilized for inputs and/or calibration for both the LSPC and GWAM models.

Groundwater Basins and Related Datasets. Groundwater basins intersecting the City boundary include: Sylmar; San Fernando; Hollywood; Santa Monica; West Coast; and Central. Datasets with information on depth to groundwater, permitted dewatering activities, and production wells were obtained. In addition, information on sedimentary deposits and aquifer characteristics (e.g. hydraulic conductivity, leakance, specific yield) was collected.

Soil Conditions and Slope. Collected soil data were used as inputs in both models and were a significant factor for characterizing relative infiltration and recharge capacity. Slope information was obtained from digital elevation maps, and slopes were classified as >10% and <10% in order to categorize hydrologic response units (HRUs).

Land Use and Related Datasets. Types of land use and related datasets collected included: (1) existing land use data; (2) parcel data; (3) HRUs; and (4) planned land use policy and general plan datasets. These datasets provided information on land use, imperviousness, availability of open space (e.g. for stormwater facilities), and other factors that could affect infiltration/recharge in the SCMP area. HRUs have the largest effect on runoff used in hydrologic watershed modeling (imperviousness, land use, soil characteristics, and slope) and are useful for prioritizing areas for infiltration/recharge.

Other Datasets for Identifying Opportunities for Stormwater Capture. A variety of other datasets were gathered and evaluated to identify potential opportunities for implementation of future stormwater capture programs, policies, or projects. Other opportunities for stormwater capture included: (1) compliance with low impact development (LID) ordinances as part of municipal separate storm sewer system (MS4) permit compliance or by coupling stormwater capture retrofit programs with other revitalization efforts (e.g. green streets); (2) expected areas of redevelopment identified by City Planning; and (3) existing or planned bicycle lanes/corridors.

Other Datasets for Identifying Constraints to Stormwater Capture. Certain areas are not suited to stormwater capture due to geotechnical concerns (i.e. landslide and liquefaction zones), and these mapped areas were identified. Furthermore, areas with ongoing remedial action and/or known pollutants are not suitable. Datasets used to identify these environmentally constrained areas included: (1) a dataset showing the extent of the saline plume in the West Coast Groundwater Basin; (2) the EPA's Facility Registry Services (FRS) database identifying Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, aka Superfund) and Resource Conservation and Recovery Act (RCRA) sites; and (3) the SWRCB Geotracker and the Department of Toxic Substances Control's (DTSC) Envirostor databases.

3.2. EXISTING STORMWATER CAPTURE FACILITIES

Existing centralized and distributed stormwater capture facilities, projects, and programs within the SCMP Study Area were evaluated and summarized. This work included describing Los Angeles County Flood Control District (LACFCD) flood control structures as well as existing centralized and distributed stormwater capture facilities/structures, projects, and programs within the City and surrounding watersheds that may affect City stormwater capture and groundwater recharge efforts. Results of this work are summarized below and fully documented in Appendix C.

3.2.1. REGIONAL FLOOD CONTROL SYSTEM

The regional flood control system includes conveyances, impoundments, spreading grounds, flood control basins, and debris basins. Its purpose is to protect urban infrastructure from flooding and to provide water conservation for replenishment of local groundwater basins.

Over the past few decades, as imported water has become 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.

3.2.2. CENTRALIZED STORMWATER CAPTURE

Centralized stormwater capture facilities are engineered features located in specific locations that perform well at capturing large flows when available. In general, these facilities can capture and infiltrate more than 100 acre-feet per year. In some cases, a project's circumstances can cause a project with less than 100 acre-feet per year to be included in the list of centralized projects. Table 2 summarizes the major categories of centralized stormwater capture projects.

Flood control facilities within the Los Angeles region protect the highly urbanized regions and provide significant groundwater replenishment. However, the highly urbanized nature of the region leaves limited opportunities for new large-scale conservation projects within the Los Angeles River watershed. Therefore, optimization of the existing infrastructure, along with focused efforts to maximize the use of open space (such as parks, power line easements, gravel pits, and unlined portions of existing channels) and multi-use stormwater capture projects, provides the best opportunities for increased stormwater capture and conservation.

Table 2. Types of Centralized Stormwater Capture Facilities

Facility Type	Description
Dams and Reservoirs	Dams and reservoirs are located on major streams throughout the region, providing flood protection and water conservation. The dams that LACFCD owns and operates often have dual purposes, while the dams operated by the U.S. Army Corps of Engineers (USACE) 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	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 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. Debris basins are of interest to the SCMP because opportunities may exist to retrofit these facilities in order to augment retention for later release to downstream spreading areas.
Channel Networks	The LACFCD and USACE storm channel system represents the major drainage infrastructure within the City and County of Los Angeles, conveying stormwater runoff. 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.
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 underlying aquifers 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 from Northern California or the Colorado River. Reclaimed water is the effluent produced by waste water reclamation plants. While space constraints limit the possibility of new centralized water conservation facilities, there are opportunities to retrofit existing facilities to increase their capacity for recharging groundwater basins.

3.2.3. 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. Therefore, they can be installed within the highly developed landscape of Los Angeles. Distributed stormwater facilities in the City are important for future stormwater capture efforts.

Distributed facilities are versatile in their applicability and are garnering support from a wide range of organizations because of the multitude of benefits that they can provide. Not only can distributed facilities augment groundwater supplies, but they also can provide wildlife habitat, flood protection, cleaner air, cleaner water, and recreation opportunities. Distributed projects also have the benefit of raising awareness of water resource issues. The multi-benefit nature of these projects facilitates funding by incentivizing multiple agencies to share construction and maintenance costs and by increasing grant opportunities.

The regulatory landscape is also encouraging the development of distributed stormwater capture. The City of Los Angeles and Los Angeles County both have LID Ordinances that 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.

The City of Los Angeles possesses a growing number of distributed facilities for stormwater capture and treatment. Because these projects are by definition small and distributed throughout the City, a selection of distributed projects were evaluated in the context of their contributions to the larger context of stormwater capture in Los Angeles. Detailed information can be found in the report "Green Infrastructure for Los Angeles: Addressing Urban Runoff and Water Supply through Low Impact Development" (City of Los Angeles, 2009).

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. 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. 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. Through reduced permit fees, pre-approval, and expedited review, it provides incentives for their adoption on a larger scale.

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. 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. Monitoring and evaluation at Elmer show that the conceptualized benefits of distributed stormwater capture have values that are observable and quantifiable, without significant evidence of unintended consequences like contaminant accumulation or resident apathy.

Similar to the Elmer project, the ***Woodman Avenue Green Infrastructure Project (Woodman)*** along Woodman Avenue in Panorama City served an important flood control objective. The Woodman project replaced a 3/4-mile long concrete median with a naturalized swale that captures runoff and infiltrates it into the groundwater rather than directing it into the nearby Tujunga Wash, thereby enhancing the Tujunga Wash's flood control capacity.

The BMPs installed at ***1100 South Hope Street (Hope St.)*** represent a distributed system of stormwater management strategies implemented by private development. The developers of Hope St. successfully sought approval for, and subsequently incorporated, wider sidewalks and street trees into the condo project where widening of the street was originally required. As a result, after being incentivized by the City of Los Angeles, private developers successfully incorporated a distributed stormwater management system into their overall project. With appropriate incentives, private development can be an important participant in the expansion of distributed facilities for stormwater management.

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. In partnership with the LADWP, 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 contribute to increased stormwater management without loss of public space or a reduction of park amenities.

Beyond specific instances of project implementation, important work is being done to promote ongoing implementation of distributed projects. For example, TreePeople provides community workshops and greening projects, rain barrel distributions, how-to videos and online toolkits to educate and empower Angelenos to capture stormwater for reuse. Further, guidance documents such as Water LA's Homeowner's "How-To" Guides are becoming available to help individuals set up small-scale stormwater capture and use systems.

3.2.4. EXISTING PLANS AND STUDIES

Existing plans and studies in the Los Angeles basin relating to stormwater capture were reviewed and summarized in order to assist with the determination of the feasibility and compatibility of recommended stormwater capture projects (the results of this work are summarized below and fully documented in Appendix D). Types of documents reviewed included:

- Enhanced Watershed Management Plans;
- Urban Water Management Plans and Related Documents;
- Integrated Resource Plans;
- Integrated Regional Water Management Plans;

- Watershed Management Plans; and
- Other Studies Informing the Context of Stormwater Capture in the City of Los Angeles.

Review of these documents revealed a significant existing body of research on stormwater capture that is relevant to stormwater capture in the City of Los Angeles. Relevant studies informing the feasibility of stormwater capture in Los Angeles demonstrate that it 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.

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 water supply, water conservation, improved water quality, groundwater recharge, flood control, habitat restoration, and adaptation to climate change.

3.3. REGULATORY FRAMEWORK

Regulatory drivers (policies and ordinances) pertinent to City-wide stormwater capture at the local, regional, state, and federal levels were reviewed and summarized in order to understand the regulatory landscape driving or inhibiting stormwater capture. More specifically, water rights, groundwater basins and storage incentive programs, and regulatory drivers were reviewed. This review included those that encourage stormwater capture as well as those that pose a conflict. This effort focused on both existing and forthcoming policies, ordinances, incentives, and regulations. Results of this work are fully documented in Appendix E.

3.3.1. GROUNDWATER REGULATION

Increasing the stormwater component of the water supply portfolio will require storing water that arrives and is captured during wet periods for use during dry conditions. Groundwater basins offer the greatest potential to store large volumes of water. In particular, the San Fernando, Central, and West Coast Basins offer significant potential for storage; however, their use is limited by contamination and the capability to readily recover recharged water.

Groundwater regulation states that recharge cannot negatively impact any existing plumes; however, regulation of contaminated groundwater is complicated because 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, the RWQCB, and the California Department of Public Health (CDPH) Division of Drinking Water. 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 require close coordination among regulatory agencies.

3.3.2. REGULATORY DRIVERS PROMOTING STORMWATER CAPTURE

Recently, several pieces of legislation, policies, and administrative directives that positively impact stormwater capture and storage have been passed on local, regional, and state-wide levels:

- Mayoral Directive Number 5 signed by Mayor Garcetti on October 14, 2014, calls for a 20% reduction in the City's fresh water use by 2017, a 50% reduction in the LADWP's purchase of imported potable water by 2024, and the creation of an integrated water strategy that increases local water supplies and that improves water security in the context of climate change and seismic vulnerability.
- The Enhanced Watershed Management Plans (EWMPs) under development as part of Los Angeles Bureau of Sanitation's (LASAN) compliance with the new LA County MS4 Permit are directly related to the SCMP. LASAN is the lead agency responsible for preparing EWMPs for four watersheds that fall within City boundaries: Ballona Creek Watershed, Santa Monica Bay Beaches, Upper Los Angeles River Watershed, and the Dominguez Channel Watershed. The draft EWMPs were submitted to the Los Angeles Regional Water Quality Control Board on June 29, 2015. One round of comments is expected, and the EWMPs are anticipated to be finalized in the fall/winter of 2015-2016.
- City of Los Angeles LID Ordinance, which became effective in May 2012, requires all development and redevelopment projects that create, add, or replace 500 square feet or more of impervious area to capture the three-quarter-inch rain event for infiltration or reuse on site. Single-family residences can comply in a more simple way by installing rain barrels, permeable pavement, rainwater storage tanks, or infiltration swales.
- County of Los Angeles LID ordinance, which became effective in October of 2008 and was amended in November of 2013, requires the use of LID principles in all development projects except road and flood infrastructure projects.
- 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.
- City of Los Angeles Council Motion 14-0748, Development of draft ordinance that requires all public street construction and reconstruction projects to incorporate Stormwater Management Guidelines for Public Street Construction and Reconstruction
- Assembly Bill No. 1739 would authorize the state board to develop and adopt an interim plan for a probationary basin and would require state entities to comply with this plan. This bill would remove the authority of the local agencies to continue to implement parts of the plan or program that the board determines to be adequate and instead would require the state board to include in its interim plan a groundwater sustainability plan.
- Senate Bill No. 1319 requires a local agency seeking state funds administered by the Department of Water Resources for groundwater projects or groundwater quality projects to do certain things, including, but not

limited to, preparing and implementing a groundwater management plan that includes basin management objectives for the groundwater basin.

- Senate Bill No. 1168 would require the DWR to categorize each groundwater basin as high-, medium-, low- or very-low-priority. This bill would additionally authorize the SWRCB to designate certain high- and medium-priority basins as probationary basins if, after January 31, 2025, prescribed criteria are not met.

In addition, changes in basin management, 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.

3.3.3. REGULATORY DRIVERS IN CONFLICT WITH STORMWATER CAPTURE

Potential conflicts to the SCMP are potentially responsible party (PRP) restrictions, which 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 and restrictions on discharges. In addition, there is a set of RWQCB policies that place strict limits on discharges to groundwater and discharges of groundwater to surface waters. These limitations may restrict the ability to efficiently store and extract captured stormwater. Other considerations that conflict with stormwater capture include outdated methods of describing and delineating liquefaction potential and a lack of knowledge of the locations and extents of expansive and collapsible soils.

4. IMPLEMENTATION SCENARIOS

The overarching purpose of the SCMP is to identify actions LADWP can take to increase stormwater capture. In addition, there are many factors outside the full control of LADWP that will influence how effectively LADWP will be able to implement these actions. Therefore, when developing targets for stormwater capture as part of the development of the SCMP, two scenarios have been considered to create an "envelope" of the range of potential future outcomes. The Conservative Scenario represents a future scenario in which fewer of the supportive conditions are present (i.e. political, financial, social), or a scenario in which other water supplies come to the forefront, such as increased imports or desalination. Given the current trajectory of stormwater capture, it is unreasonable to assume a future condition in which stormwater capture is entirely deprioritized. The Aggressive Scenario represents future conditions that result in an increase in prioritization of stormwater capture from political, financial, and social perspectives. This prioritization would result from a continued increase in the availability of funding for stormwater capture projects, public awareness of stormwater capture, and political will to push a strong stormwater agenda at federal, state, and local levels. However, swift and sustained action on the part of LADWP and its partners is a significant part of realizing either scenario.

The following list shows representative conditions that would support the implementation of the SCMP:

- Increased public/political will for implementation of stormwater projects brought about by:
    - Prolonged drought; and
    - Well-implemented stormwater capture projects.
- Increased availability of funds/financing options:
    - Water bond availability;
    - Public-private-partnerships (P3s) for incentives or funding for projects on public and private land;
    - Cap and trade funds;
    - 1.3 billion dollars to be invested in sidewalk repairs as a result of the settlement from an Americans with Disabilities Act (ADA) lawsuit;
    - Increased incentives from MWD or other water agencies; and
    - Initiation of programs like Property Assessed Clean Energy (PACE) to fund stormwater capture projects.
- New government mandates:
    - City/State water use guidelines in the form of directives;
    - New/more stringent regulations;
    - Increased LID Ordinance;
    - Green Streets Ordinance;
    - New MS4 permit; and
    - Irrigation restrictions.
- Amendments to groundwater basin adjudications that allow cities to take credit for stormwater capture projects (using monitoring OR modeling);

- Advancements in groundwater cleanup; and
- No large-scale commitments to develop new imports or desalination plants.

5. EXISTING AND POTENTIAL STORMWATER CAPTURE

Potential stormwater capture in the City and tributary areas was quantified for the existing conditions and the volume of stormwater that could potentially be captured for aquifer recharge (infiltrated stormwater) and direct use (stormwater captured and used for non-potable demand). Potential stormwater capture could be realized through the implementation of centralized facilities and distributed facilities. Geophysical (infiltration rate, soils, geology, aquifer class, liquefaction potential) and anthropogenic constraints (contaminant plumes, superfund sites, dewatering permits, and heavy industrial land use) were considered in this analysis to ground this estimate in the reality of the physical and political landscape of the City and establish attainable goals for stormwater capture. As discussed in the previous section, two future scenarios with regards to stormwater capture (Conservative Scenario and Aggressive Scenario) were considered to establish a range of potential capture.

This section summarizes:

- The delineation of the subwatersheds;
- The two hydrologic models used;
- The quantification of existing capture, the constraints, opportunities, priorities; and
- The methods used to develop scenarios for potential capture, and the quantification of potential capture under these future scenarios.

The results estimate the long-term (by 2099) potential average annual capture volume for each scenario broken down by aquifer and between distributed capture and centralized capture. According to modeling analysis, which is described in detail in the following sections, the fraction of the incoming flow to the City[2] (831,000 acre-feet) that is currently being captured in centralized and incidental passive distributed infiltration into water supply aquifers is 6% (64,000 acre-feet). The long-term future potential capture was estimated to be 22% (179,000 acre-feet), and 31% (258,000 acre-feet) under the Conservative and Aggressive Scenarios, respectively. 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 3).

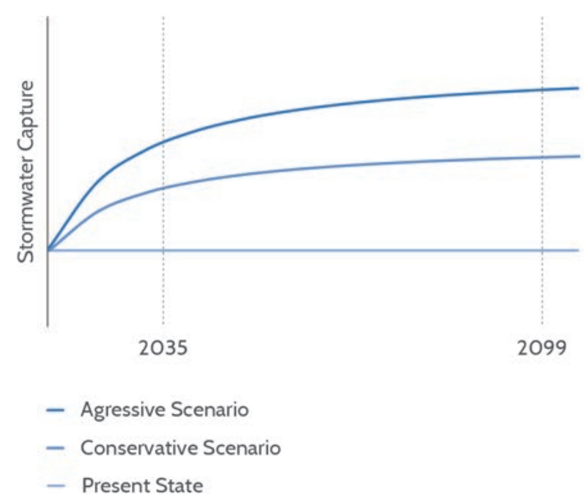

Figure 3. SCMP Potential Capture Volume

2. Incoming flow includes precipitation, run-on from areas tributary to the City, and applied irrigation.

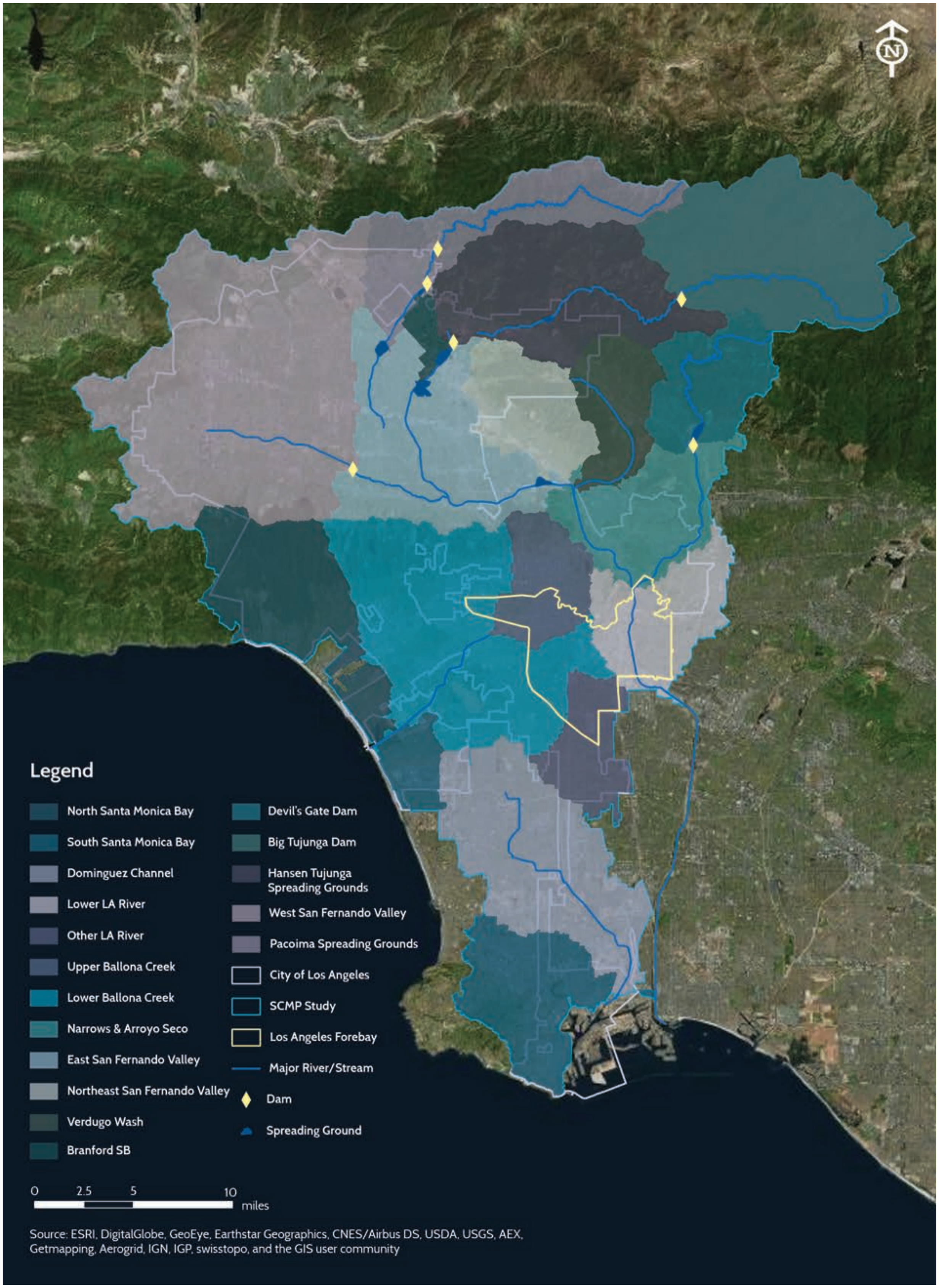

Figure 4. Subwatersheds Within the SCMP Study Area

5.1. SUBWATERSHED DELINEATION

In order for stormwater capture potential results to be meaningfully interpreted and to allow for distinct regions to be handled differently within the model, the entire study area was divided into 17 regional subwatersheds, 15 of which are within the City (Table 3).

The LA County LSPC model includes 1,001 sub-basins that were grouped into 17 regional subwatersheds using major watersheds, centralized facilities, the river network, and aquifer delineations (Figure 4). Major watersheds were the first delineated, so that each regional subwatershed is contained within a single watershed (Ballona Creek, Los Angeles River, etc.). Next, these groupings were subdivided into areas that were tributary to centralized facilities (dams and spreading grounds). 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 in its own regional subwatershed.

Table 3. Regional Subwatershed Attributes

Regional Subwatershed	Total Watershed Area (Acres)	Area Within City (Acres)	Total Percentage of Impervious Area	Percentage of Impervious Area Within 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 Spreading Grounds	45,492	11,485	5%	19%
Lower LA River	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 Santa Monica Bay/Peninsula	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 LA River	14,393	10,566	61%	62%

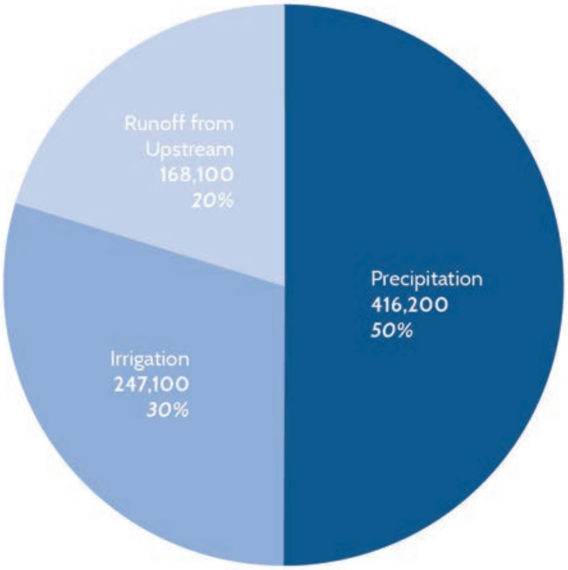

Figure 5. Incoming Flow Distribution in the City of Los Angeles (Outdoors)

The underlying aquifers were then used to further divide regional subwatersheds. For example, Ballona Creek watershed was split into the Upper Ballona Creek subwatershed and the Lower Ballona Creek subwatershed using the location where the river network left the bounds of the Los Angeles Forebay. Finally, remaining coastal areas that were not part of a major watershed were grouped by location into two regional subwatersheds.

5.2. EXISTING CAPTURE

Two watershed models were used to estimate the existing stormwater capture occurring in the City both in centralized facilities, such as spreading grounds, and as incidental distributed capture on pervious surfaces. The primary model was Los Angeles County's LSPC model because it is constructed with all of the major centralized facilities in place, calibrated to runoff for the study area, and can simulate the routing, drainage networks, storage in dams, and infiltration in spreading grounds. The second model used to corroborate the LSPC results was the GWAM because it models evapotranspiration and recharge more

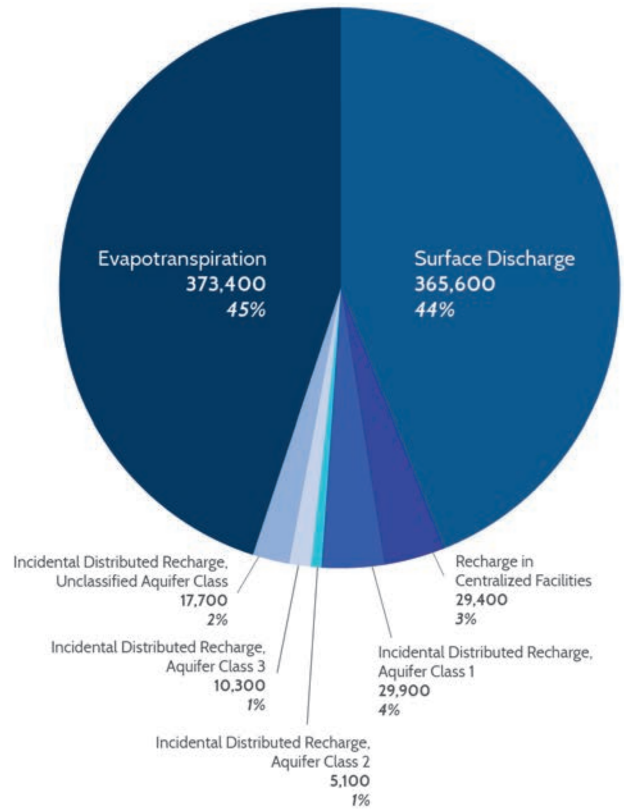

Figure 6. Outgoing Flow Distribution in the City of Los Angeles (Outdoors)

robustly than LSPC, though it does not have the ability to simulate flow routing. Based on an analysis of the results of the two models for overlapping areas, it was determined that all components of the water balance agreed well with each other except for the split between evapotranspiration and recharge of captured rainfall. Therefore, the fraction of the captured water that reached deep groundwater in LSPC was adjusted until it matched the results of GWAM.

An average annual volume of 831,400 acre-feet of water entered the city as precipitation, irrigation, or runoff from upstream areas and left either as evapotranspiration, capture in centralized facilities, incidental capture on pervious surfaces, or as runoff downstream (Figure 5 and Figure 6). Approximately 11% (92,000 acre-feet) of the total incoming water currently goes to recharge aquifers, which is

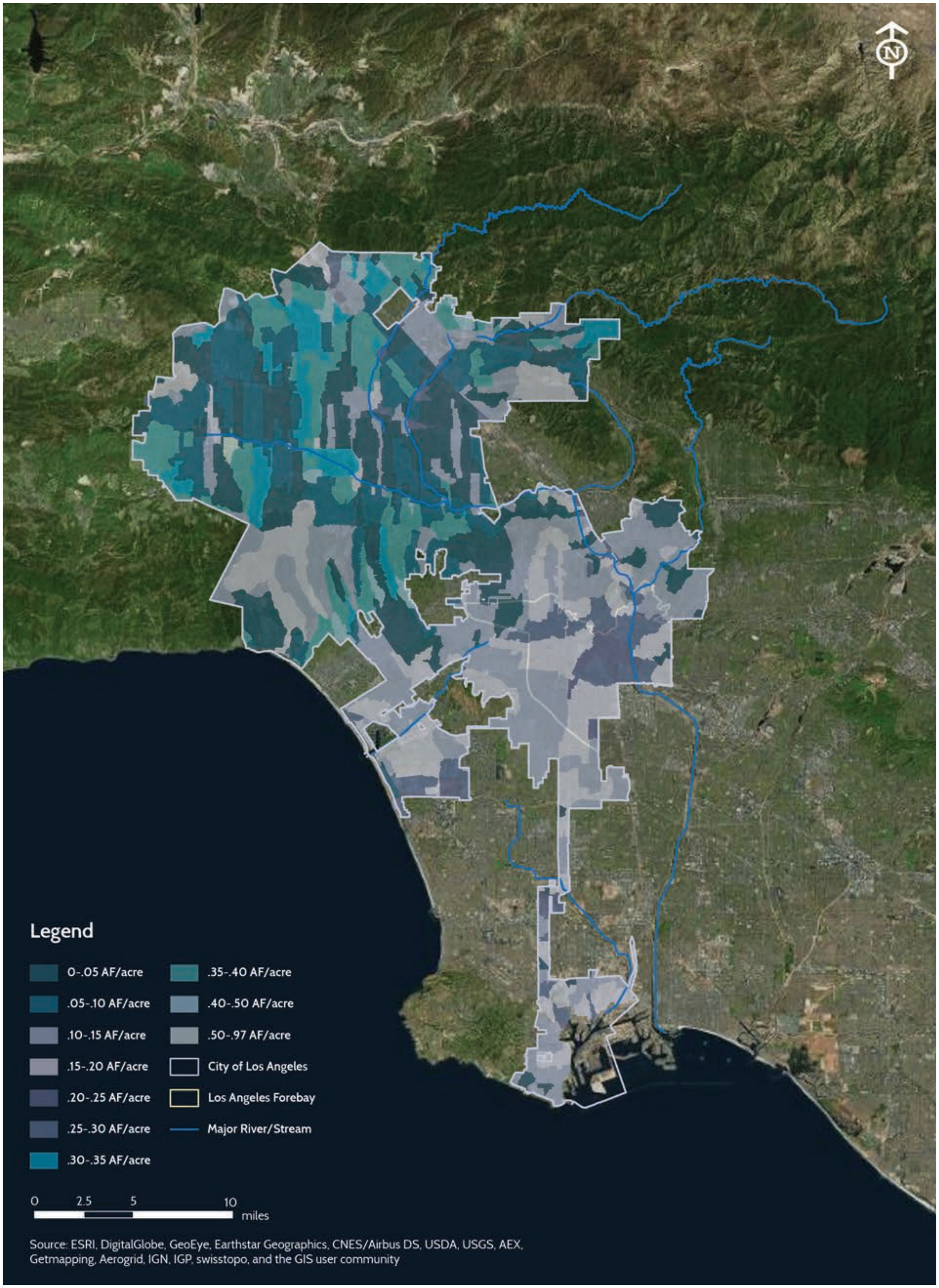

Figure 7. Existing Incidental Distributed Recharge in the City of Los Angeles

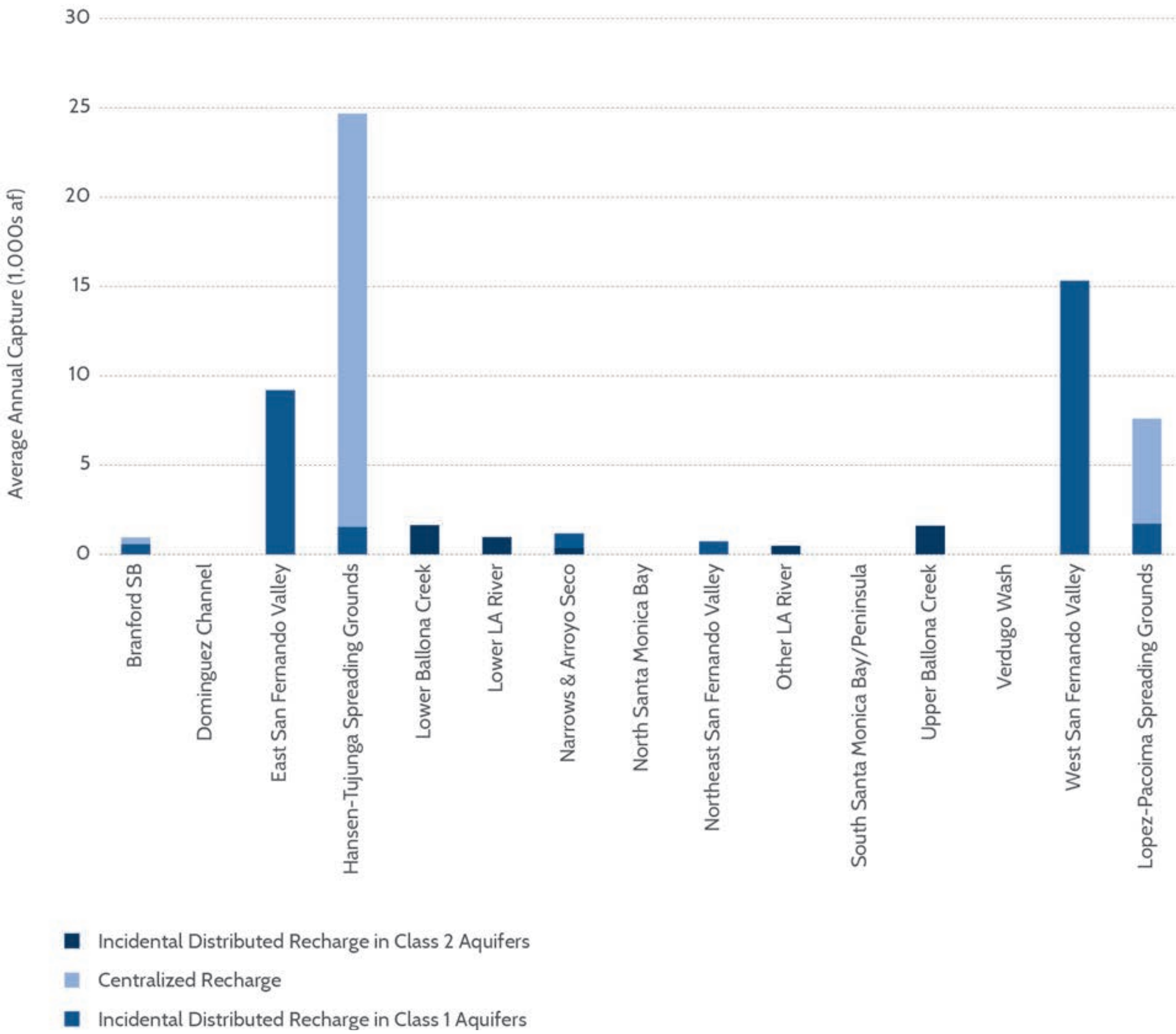

Figure 8. Recharge by Subwatershed in Existing Conditions

split between centralized facilities (29,000 acre-feet) and incidental distributed capture[3] (63,000 acre-feet). However, only 35,000 acre-feet per year of the incidental capture is being recharged into water supply aquifers. The remaining 28,000 acre-feet per year is infiltrating into soils above confined aquifers.

Water currently being infiltrated incidentally above confined aquifers does not constitute an existing supply, though it could potentially contribute to LADWP's water supply portfolio if LADWP established pumping, treatment, and distribution in the future.

Figure 7 shows a geographical distribution of where incidental infiltration is occurring, with most occurring in the San Fernando Valley. Figure 8 shows the volume of average annual incidental distributed capture in the subwatersheds that can contribute to water supply. Volumes are based on the average annual precipitation for the period of record,

3. Incidental distributed capture refers to capture that is a result of passive infiltration into pervious areas throughout the City, rather than through stormwater capture projects. Distributed stormwater capture projects currently do not contribute a significant volume of recharge.

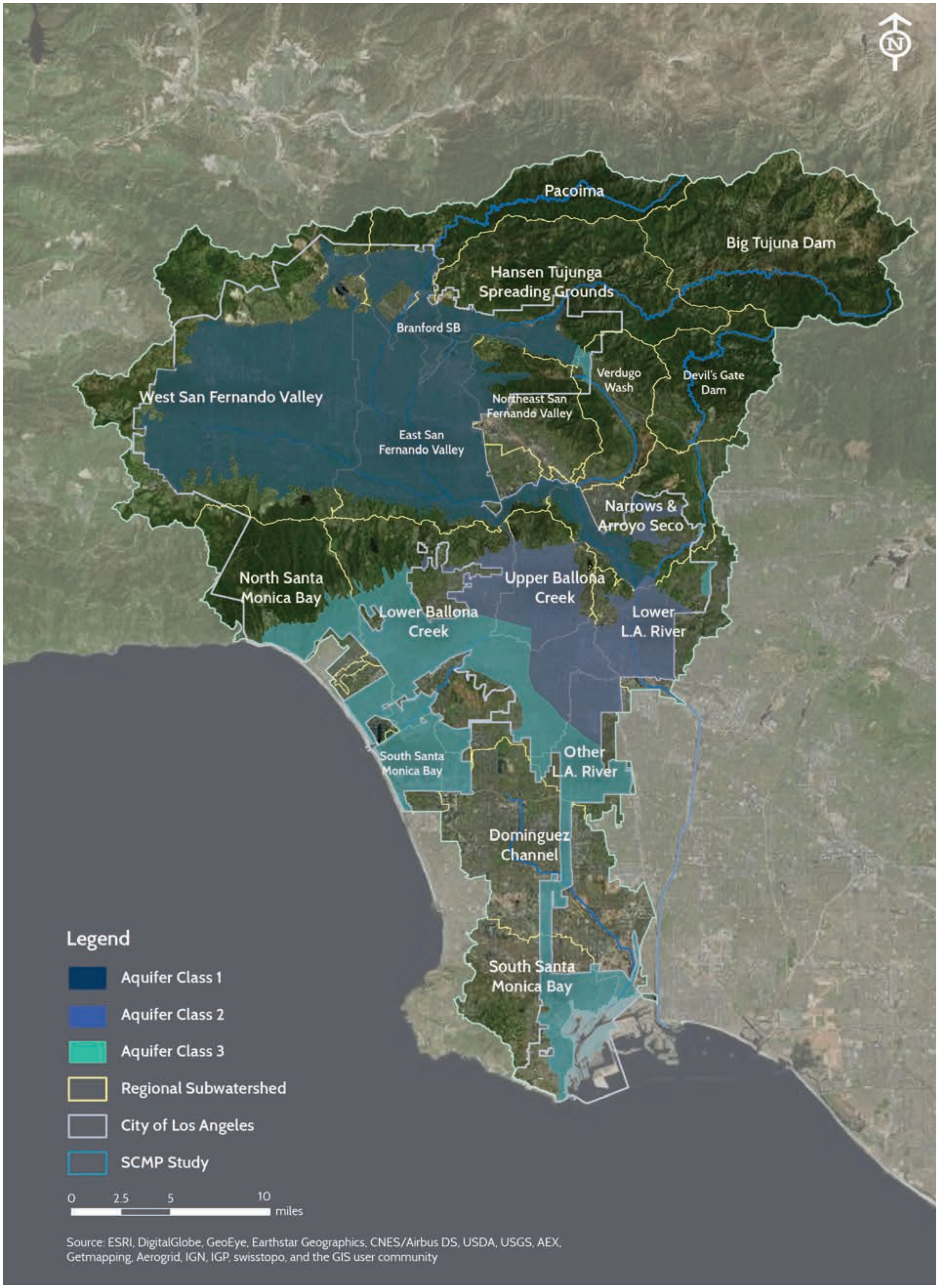

Figure 9. Aquifer Rankings by Usability Within the City of Los Angeles

1988 to 2011. More information, including description of aquifer classes and references, can be found in Appendix F.

5.3. POTENTIAL CAPTURE

The purpose of this analysis was to determine how much of the inflow to the City could realistically be captured in centralized facilities (e.g. spreading grounds), distributed infiltration BMPs (e.g. rain gardens), incidental recharge on pervious land, and direct use storage facilities (e.g. cisterns). This analysis identified which areas are most feasible for BMP implementation, defined two future BMP implementation scenarios (conservative and aggressive), and modeled those scenarios to determine how much capture is attainable.

5.3.1. CONSTRAINTS/ OPPORTUNITIES/PRIORITIES

Each area of the City was first analyzed for its geophysical properties to determine where obstacles to infiltration exist and where infiltration would be most desirable. Such properties included areas of mapped landslides or liquefaction potential, depth to groundwater, slope, hydrologic soil group, and geology (pervious or impervious).

An aquifer classification system was also developed to guide prioritization. Each aquifer underlying the City was classified according to the ability of the City to pump the aquifer for use in their distribution network (Figure 9). Aquifer classification was used to categorize existing and potential recharge by aquifer, prioritize capture facility implementation, and determine the most appropriate type of capture. Aquifers under LADWP's control were assigned to Class 1 and are all located in the San Fernando Valley. Aquifers under regional control, but still potentially usable for the City, were assigned to Class 2 and are located near the Los Angeles Forebay near Glendale, Pasadena, and Hollywood. Perched aquifers or aquifers unlikely to be usable for the City were assigned to Class 3 and are located primarily in the western and southwestern portions of the City near the coast. Areas without underlying aquifers, such as mountain ranges, were unclassified. For the purposes of the SCMP, only recharge to Class 1 and Class 2 aquifers was included in existing and potential recharge, as these are likely to be the only locations where recharge will be beneficial to the City.

Each sub-basin in the model was assigned a Category A, B, or C depending on its combination of geophysical obstacles and opportunities and aquifer class. Areas categorized as "A" were those having the fewest hydrogeologic constraints (i.e. few obstacles to infiltration, highly infiltrative soils, permeable aquifers) and were overlying the highest priority aquifers. These would be most conducive to infiltration BMPs. Category "B" areas were somewhat geologically constrained and overlying mid-level priority aquifers. These areas were also considered suitable for infiltration BMPs. Category "C" areas contain obstacles to infiltration and/or were overlying low-priority aquifers, making them more conducive to direct use BMPs. Figure 10 shows the geographic distribution of the three geophysical categories.

Obstacles to infiltration that are manmade (anthropogenic constraints), and thus could potentially be addressed in the future, were also mapped for the entire City (Figure 11). These obstacles included contaminant plumes, superfund sites, dewatering permits, and heavy industrial land uses. Under the Conservative Scenario, these obstacles were assumed to remain, and those areas considered off-limits. Under the Aggressive Scenario, it was assumed that these obstacles were removed. Areas of the City impacted by any of these will not be conducive to infiltration until they are mitigated. In the Conservative Scenario, constrained areas that would have otherwise

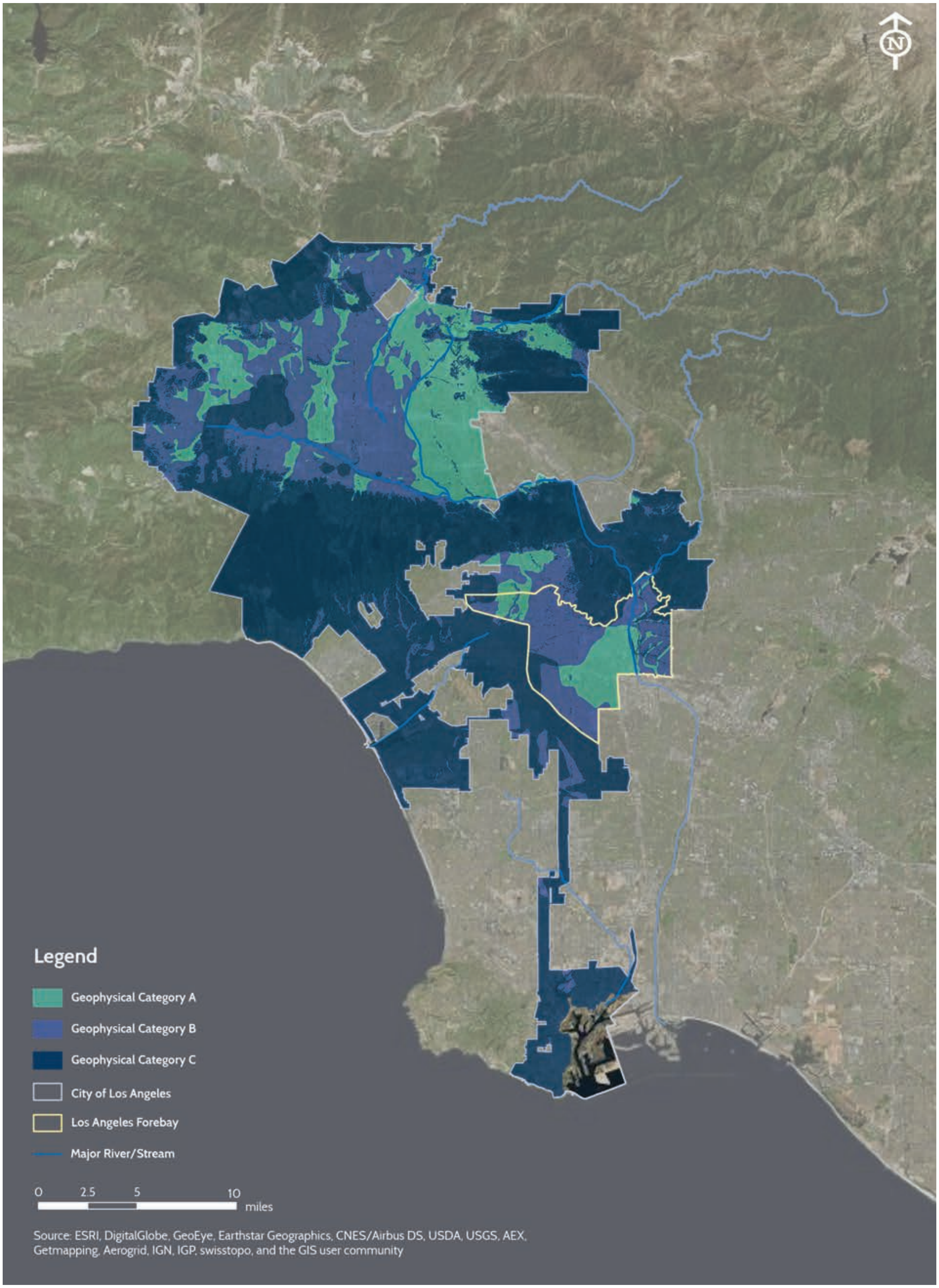

Figure 10. Geophysical Categorization of the SCMP Study Area

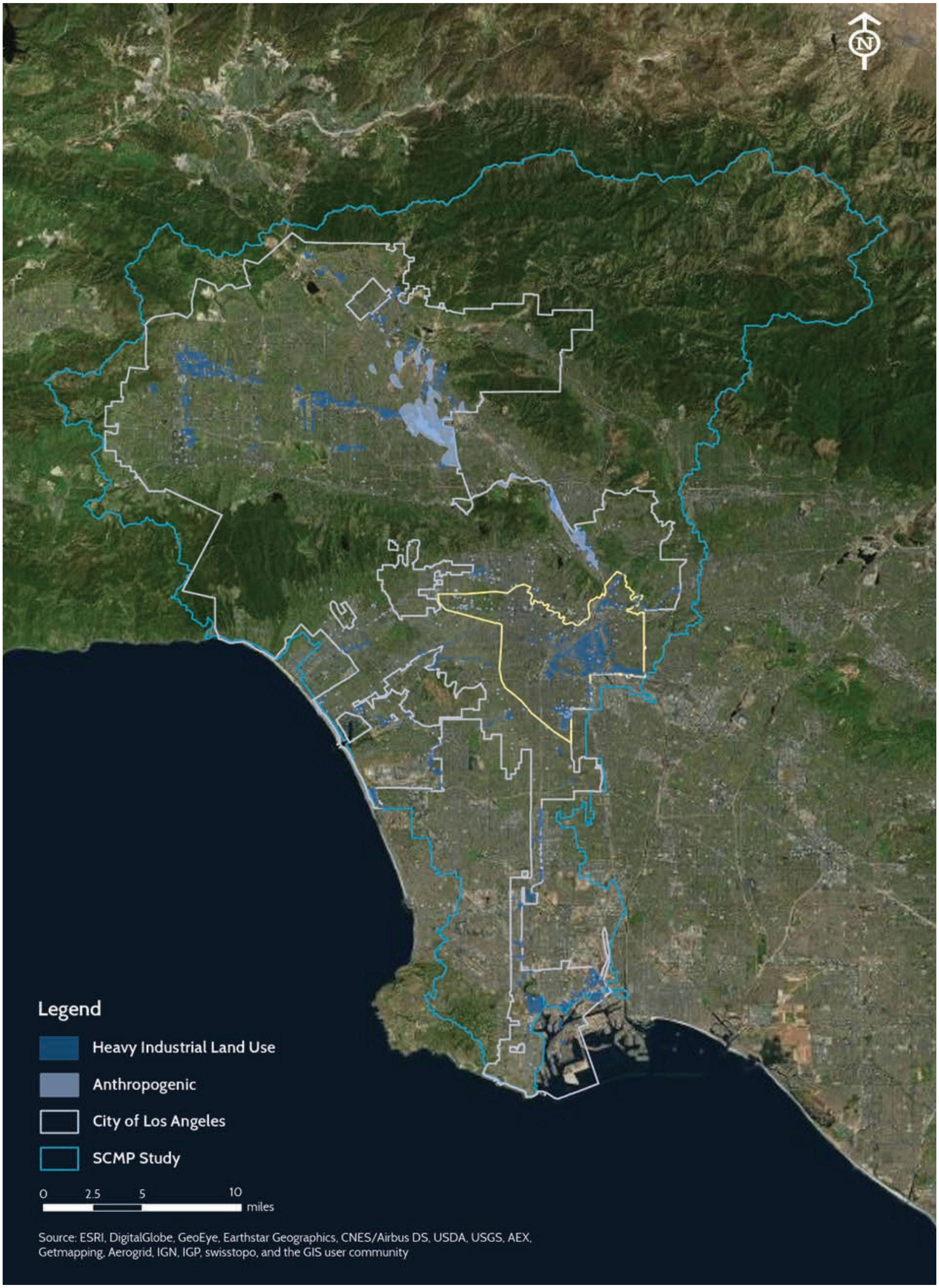

Figure 11. Anthropogenic Constraints in the SCMP Study Area

been considered good opportunities for aquifer recharge were reclassified to areas more suited to direct use BMPs, such as collecting stormwater in cisterns for use in irrigation. In the Aggressive Scenario, these constraints did not impact opportunity.

5.3.2. BMP IMPLEMENTATION RATES

Two future stormwater capture scenarios were developed that assumed different implementation rates of BMPs for different land uses. Implementation rate estimates made by an expert panel for the Los Angeles County Basin Study were used as a basis for scenario development, as shown in Table 4 (LACDPW, 2013). The anticipated sizing of the BMPs was adjusted based on the geophysical categories, assuming that more capture will take place where it is more desirable and/or less constrained. BMP sizes of 1.5, 1.2, and 1 times the 85th percentile storm depth were applied for categories A, B, and C, respectively.

Table 4. Water Augmentation Study: WAS-TAC Expert Consensus on Reasonable BMP Implementation Rates by 2095

Land Use Description	Percentage 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 drawdown time for BMPs was also a function of the geophysical category, with drawdown times of 24 hours, 48 hours, and 15 days for category A, B, and C areas, respectively.

In the Conservative Scenario, anthropogenic constraints were not assumed to be mitigated, so areas mapped as being anthropogenically constrained were considered only available for direct use BMPs. The distributed BMP implementation rates for geophysical Category C areas were set at 50% of the Category C areas for the Aggressive Scenario. These baseline implementation rates were increased for areas in Categories A and B, as was done in the Aggressive Scenario (Table 5). The volume of the remaining runoff captured in centralized facilities was half of what was in the Aggressive Scenario (30% for Class 1 and Class 2 aquifers and 15% for Class 3 aquifers).

Table 5. BMP Implementation Rates for 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%

For the Aggressive Scenario, the implementation rates for Category C areas were taken directly from the WAS-TAC implementation estimates. These baseline implementation rates were increased by 10% for areas in Geophysical Category B and an additional 10% for Geophysical Category A, with the assumption that implementation rates would be higher in areas that were prioritized for stormwater capture (Table 6). After consideration of the incidental distributed capture and distributed BMPs, centralized facilities were assumed to capture 60% of the remaining runoff in subwatersheds overlying Class 1 and 2 aquifers and 30% in subwatersheds overlying Class 3 aquifers. In this scenario, it was assumed that anthropogenic constraints were addressed and did not create impediments to implementation.

Table 6. BMP Implementation Rates for 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%

To model these scenarios, a method was developed to simulate the implementation of the various distributed BMPs into the 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 gauges), sizes, and drawdown times to create a long-term average annual capture rate nomograph for 7,100 different scenarios. These unit models were then scaled up (or down) for any size of contributing impervious area to the BMP. These nomographs illustrate that the capture rate increases with BMP volume, but as the BMP volume increases, the relative increase in capture rate decreases. Beyond the "knee" of the curve, additional BMP volume (and therefore cost) provide diminishing returns in terms of capture rate. Figure 12 depicts one of these nomographs.

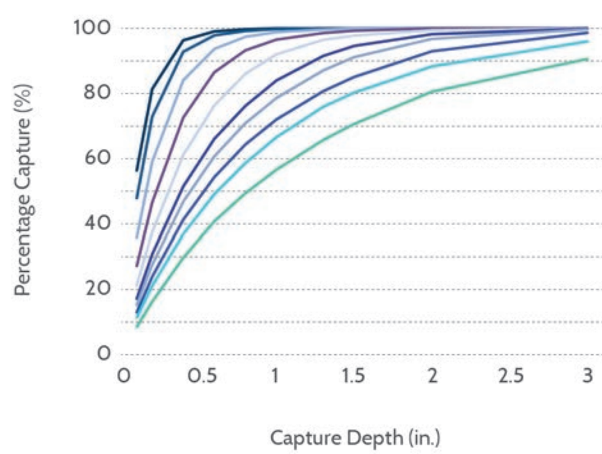

Figure 12. Sample Nomograph–LAX Rain Gauge

The percent of volume captured obtained from these nomographs was 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 sub-basin.

5.3.3. RESULTS

Figure 13 shows the long-term (by 2099) potential average annual capture volume for each scenario broken down between distributed capture and centralized capture. Distributed capture is further broken down between that occurring over Class 1 or Class 2 aquifers, which would be most suitable for infiltration type capture, and that occurring over Class 3 or unclassified aquifers, which would be more suited for direct use type capture. The fraction of the incoming flow to the City that would be captured and usable by the City is 8% (64,400 acre-feet), 20% (169,000 acre-feet), and 31% (258,000), under the existing, Conservative, and Aggressive Scenarios, respectively. This represents a captured volume of approximately double and triple the existing volume in the Conservative and Aggressive Scenarios, respectively. As in the existing condition, most of the distributed recharge, and most of the

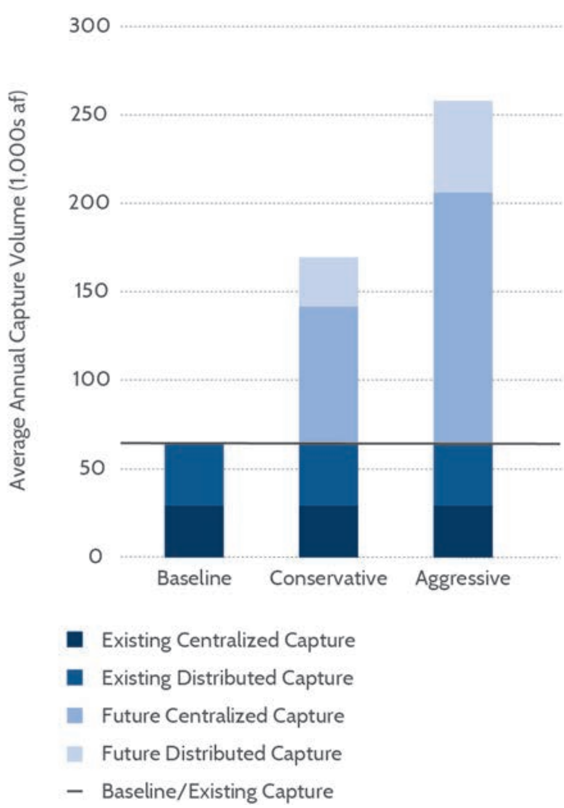

Figure 13. Potential Stormwater Capture by 2099

increase in recharge, will take place in the San Fernando Valley and the Los Angeles Forebay area under all scenarios, reflecting well suited infiltration characteristics and the prioritization of Class 1 and Class 2 aquifers.

5.3.4. CLIMATE CHANGE

Because the LSPC model uses historic rainfall data, it cannot account for the anticipated effects of climate change. The 47 preliminary climate change prediction results from the Los Angeles County Basin Study were reviewed to estimate the impacts that climate change may have on the anticipated capture. While the range of effects varies widely, generally speaking, climate change will not greatly affect total precipitation volumes, but will cause the total volume to come in more large storms and fewer small storms in the Los Angeles area (USBR, 2013). Temperatures are also expected to increase, which in turn would also increase evapotranspiration. 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.

6. STORMWATER CAPTURE ALTERNATIVES

The purpose of developing stormwater capture potential as part of the SCMP is to: (1) identify the stormwater capture potential spatially across the City; (2) identify potential stormwater capture alternatives and siting opportunities for these alternatives; (3) estimate the feasible range of water supply benefits and costs (per acre-foot of capture) associated with each stormwater capture alternative; and (4) estimate some of the ancillary benefits of each alternative, including water quality improvement, peak flow attenuation, and the potential addition of green space.

Stormwater capture alternatives identified include both centralized projects and distributed programs. The methods for identifying opportunities and estimating costs and benefits of both types of alternatives are described in the following sections.

6.1. CENTRALIZED PROJECTS

A comprehensive list of centralized project alternatives was compiled from a review of previously completed stormwater capture studies (with particular focus on the Tujunga Wash Watershed Groundwater Recharge Master Plan), LADWP's current list of centralized projects, new project concepts developed by the Geosyntec Team, and input from the TAT, key stakeholders, and the general public. These centralized stormwater capture alternatives were identified for potential inclusion in the final SCMP. Potentially feasible alternatives were evaluated and scored based on criteria developed by the SCMP Project Team, including water supply benefit, cost, ownership, compatible uses/ partnership opportunities, and operating costs.

Project fact sheets were developed for 10 of the identified projects, and concept design reports and Scope of Work (SOW) documents were prepared for three of the projects.

- Arundo Donax Removal Project–Phases I and II
- Big Tujunga & Pacoima Dam to LA Filtration Plant
- Big Tujunga Dam Sediment Removal
- Big Tujunga Dam Seismic Retrofit
- Boulevard Pit Multiuse
- Branford Spreading Basin Upgrade
- Bull Creek Pipeline
- Cal Mat Pit
- Canterbury Power Line Easement
- Debris Basin Retrofit #1 (pilot), #2, and #3.
- East Valley Baseball Park (Park Retrofit #2 and #3)
- Hansen Dam Water Conservation Project
- Hansen Spreading Grounds Upgrade
- LA Forebay Recharge System (LAR Pilot, LAR Full Scale, and Upper Ballona)
- Lakeside Reservoir (Options A and B)
- Lopez Spreading Grounds Upgrade
- North Hollywood Power Line Easement
- Old Pacoima Wash
- Pacoima Dam Sediment Removal
- Pacoima Spreading Grounds Upgrade
- Rory M Shaw Wetlands Park Project (Strathern)

- San Fernando Road Swales
- Sepulveda Basin–Hansen SG Pipe Line 54"
- Sheldon Pit Multiuse
- Sheldon-Arleta Gas Management System
- Silver Lake Stormwater Capture Project
- Spreading Grounds Optimization
- Storm Drain Mining (Treat and Inject / Treat and Directly Use)
- Tujunga Spreading Grounds Upgrade
- Valley Generating Station Stormwater Capture (Phases I and II)
- Van Norman Stormwater Capture
- Van Nuys Airport
- Whiteman Airport
- Whitnall Hwy Power Line Easement
- Whitsett Sports Fields Park Retrofit

6.1.1. PROJECT EVALUATION

To guide LADWP in prioritizing projects, evaluation criteria were developed and subsequently refined to score each of the projects. The ranking criteria included items such as stormwater capture potential and cost, as well as ownership and partnership opportunities. Each of these criteria was weighted based on its relative importance to LADWP. A complete list of the evaluation criteria, scoring guidelines, and criteria weighting is included in Appendix G.

6.1.2. CONCEPT DESIGNS

The ranked projects were reviewed by the SCMP Project Team. Those with the high scores but with minimal existing design information were selected for concept design development:

- East Valley Baseball Park;
- Old Pacoima Wash; and
- Canterbury Power Line Easement

It is noted that while some projects are underway, and most projects are feasible and will be explored in the future, concept reports were only developed for three projects (per the SCMP scope of work). These reports include information on concept-level cost estimates and implementation schedules, environmental considerations, and funding opportunities. Additionally, LADWP's standard SOW document was prepared for each project to assist LADWP with beginning the process for implementation. A summary of each of the three projects is provided below, and the Concept Reports and SOW Documents are provided in Appendix H.

6.1.2.1. East Valley Baseball Park

The proposed East Valley Baseball Park Infiltration System Stormwater Capture Project would modify approximately 9 acres of land to construct three infiltration basins. The infiltration basins would receive and retain stormwater from the Tujunga Spreading Grounds (TSG) and tributary flows from a local storm drain (Figure 14). Construction of the infiltration basins would include the installation of diversion structures, inlets, weir box outlets, riprap aprons, reinforced concrete pipe (RCP), flow measuring devices, educational signage, and access roads. The basins would vary from 7 to 10 feet in depth for optimal retention.

The facility could be operated by the City or possibly by the LACFCD for stormwater recharge, similar to surrounding proposed projects and the TSG.

The infiltration rate at TSG is 1.89 inches/hour, or 3.78 feet/day, which is assumed to be the same for the East Valley Baseball Park. When completed, this project would add a storage volume of approximately 60 acre-feet, with an approximate total percolation rate of 17 cubic feet per second (cfs). The East Valley Baseball

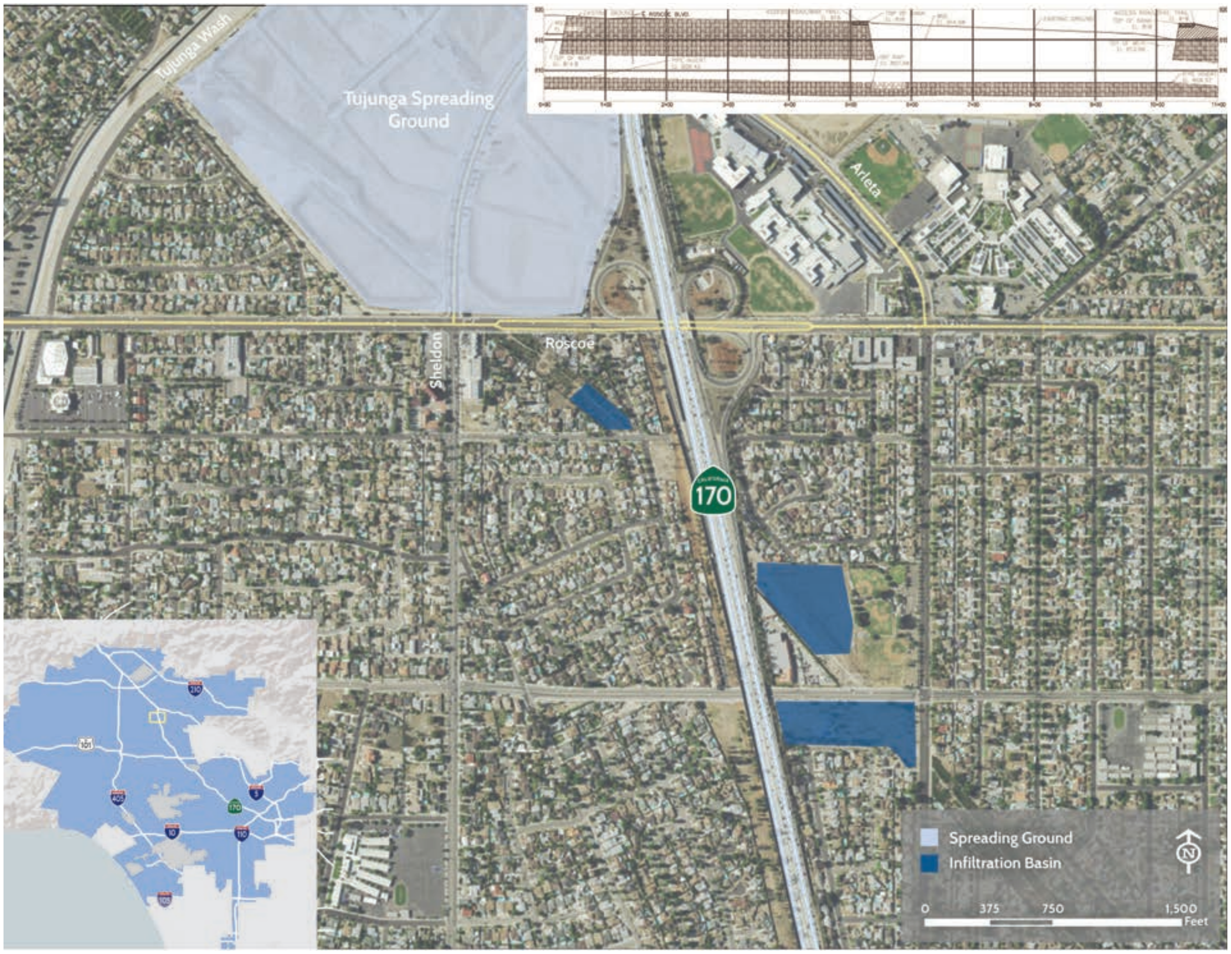

Figure 14. East Valley Baseball Park

Park Infiltration System project is estimated to yield an annual recharge benefit of 174 acre-feet annually from local runoff and potentially capture another 1,000 acre-feet through the TSG.

The proposed ROW basins would 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 would increase over the existing operation costs at the TSG.

6.1.2.2. Old Pacoima Wash

The Old Pacoima Wash Stormwater Infiltration Project would involve construction of multiple infiltration basins in an approximately two-mile stretch of the Old Pacoima Wash. Each infiltration basin would receive and retain stormwater from the upstream Pacoima Spreading Grounds (PSG) and would act as an extension of the spreading grounds (Figure 15). Local flows would also be captured, which would require modifications to storm drain lines. In addition, approximately 600 catch basins would need to be retrofitted with trash screens, if these modifications have not been completed under the City of Los Angeles Trash Total Maximum Daily Load (TMDL) Compliance Method: Structural Measures, Bureau of Sanitation Watershed Projection Division, September 2011. Modifications to the Old Pacoima Wash would include the removal of

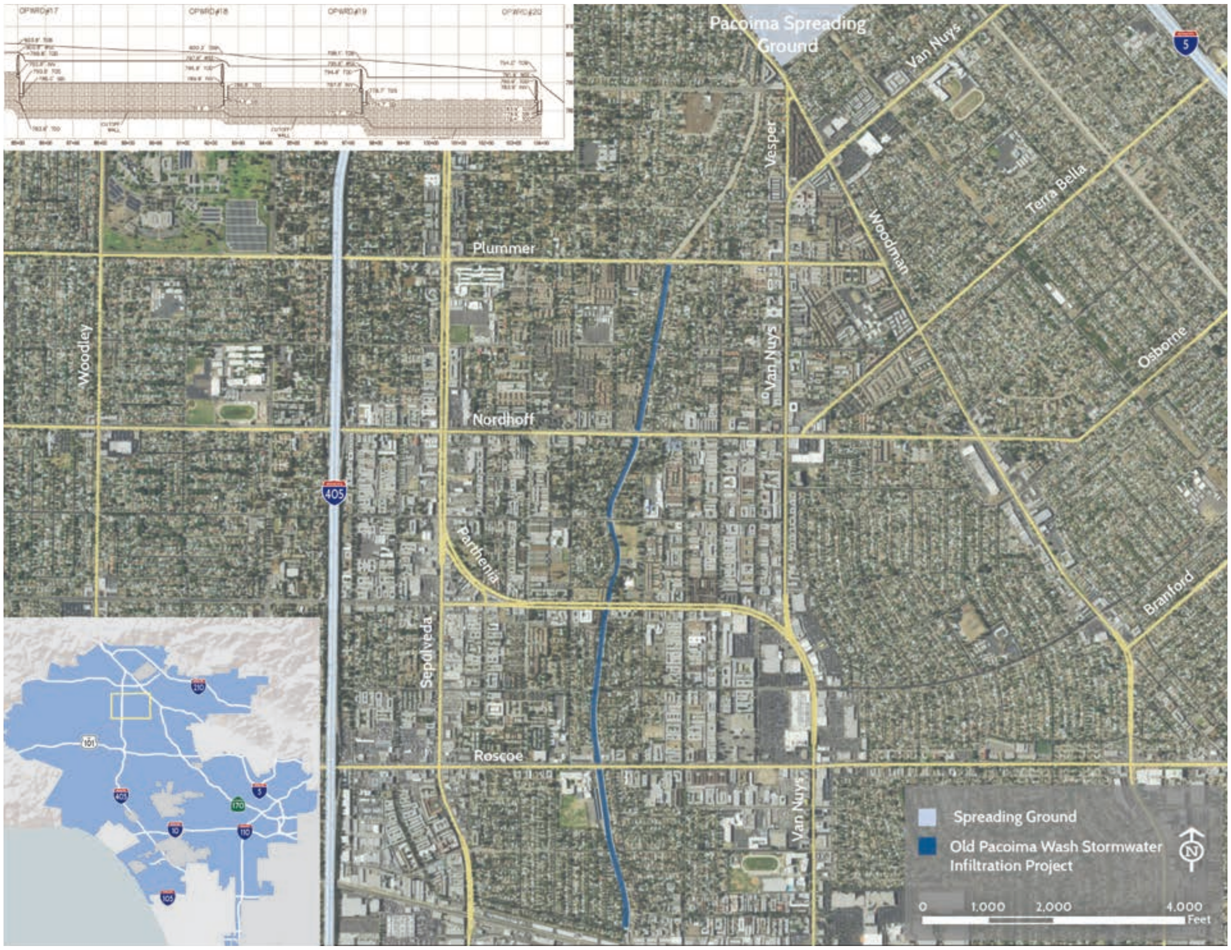

Figure 15. Old Pacoima Wash

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.

Both the PSG and Old Pacoima Wash are owned and operated by the LACFCD. It is expected that funding arrangements would be required for construction and potentially for maintenance as well.

Stormwater infiltration would be determined by the LACFCD. For small storms, it is expected that the basins would be filled from the downstream to the upstream end by raising dams sequentially as downstream basins filled. In order to dry some basins for maintenance or vector issues, a filling pattern from upstream to downstream could be completed with water from PSG. Having the system automated and on telemetry would improve stormwater capture and operations. All rubber dams and stilling basins would be sized to pass the design flows for the channel with the dams in the deflated position. All infiltration basins would be designed and sized to completely infiltrate within 48-72 hours following a storm event.

Constructing the Old Pacoima Wash Project would yield an estimated annual recharge benefit of 380 acre-feet annually from local runoff and the potential to capture another 1,000 acre-feet through the PSG.

The proposed infiltration basins would 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 would be expected to increase as compared to the existing operation costs at the PSG.

6.1.2.3. Canterbury Power Line Easement

Canterbury Avenue Power Line Easement Stormwater Capture Project would modify the 18.8 available acres of Canterbury Avenue Power Line Easement to construct 24 recharge basins. The recharge basins would receive and retain stormwater from the adjacent PSG and local flows from the neighboring tributary area between the Pacoima Diversion Channel and the Canterbury Power Line Easement (Figure 16). Construction of the recharge basins in the Easement would include the installation of inlets, weir box outlets, riprap aprons, RCP, flow measuring devices, educational signage, and access roads. The basins would vary in depth from 7 to 10 feet for optimal retention. Local flow capture would require modifications to the LACFDC's storm drains and the addition of 26 catch basins with screen inserts to divert, capture, and pre-treat tributary flows. 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 PSG.

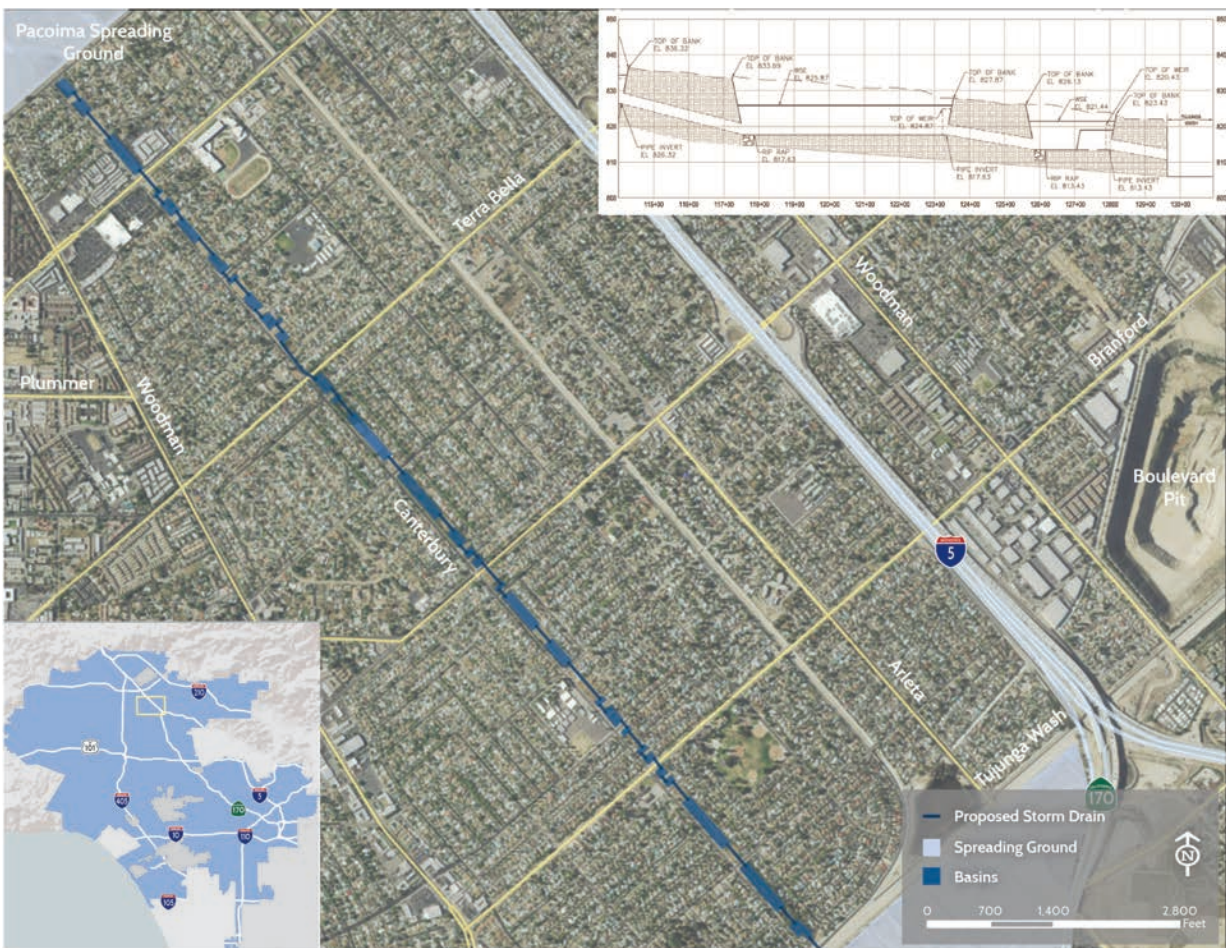

Figure 16. Canterbury Power Line Easement

Although the basins would capture local runoff, the connection to PSG would require coordination with the LACFCD. Similar to the TSG, these proposed improvements can be managed where the facility is owned by LADWP and the LACFCD operates the facility for stormwater recharge. A maintenance plan and agreement with the LACFCD should be developed to define responsibilities by agency.

The proposed project would include a bypass line constructed between PSG and one of the proposed Canterbury Power Line Easement recharge basins. The bypass line would provide flexibility in operating the basins as a set of recharge batteries. This would allow the two sets of basins to be filled, drained, and dried independently, providing important flexibility for maintenance of the basins, as well as for emergency maintenance of the power lines.

6.2. DISTRIBUTED PROGRAMS

To identify stormwater capture program opportunities and evaluate their costs and benefits, an emphasis was placed on flexibility such that the widest possible variety of programs could be evaluated based on their implementation in different areas throughout the City in order to guide development of the final SCMP implementation strategy. To this end, stormwater capture programs were grouped into program types, and an analytical framework, termed the SCMP Evaluation Framework (the Framework), was developed that allows each program to be evaluated under a range of different implementation scenarios. The inputs into the Framework include performance estimates for individual programs, program costs, opportunity areas, and geographic information describing climate and physical conditions. The outputs include cost per acre-foot of capture, water quality improvements, and acres of added green space for each program under the specified conditions. Additionally, a tool was developed to allow the Framework to be run in a "batch processing" mode, which outputs the relative opportunities of each program Citywide.

Results based on the comparison between programs completed indicate that subregional programs offer the most opportunity area for implementation. Infiltration programs, especially subregional infiltration, offer the lowest cost per unit volume captured, while impervious pavement replacement offers the highest. However, all of the programs have overlapping ranges of cost efficiencies, with each offering high-cost effectiveness in certain situations. Direct use programs offer a relatively high cost per unit volume captured, but this is partly due to the distribution and treatment requirements not necessary for infiltration programs. Impervious pavement replacement has the potential to capture the most volume per acre treated, because there exists an extensive implementation area. Infiltration programs offer a higher capture volume per unit acre than direct use programs, primarily because direct use programs have longer drawdown times. This section:

- Summarizes the steps taken to get to these results through development of various components of the SCMP Evaluation Framework;
- Compares the costs and benefits of each program using the Framework; and
- Discusses conclusions that can be drawn from these results that were used to guide the implementation planning process.

A more detailed description of this work is provided in Appendix J.

6.2.1. DEFINITION OF STORMWATER CAPTURE PROGRAMS

Six stormwater capture program types were considered in developing stormwater capture alternatives. Program types were intended to be general so they would be inclusive of the possible programs that could be implemented within the City. For this reason, programs were grouped into two general categories: type of capture (infiltration or direct use) and potential tributary area (self-mitigating, on-site, streets, subregional). Each program type was subdivided into subcategories in which they might be applied. For example, the on-site infiltration program covers all programs in which a BMP located on a particular property captures and infiltrates runoff generated on that same property. Program type subcategories refer to the land use on which a BMP can be located; whereas, the opportunity area refers to the contributing land use (or land uses) that contribute runoff into the BMP. In the case of on-site stormwater capture program types, program type subcategory is the same as land use. However, green streets and subregional BMPs receive runoff from additional areas other than the parcel on which the BMP is located.

Each program type could be implemented using a variety of BMPs. For example, the on site infiltration programs could include rain gardens (for a residential rain garden program), infiltration galleries, or permeable pavement (for a parking lot retrofit program). The flexibility to implement various BMPs as part of a program is considered necessary to ensure that suitable options are available for a wide range of site types and conditions. Brief descriptions of each program type are provided below, and they are summarized in Table 7.

6.2.1.1. Self-Mitigating BMPs

Self-mitigating BMPs are designed to infiltrate water that directly falls on them rather than collect runoff from a larger tributary area. The applicable BMPs for this program in the context of the SCMP include self-mitigating permeable pavement. While permeable pavement can be designed to capture runoff from a larger tributary area, a self-mitigating permeable pavement system can be less extensive, requiring less excavation and materials, leading to less cost. Although these BMPs cannot capture runoff from larger areas, they can be applied over a large area and have a significant cumulative impact. Example programs include a driveway and patio retrofit program for single- and multi-family land uses, a schoolyard retrofit program for educational land uses, and a parking lot retrofit program for commercial and industrial land uses.

Table 7. Distributed Stormwater Capture Program Types

Program Type	Subcategory	BMPs	Specific Program Examples
Self-Mitigating BMPs	Single-Family Residential	Self-Mitigating Pervious Pavement	Driveway, patio, and walkway retrofit program
	Multi-Family Residential		Driveway, parking lot, patio, and walkway retrofit program
	Commercial		Parking lot retrofit program
	Institutional		Parking lot/courtyard retrofit program
	Industrial		Loading dock and parking lot retrofit program
	Educational		School yard retrofit program

Table 7. Distributed Stormwater Capture Program Types

Program Type	Subcategory	BMPs	Specific Program Examples
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 with Tributary Area, Simple On-site Rain Garden, Dry Wells	Green streets program in commercial corridors
	Residential Streets		Parkway bioretention program
	Rio Vistas		Green streets retrofits along street ends adjacent to major streams and rivers

Table 7. Distributed Stormwater Capture Program Types

Program Type	Subcategory	BMPs	Specific Program Examples
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 buildings
			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

6.2.1.2. On-Site Infiltration

On-site infiltration is the practice of collecting 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 improve the aesthetics of a property in addition to providing an environmental resource. For each of the land uses 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 the program to site conditions and, as a result, maximize capture. Example programs include a residential rain garden program for single-family residential land uses, a "big box store" parking lot retrofit program for commercial land uses, and a hospital or university parking lot retrofit program for institutional land uses.

6.2.1.3. On-Site Direct Use

On-site direct use is the practice of collecting stormwater generated on site for non-potable on-site uses (e.g. irrigation or toilet flushing). On-site direct use reduces potable demand, therefore taking pressure off the municipal water supply, and can help residents save money on their water bills. 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. Example programs include a residential cistern program for single- and multi-family land uses for use in irrigation, a cistern program for institutional facilities such as fire and police stations for use in vehicle cleaning, and a school yard cistern and gardening program for use in educational land uses. It should be noted that several potential on-site direct use practices (e.g. toilet flushing) would require changes to the Department of Building and Safety building code.

6.2.1.4. Green Streets

Green streets incorporate one or more BMPs to manage stormwater runoff while maintaining the roadway's primary function of accommodating vehicular traffic and safe pedestrian access. Stormwater BMPs capture and infiltrate runoff from the street itself as well as some percentage of adjacent properties. BMPs can be located in/beneath the street and sidewalk (permeable pavement, dry wells) or in parkways (vegetated swales, bio-retention curb bump-outs, tree wells, planters, and bio-retention basins). Example programs include a parkway bioretention program for single- and multi-family residential land uses, curb bump-out and tree wells in commercial land uses, and a bioretention program along Rio Vista corridors (street ends adjacent to major streams and rivers).

6.2.1.5. 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 programs 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 bioretention. Subregional infiltration BMPs can be adapted to meet the needs of a property owner or neighborhood. For example, a vegetated bioretention unit could be installed in a park to provide habitat and visual interest. When space constraints are such that land area cannot be lost, the BMP can be contained underground as with an infiltration gallery. In this way, the BMP footprint is available for uses such as parking, bike paths, or sidewalks. Example programs include neighborhood recharge facilities on educational land uses, incentives to industrial, commercial, or institutional land owners to house regional infiltration BMPs, and a program to standardize the integration of subregional infiltration BMPs into the design of new parks and park retrofits.

6.2.1.6. Subregional Direct Use

In subregional direct use, stormwater runoff is collected from multiple parcels, blocks, or an entire neighborhood for indoor or outdoor non-potable uses. Flows are routed into storage facilities, such as a cistern or pond, by diverting storm drain infrastructure from the public ROW onto a private or publicly owned parcel with available space and adequate reuse needs. Stored water is most often treated and pumped to its end purpose, which may include irrigation, toilet flushing, or cleaning vehicles and equipment. Example programs include incentives for stormwater capture and use in manufacturing processes or cleaning of equipment in industrial land uses, incentives for stormwater capture for use in toilet flushing in educational land uses, and a program to standardize the integration of subregional direct use BMPs into the design of new parks and park retrofits.

6.2.2. ANALYSIS OF ALTERNATIVES

Each of the distributed program alternatives was analyzed with regards to its potential opportunity area, unit cost, stormwater capture potential, and potential for ancillary benefits. These analyses are summarized in the following sections.

6.2.2.1. Opportunity Areas

An opportunity area is defined as the total area throughout the City that could be captured by a BMP for a given program type. Stormwater capture program areas of opportunity were developed based on three attributes: geophysical classification; impervious area potentially captured; and subcategory (Table 8). Infiltration program types (self-mitigating BMPs, on-site infiltration, and subregional infiltration) were considered only suitable for areas conducive to infiltration (geophysical Categories A and B), while direct use program types (on-site and subregional direct use) were considered only suitable for areas less conducive to infiltration (geophysical Category C).[4] Land use further restricts suitability for certain program types. For instance, vacant and agricultural land uses were not considered as contributing to subregional programs because they are entirely pervious. Finally, opportunity area was reduced based on drainage patterns within given land uses. For instance, on-site programs would not capture runoff from the ROW, since this area generally does not drain onto the property where the BMP would be located. Green street programs can receive runoff from the ROW, as well as a portion of adjacent properties. The self-mitigating BMP program type, by definition, only accepts runoff from the impervious portion of each land use it is applied to.

Table 8. Stormwater Program Opportunity Area with Corresponding Land Use and Geophysical Classification

Program Type	Geophysical Classification	Subcategory	Impervious Opportunity Area (Acres)	Impervious Opportunity Area Description
Self-Mitigating BMPs	A, B	Educational	2,026	Parking lots, driveways, sidewalks, walkways within parcel
		SF Residential	4,833	
		MF Residential	6,325	
		Commercial	4,011	
		Institutional	651	
		Industrial	4,499	

4. For discussion of geophysical categories, see Section 3 or Appendix F. Note that runoff from pervious areas will be captured, but areas were normalized across impervious areas for analysis and reporting within the SCMP Evaluation Framework.

Table 8. Stormwater Program Opportunity Area with Corresponding Land Use and Geophysical Classification

Program Type	Geophysical Classification	Subcategory	Impervious Opportunity Area (Acres)	Impervious Opportunity Area Description
On-Site Infiltration	A, B	Educational	2,895	100% of impervious area within parcel
		SF Residential	11,425	
		MF Residential	10,201	
		Commercial	8,248	
		Institutional	1,330	
		Industrial	7,868	
On-Site Direct Use	C	Educational	2,075	100% of impervious area within parcel
		SF Residential	12,236	
		MF Residential	9,292	
		Commercial	6,090	
		Institutional	1,121	
		Industrial	5,302	
Green Street Programs	A, B	Commercial Streets	11,442	100% of impervious area within parcel and ROW
		Residential Streets	34,174	84 to 91% of impervious area within parcel and 100% of impervious area in ROW
		Streets Adjacent to River (Rio Vistas)	2,471	Same as above for residential, commercial, industrial sites within 400 feet of major stream or river bank
Subregional Infiltration	A, B	All of the above plus Parks and Transportation	69,792	100% of impervious area within parcel and ROW of mixture of developed land uses
Subregional Direct Use	C	All of the above plus Parks and Transportation	66,026	100% of impervious area within parcel and ROW of mixture of developed land uses

Figure 17 shows the total impervious opportunity area for each of the program types in the City. Program type subcategory refers to the land use on which a BMP can be located, and the opportunity area is the land use (or land uses) that contributes runoff into the BMP. For on-site stormwater capture program types, program type subcategory is the same as land use. However, green streets and subregional BMPs receive runoff from additional areas other than the parcel on which the BMP is located.

Subregional infiltration and subregional direct use cover the entire City and consequently have the highest opportunity area – approximately 70,000 impervious acres in geophysical Categories A and B and 66,000 impervious acres in geophysical Category C. Because on-site infiltration and on-site direct use exclude the ROW as well as parks and transportation land uses (which are covered by other program types), they have much less opportunity area – approximately 42,000 impervious acres in geophysical Categories A and B and 36,000 acres in geophysical Category C.

Green streets represent another substantial opportunity with 48,000 impervious acres potentially contributing to green street program areas. Rio Vistas, a subset of the green street program, have an impervious opportunity area of approximately 2,500 acres, including all commercial, single-family residential, multi-family residential and industrial land uses within 400 feet of major rivers. Residential and commercial Rio Vista areas were not included in the opportunity area for Residential and Commercial Green Streets. The self-mitigating BMPs program type has the smallest opportunity area (22,000 impervious acres) of the program types, because it includes only the portion of impervious areas within parcels that can be replaced by pervious pavement.

6.2.2.2. Cost Curves

Stormwater capture program costs were estimated by developing a representative mix of BMPs that would be implemented as a part of each program type and averaging their unit costs. BMP capital costs were developed using a line item unit cost approach. For each BMP, material costs were estimated for three BMP storage volumes to establish a cost curve. Two curves were developed for each BMP, one representing a "high cost" scenario, reflecting retrofit scenarios, less amenable site conditions, and complex design goals, and one representing a "low cost" scenario, reflecting cost in cases with new development, favorable site conditions, and simpler design goals. "Soft costs," including design, operation and maintenance, and permitting, were estimated as a percentage of the total line item costs. To account for different BMP lifespans and maintenance frequencies, costs were normalized over a 100-year analysis period. The lifetime costs per cubic foot for each of the representative BMPs can be found in Figure 18.

In order to size the BMPs, a representative drainage area was selected for each program type and subcategory. For on-site programs, Geographical Information System (GIS) case studies were conducted using the Los Angeles County parcel dataset and the Southern California Association of Governments (SCAG) land use dataset 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 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

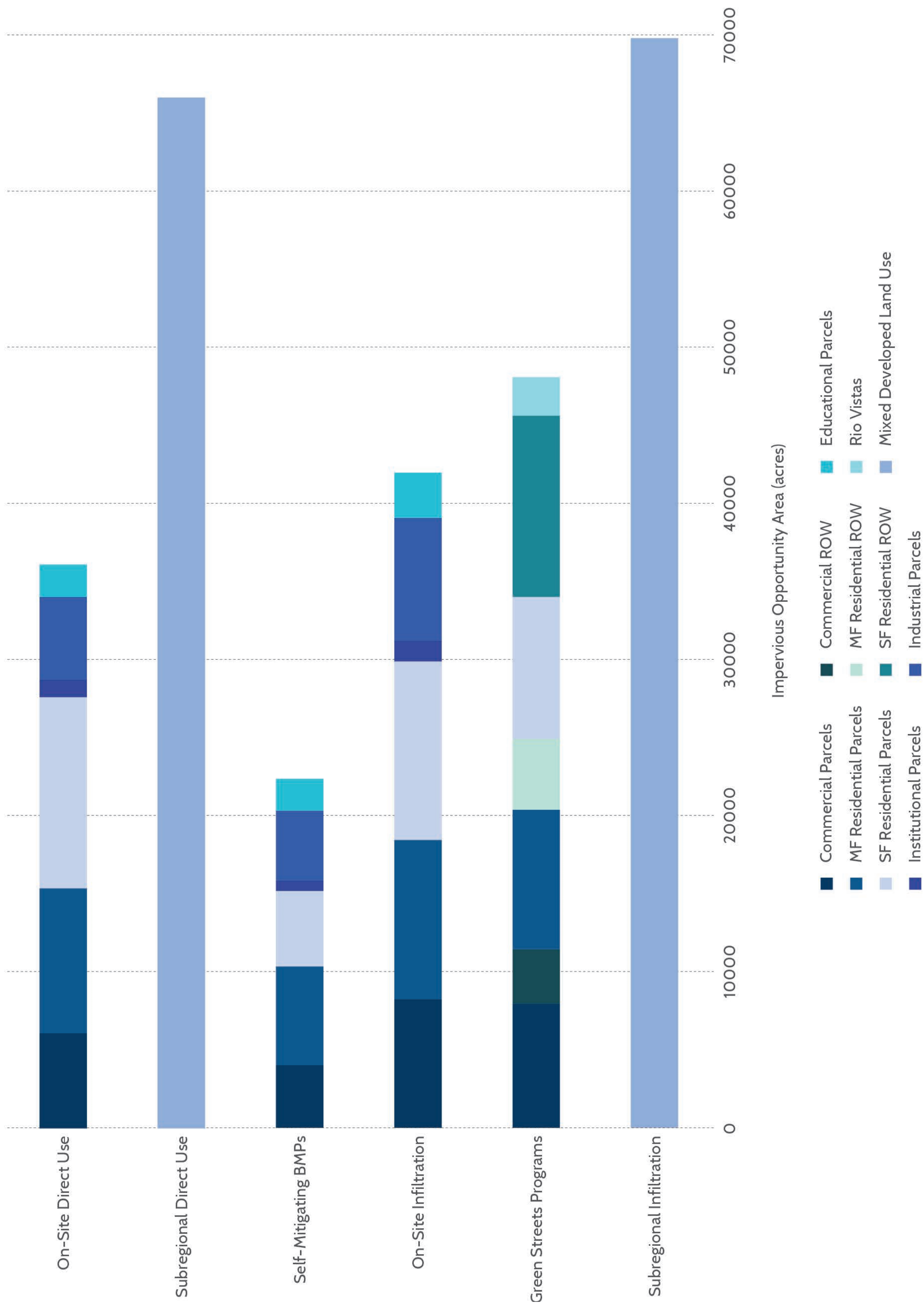

Figure 17. Impervious Opportunity Area of Representative BMPs

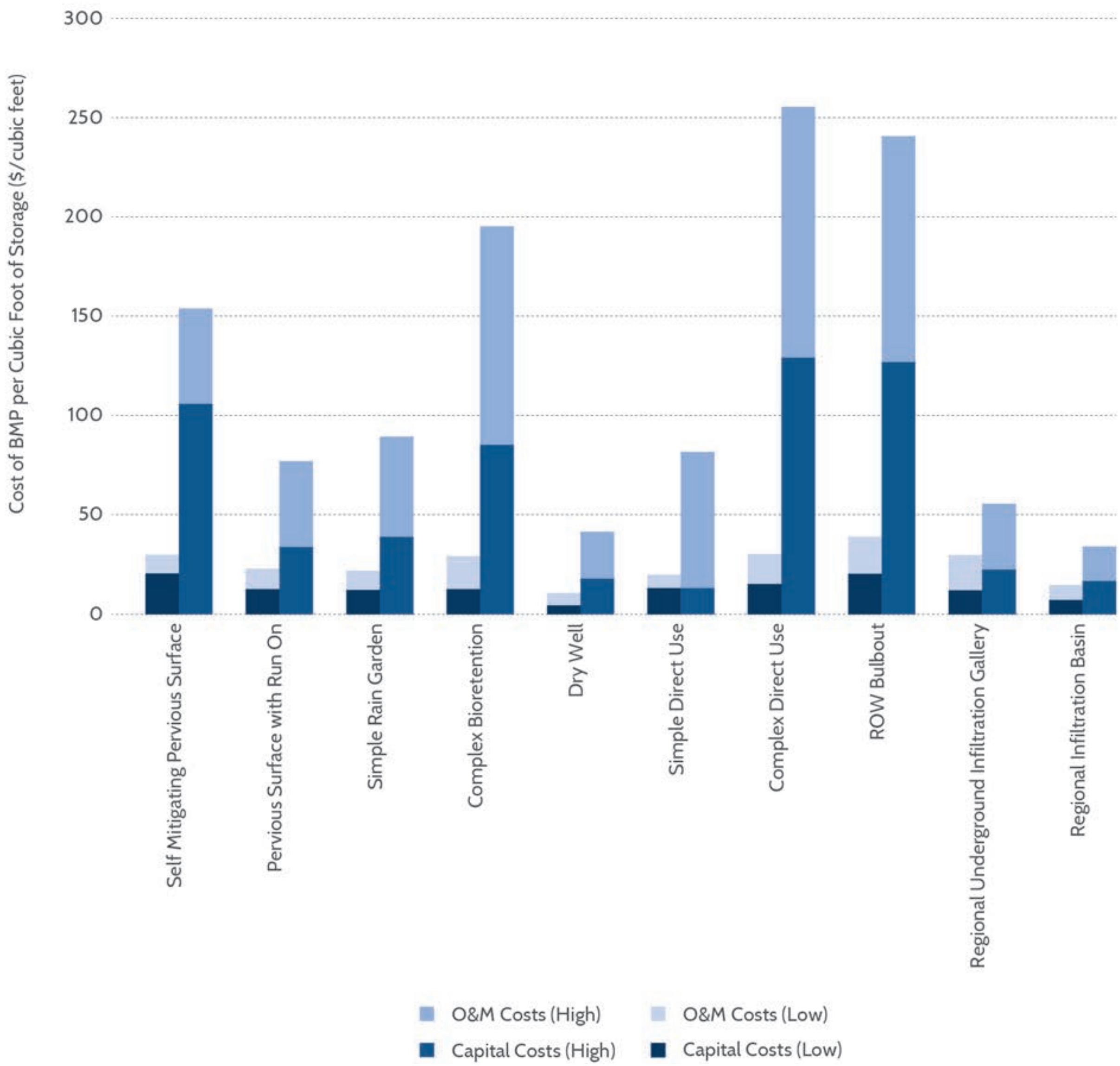

Figure 18. Total Lifecycle Costs of BMPs

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 pilot projects, best professional judgment, and input from stakeholders. Table 9 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. Next, each BMP was sized based on the selected design storm, the typical drainage area, and the corresponding cost from the high curve, low curve, and an average of the high and low curves. The individual BMP costs were then aggregated based on the assumed mix of BMPs that would be implemented within each program type, and then multiplied by the number of BMPs to get the total cost.

Table 9. Typical Drainage Areas to a Single BMP

Program Type	Geophysical Classification	Subcategory	Typical Drainage Area to a Single BMP (Acres)	Source of Estimate
Self-Mitigating BMPs	A, B	Educational	2.79	Fraction of on-site drainage area eligible for pervious pavement replacement
		SF Residential	.01	
		MF Residential	.15	
		Commercial	3.16	
		Institutional	.51	
		Industrial	.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	.13	
		MF Residential	.55	
		Commercial	3.16	
		Institutional	.51	
		Industrial	.46	
On-Site Direct Use	C	Educational	7	ROW of one block plus contributing parcels
		SF Residential	.13	
		MF Residential	.55	
		Commercial	3.16	
		Institutional	.51	
		Industrial	.46	
Green Street Programs	A, B	Commercial Streets	13	ROW of one block plus contributing fraction of contributing parcels
		Residential Streets	3.7	ROW of one block plus contributing fraction of contributing parcels
		Streets Adjacent to River (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	Completed pilot projects, best professional judgment and discussion with stakeholders

Table 9. Typical Drainage Areas to a Single BMP

Program Type	Geophysical Classification	Subcategory	Typical Drainage Area to a Single BMP (Acres)	Source of Estimate
Subregional Direct Use	C	All of the above plus Parks and Transportation	65	Completed pilot projects, best professional judgment and discussion with stakeholders

6.2.2.3. Unit Stormwater Capture

To determine stormwater capture potential, unit stormwater capture curves were created to calculate 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. For all program types, except self-mitigating permeable pavement, the BMP unit capture database was used to calculate the range of unit captured volumes associated with BMPs within the program. Three representative rain gauges for each subwatershed in the City were selected for determining high, medium, and low rainfall rates. 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 and in the City overall. A range of drawdown times, or time it takes the water collected in the BMP to be used or to infiltrate into the ground, was assigned to each geophysical category. Geophysical Category C drawdown times were representative of direct use usage rates with typical storage volumes, while those in geophysical Categories A and B were based on infiltration rates of the underlying soil with typical BMP footprints.

6.2.2.4. Ancillary Benefits

The ancillary benefits associated with each stormwater capture program that were modeled as part of the Framework include water quality improvement, peak flow attenuation, and addition of green space. While not the primary focus of the SCMP, these other benefits could help to identify project partners, as projects with multiple benefits can help to leverage funding. The estimated pollutant load reductions for Total Suspended Solids (TSS), Fecal Coliforms (FC), Total Kjeldahl Nitrogen (TKN), Total Phosphorus (TP), Total Copper (TCu), Total Lead (TPb), and Total Zinc (TZn) are calculated as the average annual volume of captured stormwater multiplied by the average Event Mean Concentration (EMC) of pollutants from the contributing land uses, because the captured water is assumed to have the same concentration of the pollutants as the runoff. Because captured water does not carry trash with it, the area "treated" for trash is simply the implementation area.

While not the primary function of stormwater capture BMPs, the stormwater that they capture does decrease the peak runoff flow rate downstream. However, without site-specific design criteria to specify the peak flow attenuation, this benefit is difficult to quantify. At this time, a conservative constant loss rate approach has been applied. The estimated peak flow reduction is estimated as the steady-state loss of volume from BMPs, calculated as the BMP volume divided by the drawdown time. Because drawdown times are typically much longer than the storm duration for large storms, and because captured stormwater use is typically minimal during storm events, the peak flow reduction benefit expected from capture BMPs is modest. Nevertheless, they do provide some peak flow attenuation, often a desired benefit for BMPs. Finally, the green space provided by the program is estimated as the footprint of all BMP types within that program type that contribute green space. These include bioretention, rain gardens, infiltration basins, and ROW planters. The range of areas is calculated as the BMP volume of BMPs that are green space times the range of typical BMP depths used in cost calculations.

6.2.3. SCMP PROGRAM EVALUATION FRAMEWORK

The Framework was developed to allow evaluation of the costs and benefits of the six program types City-wide or in specific subwatersheds, to help guide recommendations for implementation of stormwater capture program types, and ultimately to set the SCMP targets. The Framework integrates the opportunity areas, typical BMP drainage areas, unit cost curves, unit capture curves, and ancillary benefit estimation techniques to allow the evaluation of the costs and benefits associated with each program type for a given subcategory, geophysical category, subwatershed, BMP size, and implementation percentage.

The Framework can be used to evaluate the unit costs and benefits of a program type, or to evaluate the cost, stormwater capture potential, and other ancillary benefits of a specific program implementation scenario as described below.

6.2.3.1. Program Evaluation

Using the Program Evaluation function of the Framework, the user can compare the unit costs and stormwater capture benefits between program types. This information can help inform the preferred implementation rate of each program type (i.e. programs with high capture/cost ratios might be targeted for prioritized implementation). Additionally, this function illustrates the optimized BMP storage volume for a given program type in a particular location within the City (i.e. the response curve illustrates the “knee of the curve” where additional BMP storage volume produces diminishing returns in terms of capture benefits).

The inputs for this function include program type, subcategory, geophysical category, and subwatershed. The outputs are unique program unit capture and cost curves as a function of BMP storage volume. The Framework will also provide the EMCs of the stormwater from the program’s contributing area for a range of pollutants. The Framework provides three curves representing the high, medium, and low estimates of capture rate (acre-feet captured/acre of tributary area) per unit BMP volume (cubic feet of storage/acre of tributary area). An example of the curves provided by the Framework is shown in Figure 19 for an on-site infiltration program in a Multi-Family Residential application area in geophysical category B in the Northeast San Fernando Valley subwatershed.

6.2.3.2. Conceptual Management Scenarios

After using the Program Evaluation function of the Framework to select an appropriate implementation rate and BMP sizing criteria for a given program type, the Conceptual Management Scenario function of the Framework allows the evaluation of the total cost and benefit for this scenario.

The Conceptual Management Scenario function combines the Program Evaluation inputs (program type, subcategory, geophysical category, and subwatershed) and outputs (unit capture, unit costs, and EMCs) with two additional inputs (implementation percentage and BMP size). The resulting output is the total application area, required number of BMPs, unit BMP volume, total capture volume, total costs, costs per captured volume, and

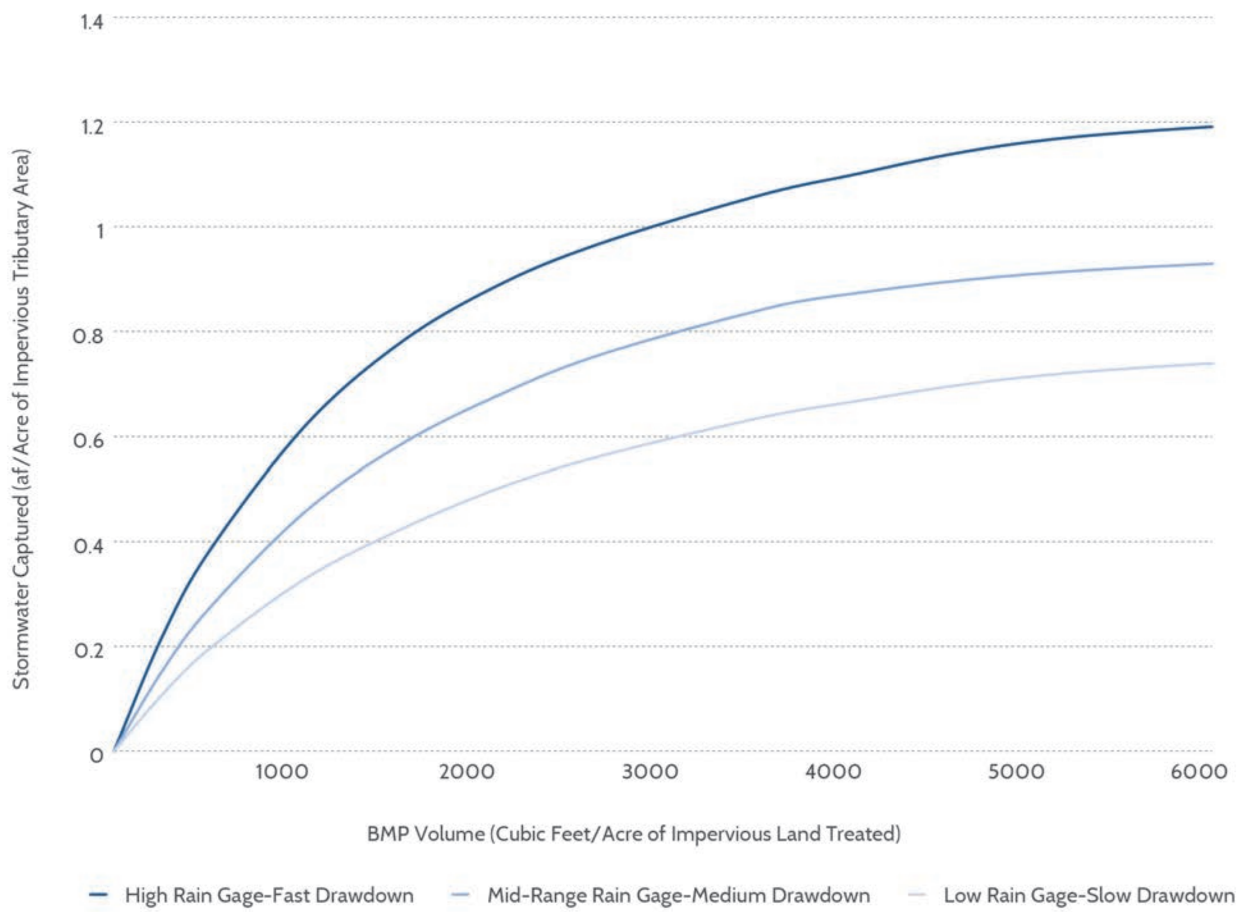

Figure 19. Example Unit Capture Nomograph from SCMP Framework

other benefits for implementation of a given program type under the specified conditions.

6.2.3.3. Comparison of Programs

To compare the total costs and benefits of various program types, the Framework was used to compare all possible scenarios at a 100% implementation rate and BMPs sized using the 85th percentile storm event from the medium rain gauge in each subwatershed. This allows for a comparison of total costs and benefits for each program if they were implemented everywhere remotely feasible within the City. Because the opportunity areas for each program are not independent from other programs, the results cannot be considered cumulative, but are useful for comparison purposes. Furthermore, 100% implementation was assumed for the purposes of program comparison and does not represent a realistic implementation goal. Therefore, results are shown on a "per volume captured" or "per impervious area treated" basis rather than total costs and capture volumes. Total costs and captures will be reported in the implementation strategy of the SCMP when specific implementation scenarios are explored.

6.2.3.3.1. Cost Per Unit Capture Volume

The total lifecycle cost for each acre-foot of stormwater captured by the BMPs was compared for each program type. Figure 20 presents a comparison of program cost per captured volume, with the horizontal lines representing the medium cost, and the error bars representing the range between high and low costs. This comparison includes the aggregate of all program type subcategories and geophysical categories, across all subwatersheds. This analysis indicates which programs are most cost effective, overall. The cost effectiveness reported in Figure 20 is based on 100% implementation of each program as modeled during alternatives development in Task 3. Cost effectiveness numbers vary slightly with implementation rates. As such, the cost effectiveness of each program reported for the final implementation plan (Figure ES-6 and Figure 49) shows slightly different numbers based on select implementation.

While there is overlap between the ranges of costs per volume captured for all of the programs, self-mitigating pervious pavement, with a tributary area limited to its own footprint, tends to have the highest cost range, from $4,000 to $19,100 per acre-foot. This is because this BMP area does not receive run-on from other areas, so it is limited to only the rainfall falling on its footprint area for volume to capture. Consequently, it takes a much greater BMP footprint to capture the same volume that the other programs would capture, greatly increasing the cost per unit capture.

Infiltration programs have a lower range of costs than direct use programs. This is partly due to long drawdown times of direct use programs and due to the fact that direct use BMPs often require more infrastructure (storage tanks, pumps, piping, etc.) than infiltration BMPs. Some direct use BMPs also include costs for treatment and distribution, while infiltration BMPs only include the costs of delivering water to the aquifer, which then must be treated and delivered to a distribution network. Subregional infiltration programs have the lowest range of costs per unit volume captured, which have a unit cost range between $600 and $1,300 per acre-foot, and, interestingly, have a wide area of applicability. This is attributable to "economy of scale" of subregional BMPs. Well designed and situated green streets have the potential to assist with

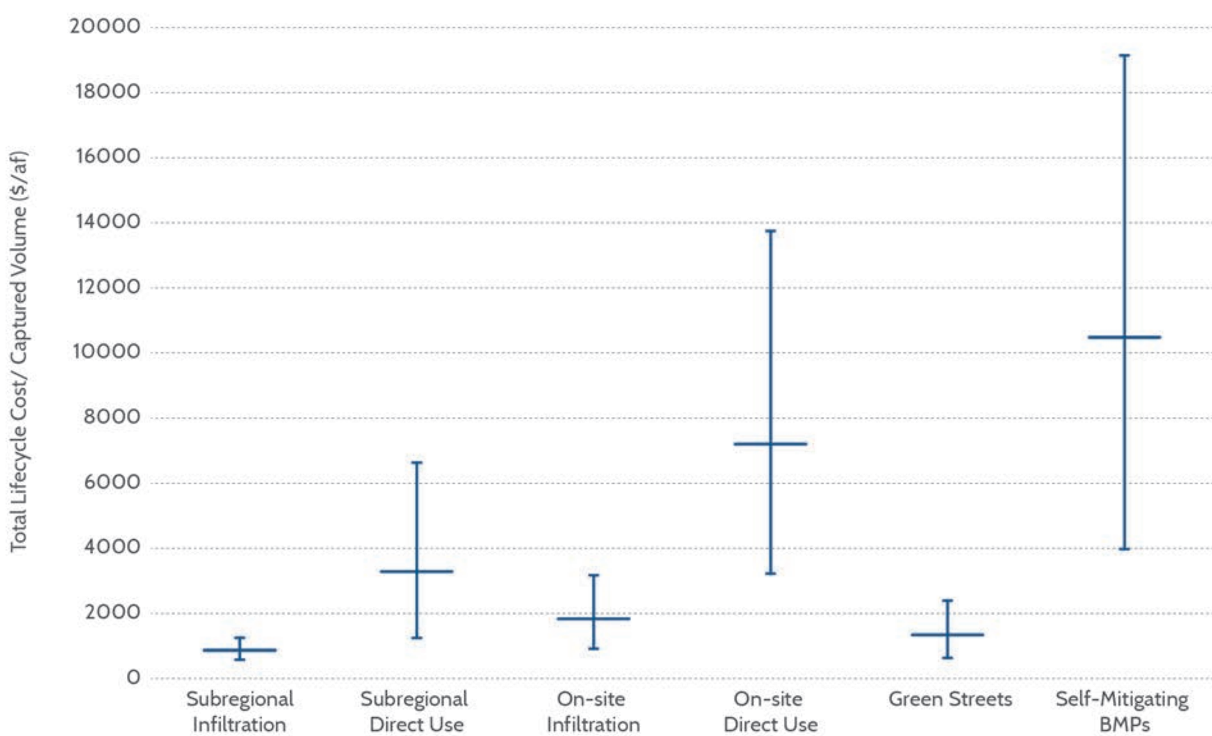

Figure 20. Cost Effectiveness of Each Program

aquifer recharge, with cost ranging between $600 and $2,400 per acre-foot. On-site infiltration unit costs range between $900 and $3,100 per acre-foot.

Subregional direct use projects offer some cost-effective opportunities with the low range of unit costs at $1,200 per acre-foot, but costs rapidly increase because these projects are usually complex. On-site direct use projects again offer some cost-effective solutions with unit cost ranges between $3,200 and $13,800 per acre-foot, with the more complex direct use projects dominating the higher ranges.

It should be noted that all programs have costs at the low end of the range that are lower than the high-range costs of other programs. This indicates that there are conditions in which more distributed BMPs could have similar cost-effectiveness to subregional BMPs. While these patterns between the programs are true over the entire City, the most cost-effective option could vary by application area, subcategory, subwatershed, geophysical category, or BMP size. The best option for different areas will need to be looked at on a case-by-case basis.

6.2.3.3.2. Capture Volume per Impervious Area Treated

The average annual volume of stormwater captured per acre of impervious area treated for each program type was analyzed to give an indication of which program types are most efficient at capturing stormwater and, thus, to determine how to capture the most stormwater from a contributing area (Figure 21). Self-mitigating BMPs are assumed to capture 90% of the rainfall falling on them. This is higher capture efficiency than most other BMPs, which are sized to capture the 85th 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 (Figure 17). Infiltration BMPs have higher unit capture rates and a slightly higher opportunity area than direct use BMPs, giving them a higher total opportunity capture volume.

6.2.3.3.3. Additional Benefits per Impervious Area Treated

The additional benefits quantified for comparison purposes were the runoff peak flow reduction per impervious acre treated (Figure 22), the green space provided per impervious acre treated (Figure 23), and the pollutant loads removed from the runoff per impervious acre treated (Figure 24 through Figure 31). Direct use BMPs provide the least peak flow reduction due to their long drawdown times, while self-mitigating pavement provides the most due to its high surface area relative to the runoff volume, providing for more rapid infiltration. Only infiltration programs include BMPs, which provide green space. On-site infiltration and green streets 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 mass of pollutants removed from surface runoff by capture BMPs is a function of both the EMCs of the contributing land uses and the capture volume per impervious treated acre. For nitrate, TSS, TKN, TP, TCu, and TPb, the aggregate EMC from all of the contributing land uses does not vary significantly across different opportunity areas; therefore, the primary driver for pollutant removal is the total capture volume. As a result, the figures showing removal of these pollutants show a pattern similar to the capture volume per impervious acre where impervious pavement replacement has the highest unit reduction, followed by infiltration programs, followed by direct use programs. For pollutants with EMCs that vary greatly between the aggregated land uses that contribute to each program type, the pattern differs from that observed in the capture volume because program types that may have lower capture potential may still have high pollutant removal potential due to high EMCs. This is the case for fecal coliforms and TZn. For these pollutants, green streets are shown to be less effective at pollutant removal because the land uses contributing runoff to green street programs (commercial and residential) have lower TZn and fecal coliform EMCs than the aggregated land uses in other programs.

6.2.4. IMPLICATIONS FOR IMPLEMENTATION

As part of the stormwater capture alternatives development, stormwater capture programs were defined, costs were developed, and a Framework and database were developed to evaluate numerous combinations of program types, subcategories, geophysical categories, subwatersheds, BMP sizes, and implementation extents.

Based on the initial comparison between programs, subregional programs offer the most opportunity area for implementation, while impervious replacement offers the least. Infiltration programs, especially subregional infiltration, offer the lowest cost per unit volume captured while impervious pavement replacement offers the highest. Direct use programs offer a relatively high cost per unit volume captured, but this is partly due to the distribution and treatment requirements not shown for infiltration programs. Impervious pavement replacement captures the most volume per acre treated, but it can only treat the area of the BMP footprint, making the cost per acre treated much higher than other program types, and was therefore dropped from further consideration for the SCMP.[5]

5. This refers only to self-mitigating permeable pavement. Permeable pavement designed to treat additional runoff could be a BMP applied for the on-site infiltration program.

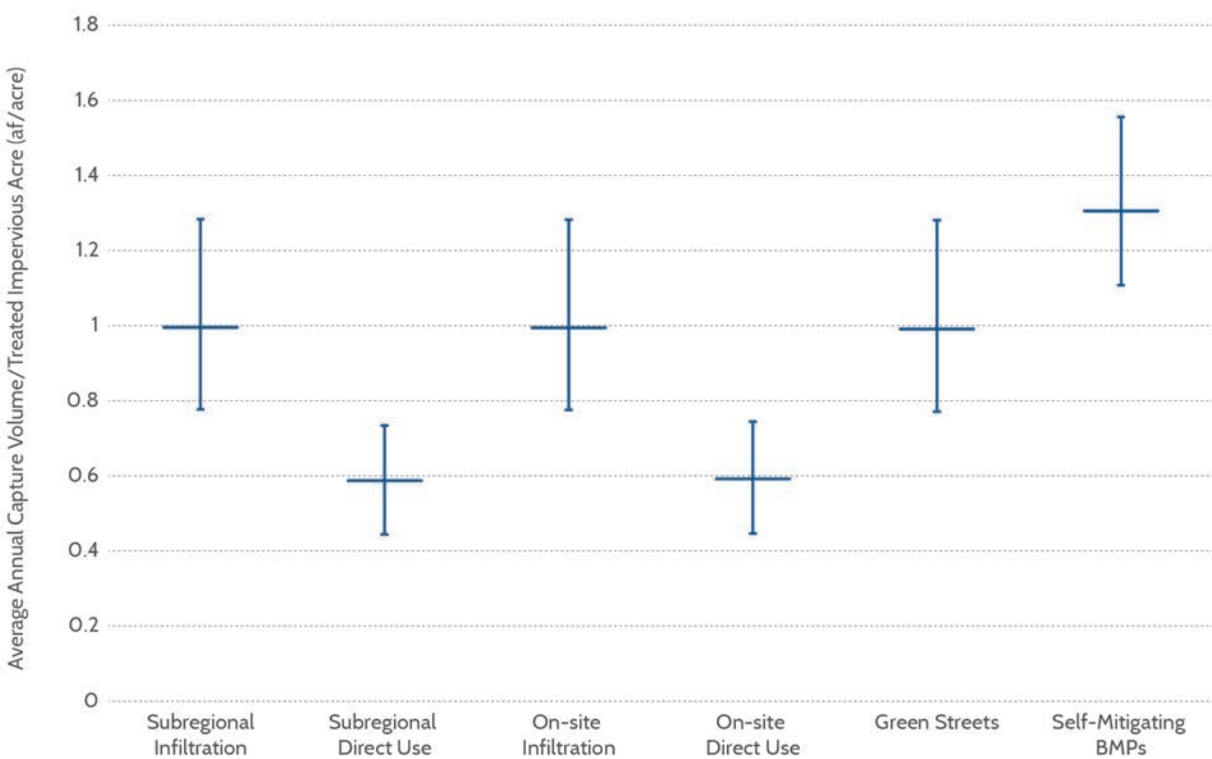

Figure 21. Annual Volume of Stormwater Capture for Siting Opportunities Within the City of Los Angeles

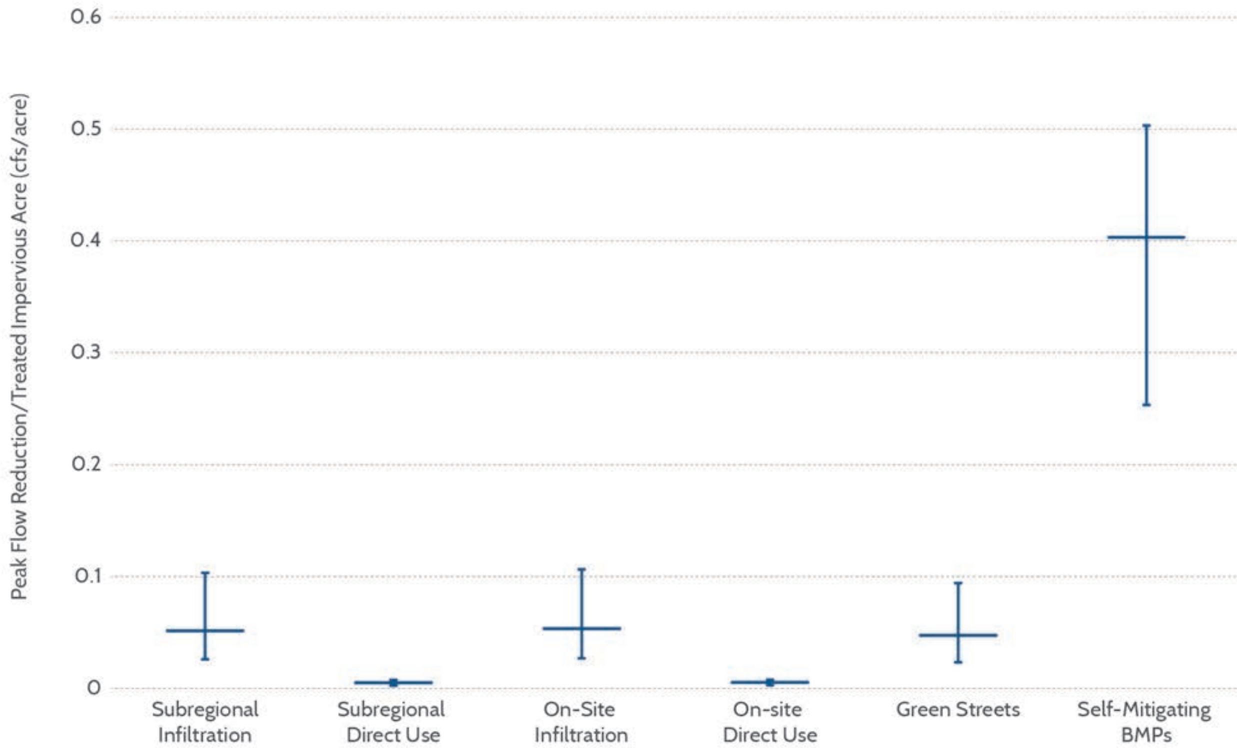

Figure 22. Peak Flow Reduction for Siting Opportunities Within the City of Los Angeles

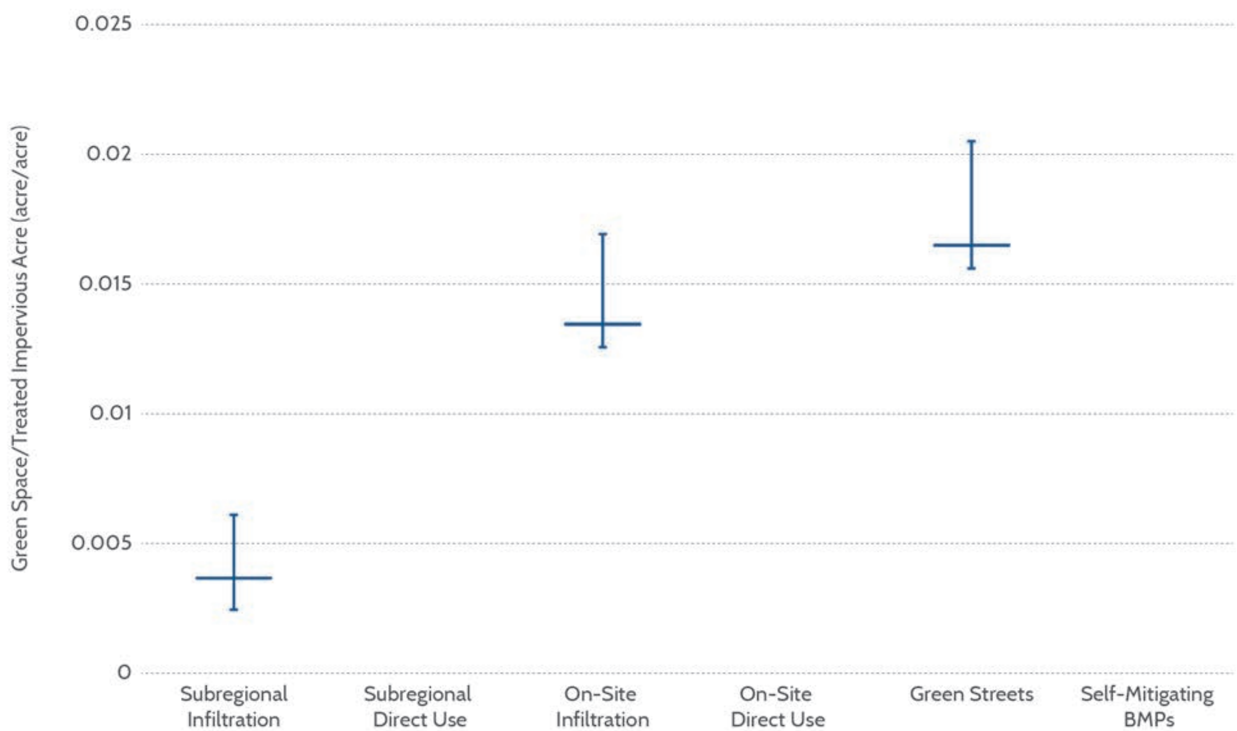

Figure 23. Creation of Green Space Area for Siting Opportunities Within the City of Los Angeles

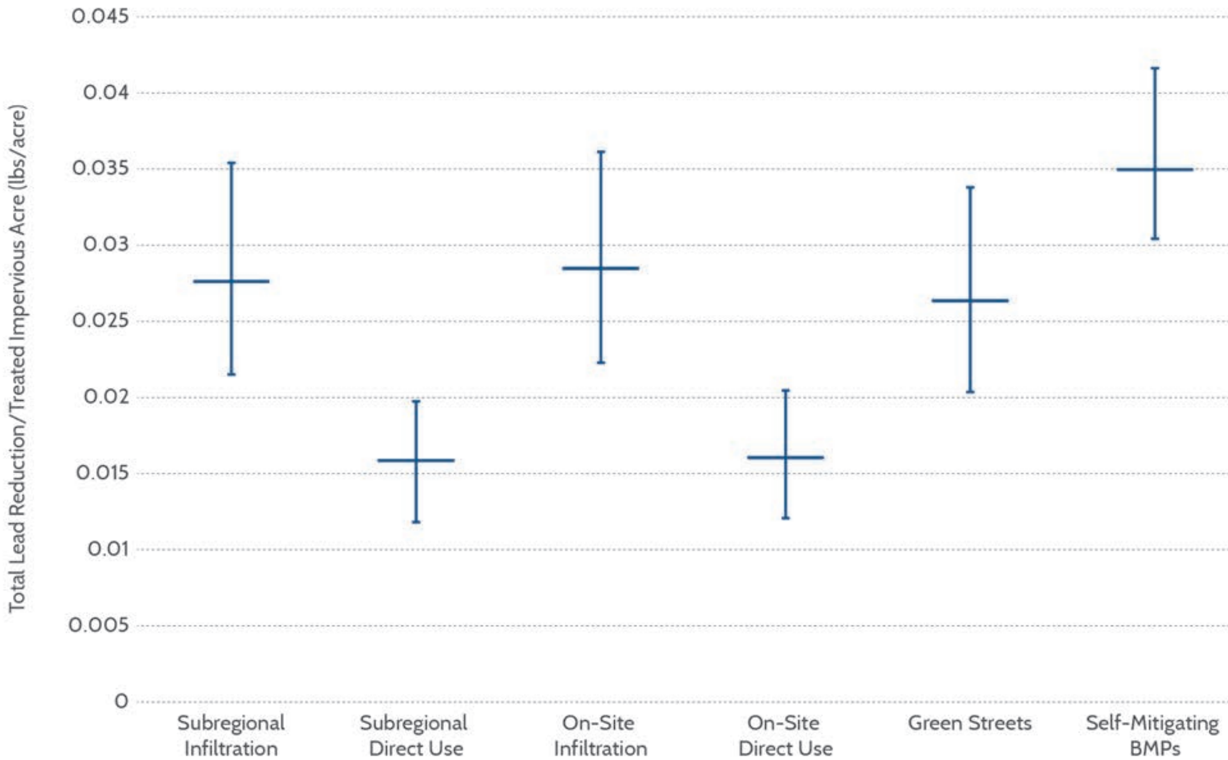

Figure 24. Lead Reduction for Siting Opportunities Within the City of Los Angeles

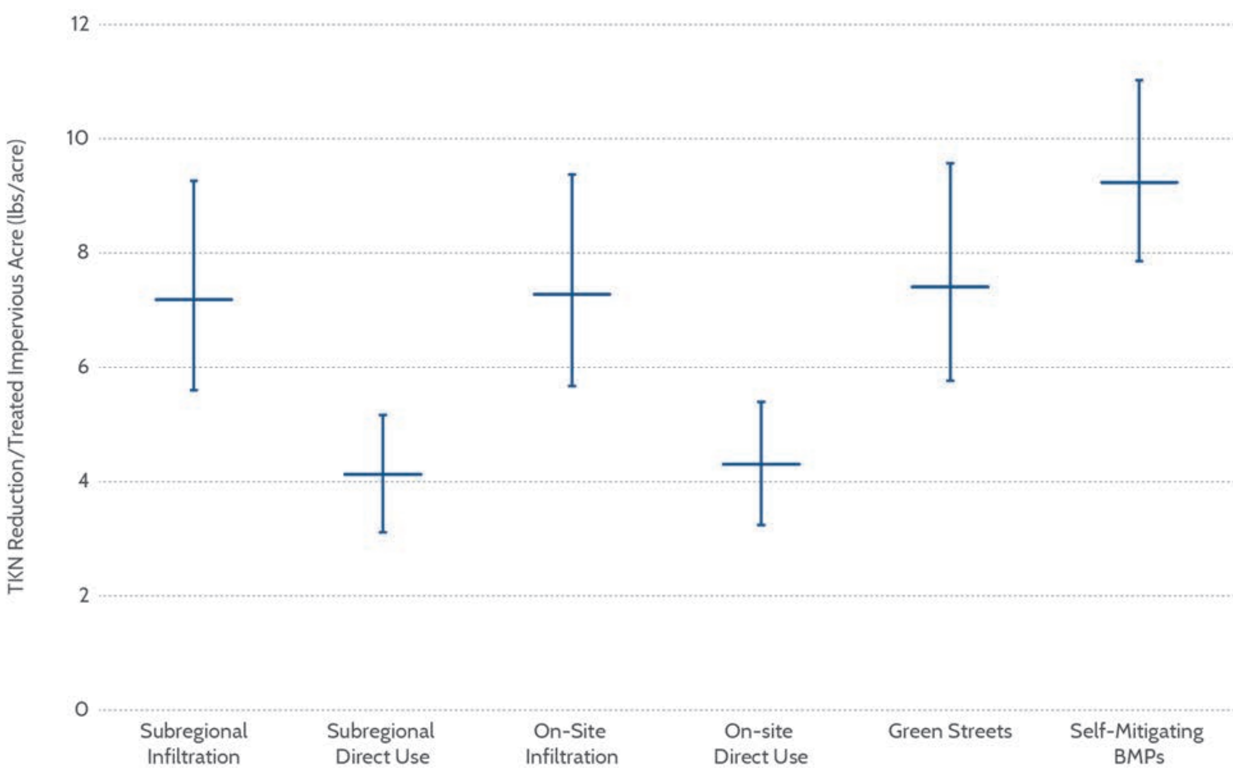

Figure 25. TKN Reduction for Siting Opportunities Within the City of Los Angeles

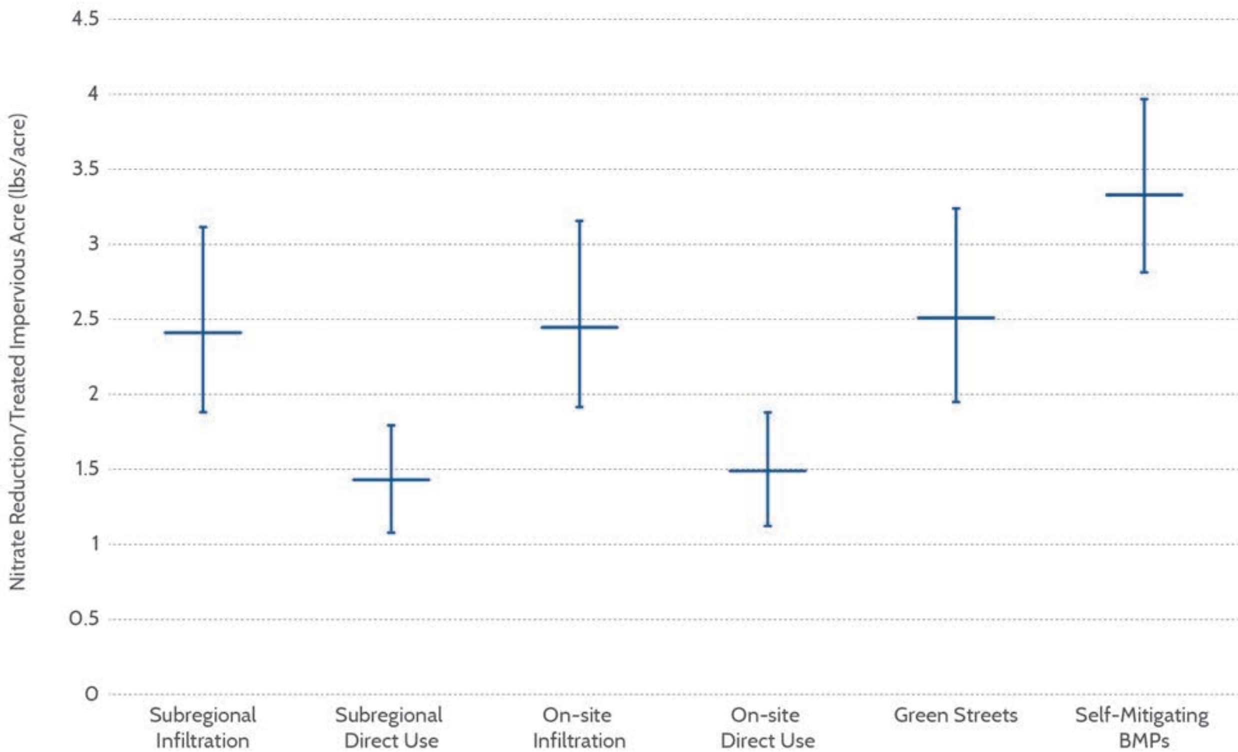

Figure 26. Nitrate Reduction for Siting Opportunities Within the City of Los Angeles

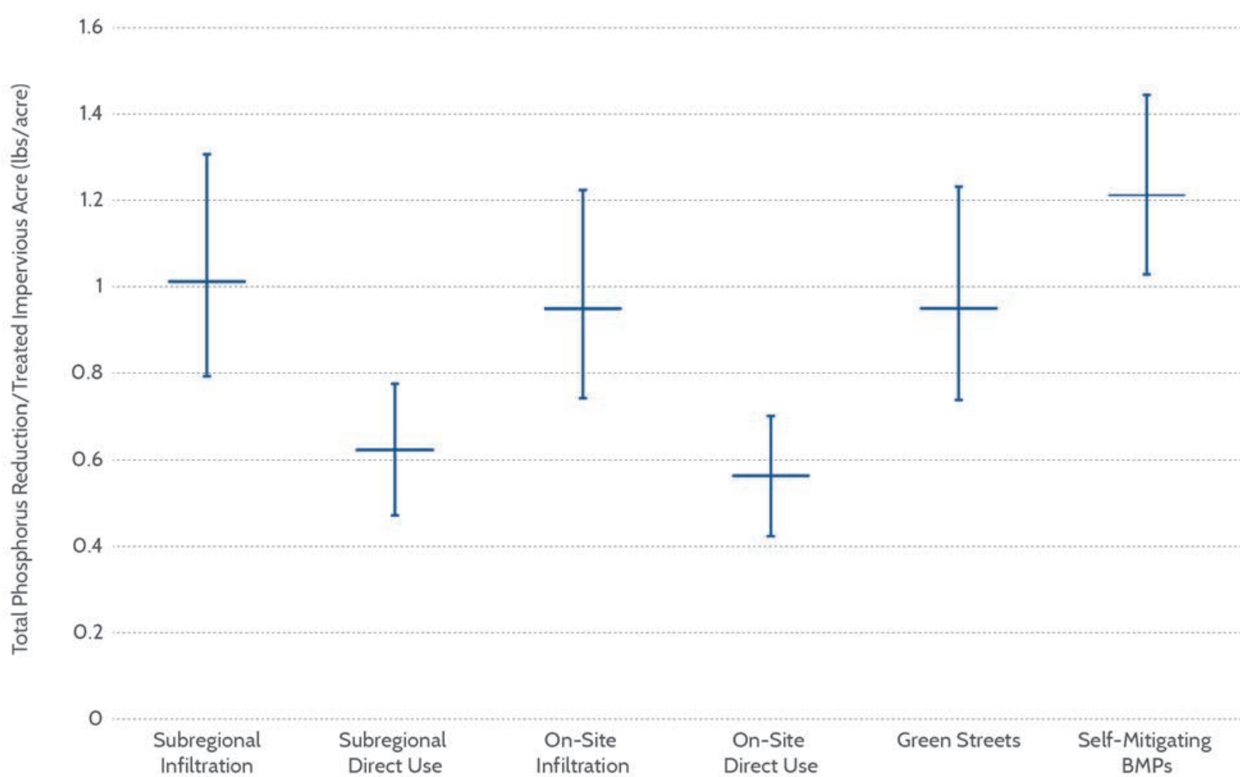

Figure 27. TP Reduction for Siting Opportunities Within the City of Los Angeles

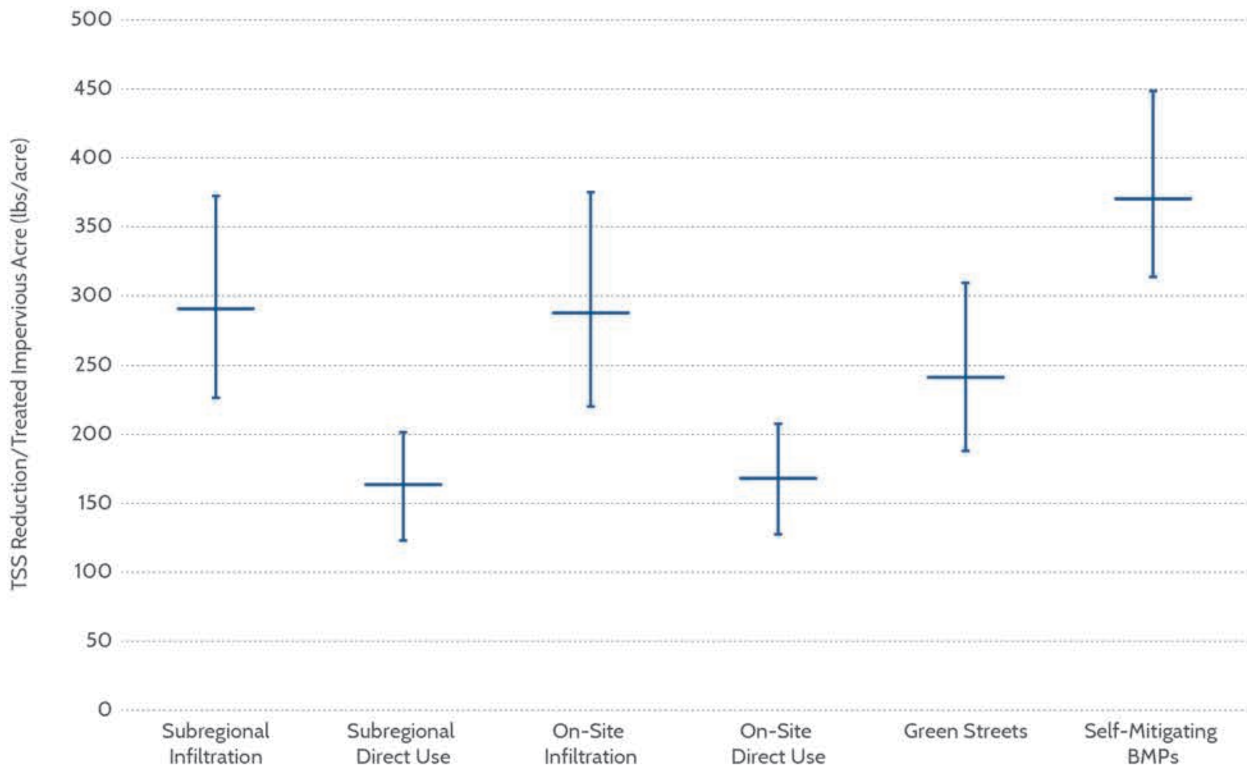

Figure 28. TSS Reduction for Siting Opportunities Within the City of Los Angeles

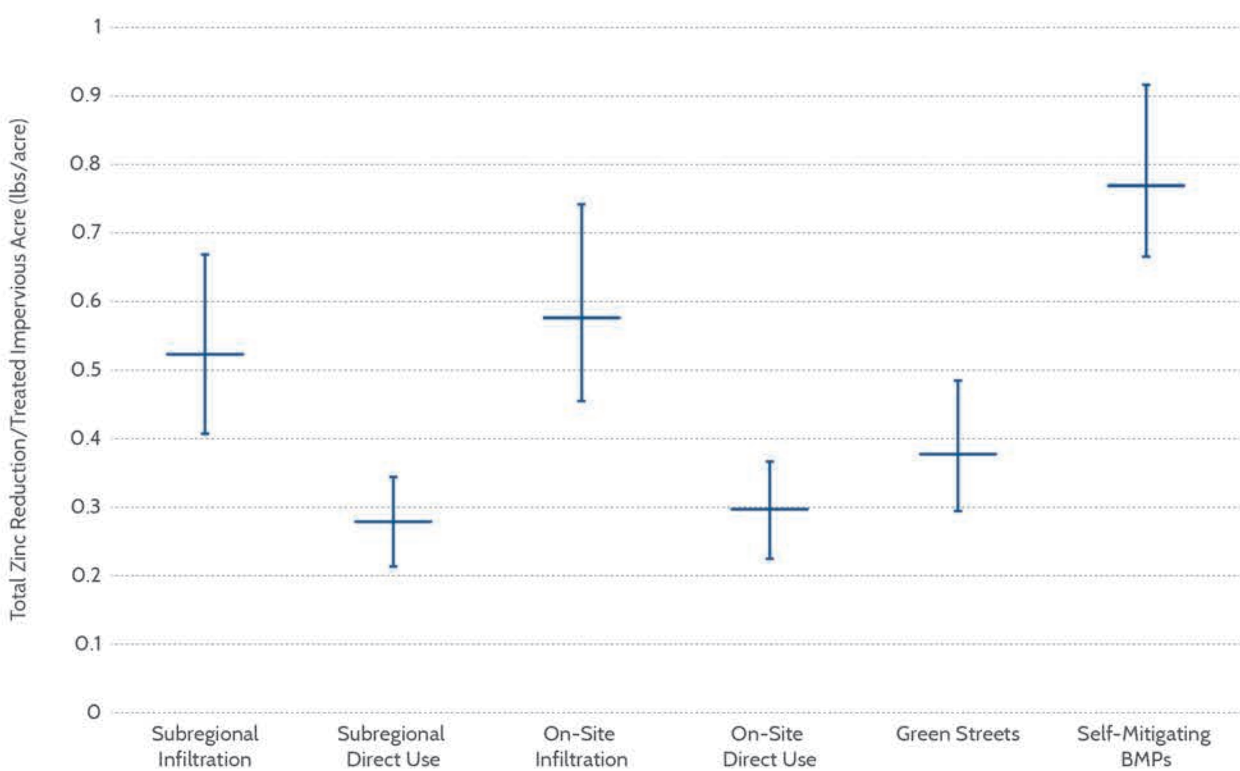

Figure 29. TZn Reduction for Siting Opportunities Within the City of Los Angeles

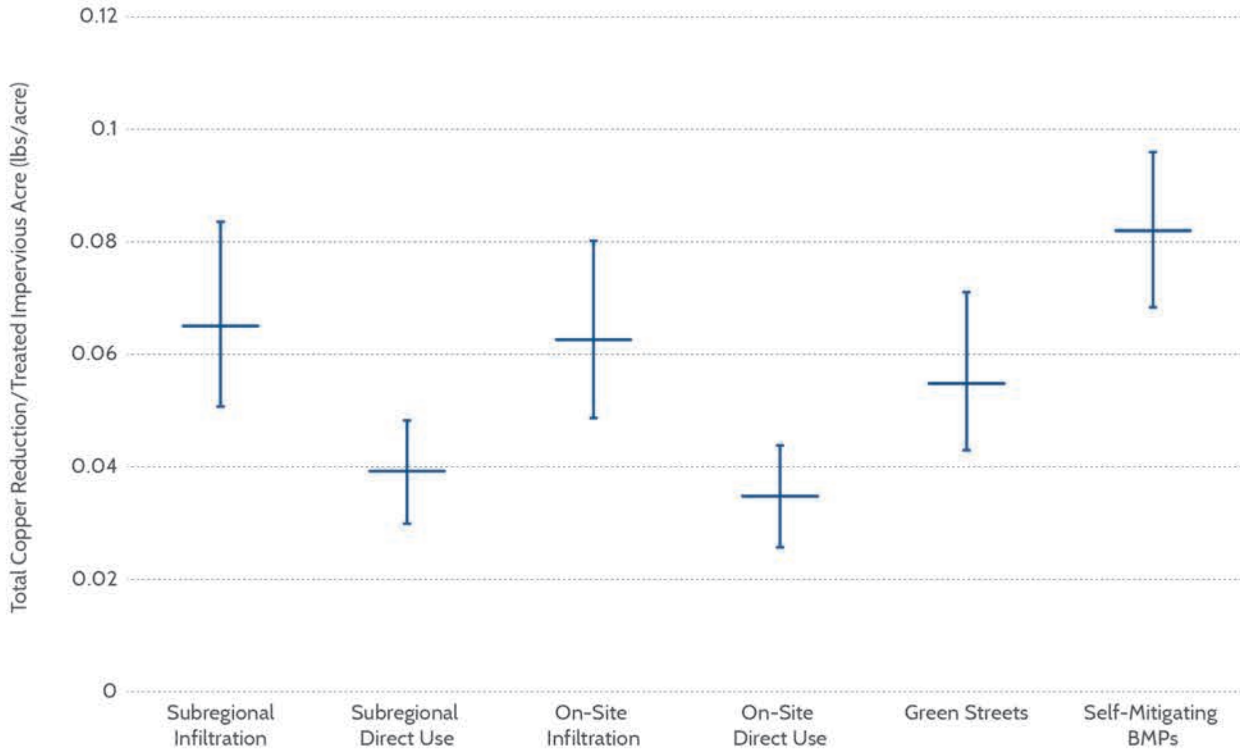

Figure 30. TCu Reduction for Siting Opportunities Within the City of Los Angeles

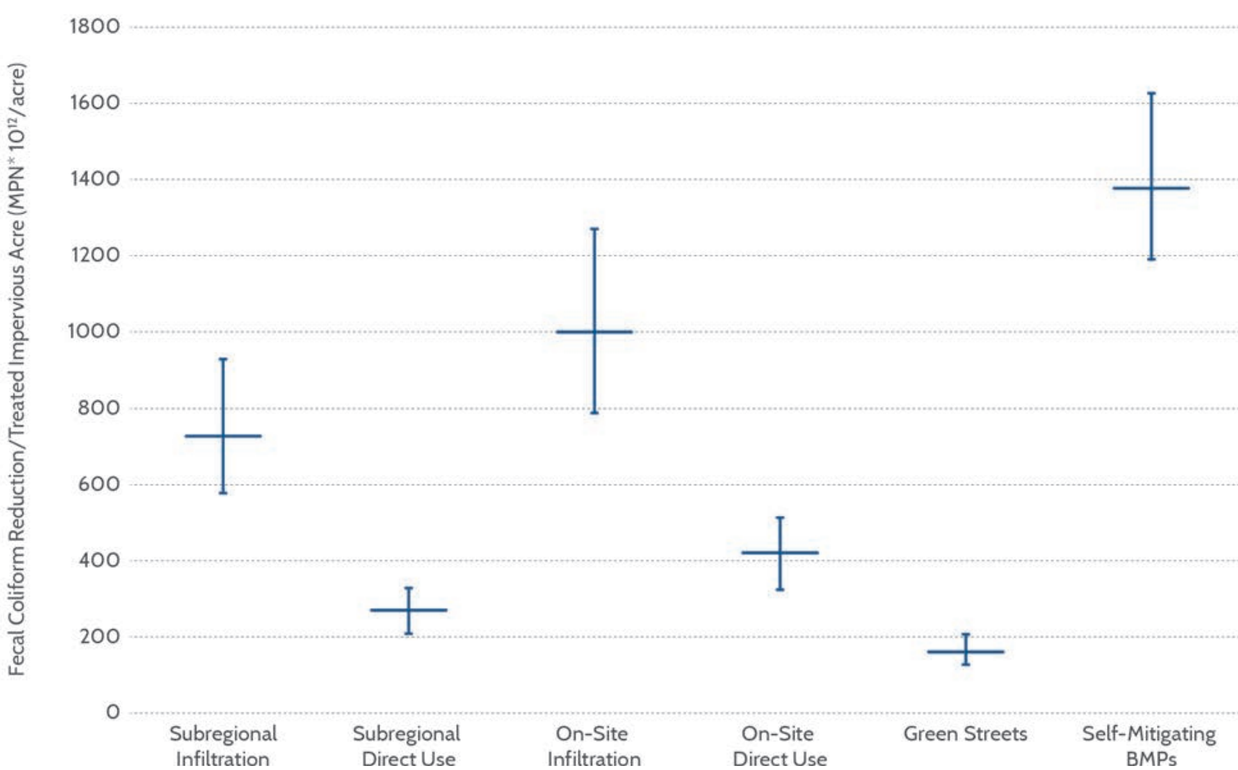

Figure 31. FC Reduction for Siting Opportunities Within the City of Los Angeles

Infiltration programs offer a higher capture volume per unit acre than direct use programs, primarily because direct use programs have longer drawdown times.

In all of these results, the relative efficacy of different programs may depend on location, application area, 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 in some areas, limiting its use. All programs offer cost-effective solutions over specific ranges of implementation.

The results obtained from this comparison are valid when looking at the entire City area with all program types, subcategories, geophysical categories and BMP sizes. Variation in costs and benefits within a single program type can vary by subcategory, geophysical category, subwatershed, or BMP size. Consequently, while one program may appear more effective than another on a City-wide basis, this may not be the case when individual implementations are compared within those programs.

7. SCMP IMPLEMENTATION TIMELINE AND TARGETS

By defining a range of possible outcomes for stormwater capture in the City over the next 20 years, the significant potential for stormwater capture is made clear. Furthermore, this range of potential can be used as a metric by which to measure LADWP's progress toward implementing stormwater capture in the coming years.

7.1. IMPLEMENTATION MILESTONES

The SCMP represents a 20-year implementation plan (through 2035) for LADWP to increase stormwater capture for water supply and water conservation. Within the 20-year plan there are interim milestones at the 5-, 10-, and 15-year marks (years 2020, 2025, and 2030). Therefore, the SCMP presents a range of potential implementation for centralized projects and distributed programs in 5, 10, 15, and 20 years, and then applies the modeling methodology developed in earlier phases of the SCMP to estimate the benefits and costs associated with this level of implementation.

7.2. CENTRALIZED CAPTURE

Preliminary SCMP model results show that the long-term capture potential (by year 2099) from centralized projects could provide an additional 77,000 to 142,000 acre-feet per year for groundwater recharge. This amount of water could be used to recharge the San Fernando, Central, and West Coast Groundwater Basins, and would be in addition to the current baseline amount of approximately 29,000 acre-feet per year that is recharged through the existing centralized facilities in the Tujunga Wash Watershed. The 44 centralized project concepts identified in the previous alternatives section of this report each have a capture capacity ranging between 100 and 10,000 acre-feet per year, and average approximately 1,200 acre-feet per year.

7.2.1. PROJECTED TIMELINE

To identify the amount of increased capture that can be recharged through enhancement of existing facilities, or through the development of new facilities, two implementation schedules were developed, one for the Conservative Scenario and one for the Aggressive Scenario. For both scenarios, several projects are already completed, in construction, or have funding committed toward project development. As shown in Table 10 and Table 11, completed projects include the Hansen Spreading Grounds Upgrade, the Big Tujunga Dam Retrofit, and the Sheldon-Arleta Gas Management System. Projects that are under development with committed funding include the Arundo Donax Removal Project–Phase I, the Tujunga Spreading Grounds Upgrade, the Pacoima and Big Tujunga Dam Sediment Removal Projects, the Branford Spreading Basin Upgrade, the Bull Creek Pipeline, and the Lopez Spreading Grounds Upgrade.

For the remainder of the projects, the implementation phasing was developed by analyzing the status of each project, understanding the technical complexity of each project, determining the level of permitting required, and assessing the individual project costs and partnership opportunities. The final schedules were completed by varying future annual budget expenditures from approximately $15,000,000 to $25,000,000 for the Conservative Scenario and from approximately $20,000,000 to $35,000,000 for the Aggressive Scenario. Cost sharing opportunities for the near-term projects (within 5 years) are better understood and range from between 30% and 70% depending on the project and identified partners. Cost sharing opportunities for the mid-term to long-term projects (within 10, 15, and 20 years, respectively) are less understood and were assumed to focus closer to 50% of total project cost.

Table 10. Centralized Facilities: Conservative Scenario Implementation Schedule

Project	Increased Capture (af/yr)	Start Date	Date of Completion
Hansen Spreading Grounds Upgrade (completed)	2,100	2007	2013
Big Tujunga Dam Seismic Retrofit (completed)	4,500	2009	2012
Sheldon-Arleta Gas Management System (completed)	100	2009	2016
Arundo Donax Removal Project–Phase I (funded)	100	2015	2018
Tujunga Spreading Grounds Upgrade (funded)	4,200	2015	2017
Big Tujunga Dam Sediment Removal 2.3-4.4 Million Cubic Yards (funded)	500	2016	2021
Rory M Shaw Wetlands Park Project (Strathern)	590	2016	2019
Spreading Grounds Optimization	650	2018	2019
Valley Generating Station Stormwater Capture – Phase I	118	2018	2020
Whitnall Hwy Power Line Easement	110	2016	2018
Branford Spreading Basin Upgrade (funded)	597	2018	2019
Bull Creek Pipeline 60"–16,000' (funded)	3,000	2018	2020
Debris Basin Retrofit #1 (pilot)	100	2021	2024
Lopez Spreading Grounds Upgrade (funded)	480	2018	2019
Pacoima Dam Sediment Removal 3 MCY (funded)	700	2018	2024
Pacoima Spreading Grounds Upgrade	2,000	2017	2019
San Fernando Road Swales	130	2018	2019
Silver Lake Stormwater Capture Project	117	2020	2024
Van Norman Stormwater Capture–1050'	1,500	2019	2021
Whiteman Airport	80	2020	2022
Storm Drain Mining (Inject)	750	2022	2024
Storm Drain Mining (treat and use)	750	2023	2024
LA Forebay Recharge System–LAR Pilot	1,000	2025	2029

Table 10. Centralized Facilities: Conservative Scenario Implementation Schedule

Project	Increased Capture (af/yr)	Start Date	Date of Completion
Old Pacoima Wash	1,000	2020	2024
Canterbury Power Line Easement	1,000	2030	2034
Arundo Donax Removal Project–Phase II	1,900	2022	2024
Debris Basin Retrofit #2	300	2025	2029
Hansen Dam Water Conservation Project	1,200	2022	2024
Lakeside Reservoir	238	2030	2034
North Hollywood Power Line Easement	750	2022	2024
Park Retrofit #2	500	2030	2034
East Valley Baseball Park	750	2022	2024
Van Nuys Airport	300	2025	2029
Whitsett Sports Fields Park Retrofit	750	2025	2029
Boulevard Pit Multiuse	5,000	2025	2034
LA Forebay Recharge System–Upper Ballona	600	2025	2029
Sepulveda Basin–Hansen SG Pipe Line 54"	3,000	2030	2034
Park Retrofit #3	500	2030	2034

Table 11. Centralized Facilities: Aggressive Scenario Implementation Schedule

Project	Increased Capture (af/yr)	Start Date	Date of Completion
Hansen Spreading Grounds Upgrade (completed)	2,100	2007	2013
Big Tujunga Dam Seismic Retrofit (completed)	4,500	2009	2012
Sheldon-Arleta Gas Management System	100	2009	2016
Arundo Donax Removal Project–Phase I (funded)	100	2015	2018
Tujunga Spreading Grounds Upgrade (funded)	4,200	2015	2017
Big Tujunga Dam Sediment Removal 2.3-4.4 MCY (funded)	500	2016	2021
Rory M Shaw Wetlands Park Project (Strathern)	590	2016	2019
Spreading Grounds Optimization	650	2016	2018
Valley Generating Station Stormwater Capture–Phase I	118	2016	2018
Whitnall Hwy Power Line Easement	110	2016	2018
Branford Spreading Basin Upgrade (funded)	597	2017	2018
Bull Creek Pipeline 60"–16,000' (funded)	3,000	2017	2019

Table 11. Centralized Facilities: Aggressive Scenario Implementation Schedule

Project	Increased Capture (af/yr)	Start Date	Date of Completion
Debris Basin Retrofit #1 (pilot)	100	2017	2019
Lopez Spreading Grounds Upgrade (funded)	480	2017	2018
Pacoima Dam Sediment Removal 3 MCY (funded)	700	2017	2022
Pacoima Spreading Grounds Upgrade	2,000	2017	2019
San Fernando Road Swales	130	2017	2018
Silver Lake Stormwater Capture Project	117	2017	2019
Van Norman Stormwater Capture–1050'	1,500	2017	2019
Whiteman Airport	80	2017	2018
Storm Drain Mining (Inject)	750	2018	2019
Storm Drain Mining (treat and use)	750	2018	2020
LA Forebay Recharge System–LAR Pilot	1,000	2019	2023
Old Pacoima Wash	1,000	2019	2021
Canterbury Power Line Easement	1,000	2020	2021
Arundo Donax Removal Project–Phase II	1,900	2022	2024
Debris Basin Retrofit #2	300	2022	2024
Hansen Dam Water Conservation Project	1,200	2022	2024
LA Forebay Recharge System–LAR Full Scale	3,000	2022	2024
Lakeside Reservoir	238	2022	2024
North Hollywood Power Line Easement	750	2022	2024
Park Retrofit #2	500	2022	2024
East Valley Baseball Park	750	2022	2024
Van Nuys Airport	300	2022	2024
Whitsett Sports Fields Park Retrofit	750	2022	2024
Big T & Pacoima Dam to LA Filtration Plant	5,000	2025	2029
Boulevard Pit Multiuse	5,000	2025	2029
Debris Basin Retrofit #3	150	2025	2029
LA Forebay Recharge System–Upper Ballona	600	2025	2029
Sepulveda Basin–Hansen SG Pipe Line 54"	3,000	2025	2029
Cal Mat Pit	750	2030	2034
Park Retrofit #3	500	2030	2034
Sheldon Pit Multiuse	1,500	2030	2034
Valley Generating Station Stormwater Capture–Phase II	700	2030	2034

7.2.2. CENTRALIZED PROJECT BENEFITS

Results from the implementation phasing for the centralized projects show that within the 20-year planning period an additional 35,000 to 51,000 acre-feet per year can be captured for recharge (Figure 32). Note that projects exist which are not included in the Aggressive Scenario list nor the Conservative Scenario list, including the LA Forebay Recharge System–LAR Full Scale, Big T & Pacoima Dam to LA Filtration Plant, Debris Basin Retrofit #3, the Cal Mat Pit, the Sheldon pit Multiuse Project, and the Valley Generating Station Stormwater Capture – Phase II. These could be slated for project development and construction in the Conservative Scenario in the years following the 20-year planning horizon.

7.3. DISTRIBUTED CAPTURE

SCMP model results show that the long-term capture potential (by year 2099) from distributed programs ranges from approximately 30,000 to 50,000 acre-feet per year. Alternatives analyses show that this potential could be met using the distributed program categories and subcategories (Table 12). To understand the potential for distributed capture in 5, 10, 15, and 20 years, implementation rates for each of these program types were developed for each of the SCMP milestones, and these rates were modeled using the SCMP Program Evaluation Framework.

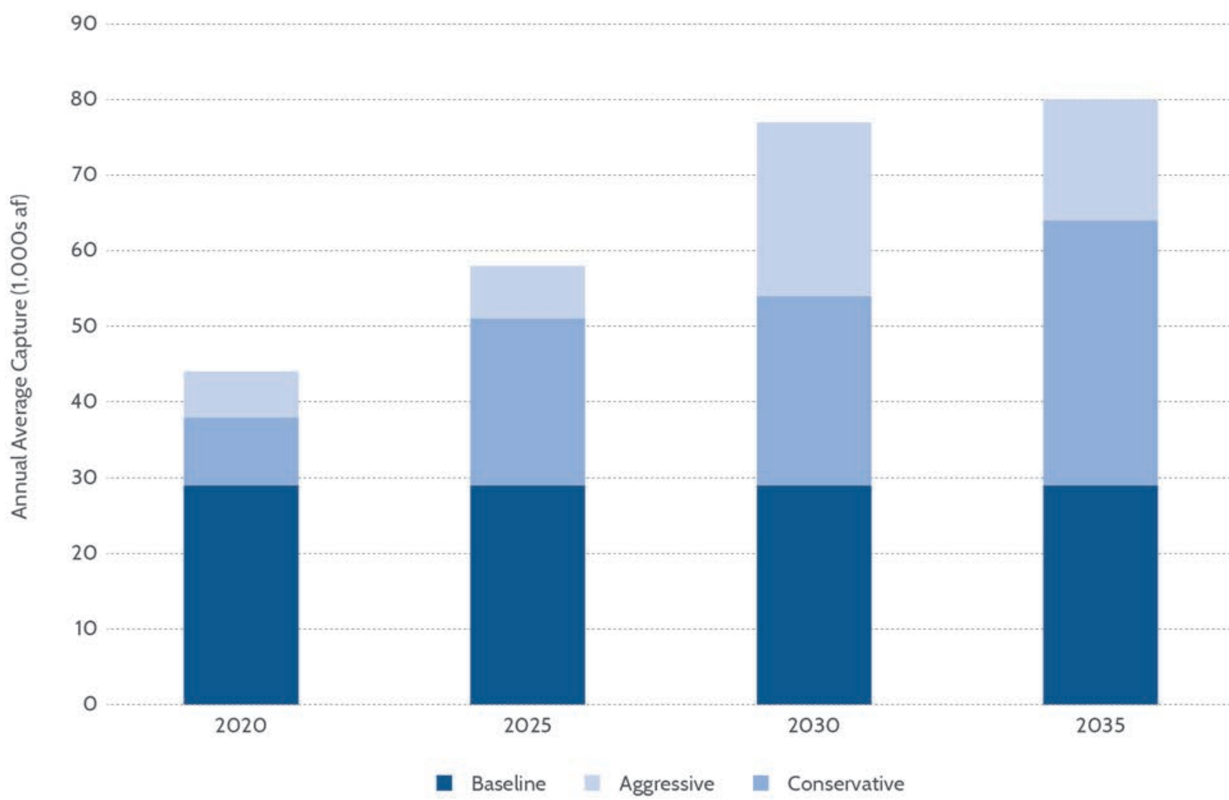

Figure 32. Centralized Project Capture

Table 12. Distributed Program Types

Program Category	Subcategory
On-Site Infiltration/Direct Use	Single Family Residential
	Multi-Family Residential
	Commercial
	Industrial
	Educational
	Institutional
Green Street Programs	Commercial Streets
	Residential Streets (Parkway Retrofits)
	Streets Adjacent to River (Rio Vistas)
Subregional Infiltration	N/A
Subregional Direct Use	N/A

7.3.1. IMPLEMENTATION RATES

Distributed programs can be implemented via three mechanisms:

1. ***Regulated Implementation.*** This refers to property owners funding, designing, constructing, and maintaining a project on their property as a result of a regulation that requires them to do so. The LID Ordinance is an example of a regulation that triggers non-voluntary implementation of stormwater capture projects by private property owners. Regulated implementation can also apply to public agencies, as would be the case with the Sustainable Streets Ordinance. This ordinance would mandate that public agencies implement distributed stormwater capture projects in any work conducted in the public right of way.
2. ***Voluntary Implementation by Private Property Owners.*** This refers to property owners choosing to fund, design, construct, and maintain a project on their property. Property owners may be incentivized to voluntarily implement projects through financial assistance (in the form of grants, rebates, financing, or utility bill credits), and/or design assistance. Incentives may also come in the form of regulations that make the benefits of voluntarily constructing a project more appealing (e.g. irrigation restrictions may encourage the voluntary construction of direct use projects to allow a property owner to increase their irrigation capabilities).
3. ***Implementation by Agency or Other Partner.*** This refers to public agencies (either LADWP, or another agency or private or non-profit entity, or a partnership among one or more agencies or entities) providing funding and contracting the design and construction of the project. The agency is then the owner of the project and responsible for ongoing operation and maintenance. This mechanism is generally limited to projects in the public ROW or publicly-owned parcels, due to the need for maintenance access.

Table 13 illustrates which implementation mechanisms are suitable for each of the program types listed. In the following sections, a description is provided of how implementation mechanisms and rates for each of these programs were developed for the SCMP milestones.

Table 13. Program Types and Implementation Mechanisms

Program Category	Implementation Mechanism(s)
On-Site Infiltration/ Direct Use	Voluntary Implementation by Private Property Owner
	Regulated Implementation by Private Property Owner

Table 13. Program Types and Implementation Mechanisms

Program Category	Implementation Mechanism(s)
Green Street Programs	Regulated Implementation by Private Property Owner/ Agencies
	Agency Implementation
Subregional Infiltration	Agency/Organization Implementation
Subregional Direct Use	Agency/Organization Implementation

7.3.1.1. On-Site Infiltration/Direct Use

Regulated implementation. Regulated implementation rates by private property owner were assumed to be equivalent with redevelopment rates (see Table 14). This means that stormwater capture projects would get implemented when properties are developed/redeveloped, in accordance with the existing LID Ordinance. It is understood that the LID Ordinance may be strengthened in the future as more emphasis is placed on stormwater capture. However, it is assumed that changes to the LID Ordinance would likely be in the form requiring individual properties to provide more capture volume, rather than increasing the rate at which the LID Ordinance is triggered. Potential increased capture requirements are accounted for in the sizing criteria that was applied to the implementation rates.

Table 14. Development/Redevelopment Rates

Land Use	Development/ Redevelopment Rate	On-site Subcategory
Residential	0.18	Single Family Residential
		Multi-Family Residential
Commercial	0.15	Commercial
Industrial	0.34	Industrial
Educational	0.16	Educational
		Institutional

Voluntary Implementation. Unlike regulated implementation, voluntary implementation is a function of a number of variables, including type of incentives offered, amount of incentive, non-financial incentives, and any number of external factors that might potentially influence people's desire to participate in a stormwater capture program. While it would be interesting to understand the impact of each of these factors independently, they are too interrelated and context-specific to perform this type of analysis with meaningful results. Therefore, rather than studying each factor independently, the collective impact of attempting to institute a stormwater capture program on implementation rates in different cities across the world was analyzed and used as the basis for developing voluntary implementation rates for the SCMP.

Research into multiple cities showed a surprising lack of data documenting the success of different stormwater capture incentive programs. Additionally, it was difficult to find cities with a reasonably similar context to Los Angeles in terms of population, population density, climate, water supply, and water quality challenges. It was determined that Adelaide, Australia provided the most useful basis for comparison, given its similar climate, highly urbanized context, and water supply challenges. Data from the Australian Bureau of Statistics showed that Adelaide was able to increase stormwater capture implementation rates by 12 percent over the course of 15 years, or 0.8 percent per year, during Australia's Millennium Drought (Australia Bureau of Statistics, 2012). Though there are obviously a number differences between the context of Adelaide during this period and that of Los Angeles in its current drought situation, this example provides a rough sense of what might be possible for the SCMP.

Therefore, the stormwater capture voluntary implementation rate (0.8 percent per year) was used as the "midline", meaning this implementation rate was halved for the Conservative Scenario and doubled for the Aggressive Scenario. Additionally, this number was apportioned between infiltration and direct use programs to reflect the relatively higher cost-effectiveness of infiltration projects (Table 15). Given the higher cost-effectiveness of infiltration projects, it is assumed that more investment would be made into these projects than direct use projects, resulting in a higher implementation rate. Therefore, implementation rates for infiltration programs were assumed to be 50% higher than those of direct use programs, approximately the same proportionality that was applied when the long-term stormwater capture potential was established previously.

Table 15. Annual Voluntary Implementation Rates for On-site Stormwater Capture

	Conservative	Aggressive
Infiltration	0.5%	1%
Direct Use	0.25%	2%

Total On-site Implementation Rate. Total implementation was the sum of implementation achieved through regulatory implementation and voluntary implementation. Total implementation rates for on-site stormwater capture programs are shown in Table 16.

Table 16. On-site Capture Annual Implementation Rates

	Infiltration		Direct Use	
Land Use	Conservative	Aggressive	Conservative	Aggressive
Single Family Residential	1.4%	4.4%	0.4%	1.2%
Multi-Family Residential	1.4%	4.4%	0.4%	1.2%
Commercial	1.3%	4.3%	0.4%	1.2%
Industrial	1.7%	4.7%	0.6%	1.3%
Education	1.3%	4.3%	0.4%	1.2%
Institutional	1.3%	4.3%	0.4%	1.2%

7.3.1.2. Green Streets

Green streets were assumed to be implemented as a result of regulatory mandate, with the anticipation of the upcoming Sustainable Streets Ordinance. Therefore, annual implementation of residential and commercial green streets was assumed to be 2.7%, or equivalent to the redevelopment rate of streets (Table 17) for the Conservative Scenario, and 1.5 times this for the Aggressive Scenario. The Rio Vistas Program, which has considerable backing and a relatively small target opportunity area, was assumed to have 50% greater uptake rates than normal green streets in the Conservative Scenario. As well, the Aggressive Scenario has Rio Vista uptake rates 50% greater than those in the Conservative Scenario.

Table 17. Annual Implementation Rates for Green Streets

	Annual Implementation Rate (%)	
Project Type	Conservative	Aggressive
Commercial Green Streets	2.7	4.05
Residential Green Streets	2.7	4.05
Rio Vistas	4.05	6.1

7.3.1.3. Subregional Projects

Because the subregional program consists of projects possibly funded by LADWP or another agency (and likely in partnership with other entities), the driving factor for implementation is available budget. In the Conservative Scenario, the assumed annual budget for this program is $6 million, whereas in the Aggressive Scenario, the assumed annual budget is $60 million. Given an estimated construction cost of one million dollars per subregional project, this equates to between 6 and 60 subregional projects being implemented annually. Further, it was assumed that 75 percent of the subregional projects would be infiltration projects, while the remaining 25 percent would be direct use projects. Given an average tributary area to each project of approximately 65 acres and a total opportunity area for the subregional projects of 232,000 acres, the annual implementation rates for the subregional projects were calculated and the results are presented in Table 18.

Table 18. Annual Implementation Rates for Subregional Projects

	Annual Implementation Rate (%)	
Project Type	Conservative	Aggressive
Infiltration	.05	.26
Direct Use	.02	.09

7.3.1.4. Summary of Implementation Rates

The annual implementation rates were applied to get program implementation rates for the SCMP milestone years (2020, 2025, 2030, and 2035). However, not all of the implementation rates would begin immediately as it takes time to implement programs and/ or policies, and to construct the first projects. Therefore, to capture this lag in accrual of benefits, a number of years was assigned to each program or policy before benefits are expected to accrue. The number of years is a function of the relative ease (or difficulty) in getting programs or policies established for the respective distributed capture category, as well as the complexity of the representative projects (and therefore the expected duration of project construction). These lags range from one to four years (Table 19).

The Conservative Scenario and Aggressive Scenario distributed stormwater capture rates for the milestone years are presented in Table 20 and Table 21, respectively.

Table 19. Years to Begin Accruing Benefits

Policy/Program	Land Use	Conservative Lag (Years)	Aggressive Lag (Years)	Explanation
Redevelopment Ordinance	Residential	1	1	Policy in place, construct
	Commercial	1	1	Policy in place, construct
	Industrial	1	1	Policy in place, construct
	Education	2	2	Policy in process, budget allocation, construct
	Transportation	2	2	Policy in process, construct
Incentive/ Rebate Program	On-site infiltration	3	2	Need to adopt policy, implement policy, construct
	Direct Use	3	2	
Subregional Project Program	On-site infiltration	4	3	Need to adopt policy, budget allocation, project development, design, construct, monitor
	Direct Use	4	3	

Table 20. Distributed Implementation Rates for the Conservative Scenario

Program		5 Year: 2020 (%)			10 Year: 2025 (%)			15 Year: 2030 (%)			20 Year: 2035 (%)		
		A/B	C	Total	A/B	C	Total	A/B	C	Total*	A/B	C	Total
On-site Infiltration (A/B) and Direct Use (C)	Single Family Residential	2	1	1	5	3	4	9	6	7	12	8	10
	Multi-Family Residential	2	1	1	5	3	4	9	6	7	12	8	10
	Commercial	2	1	1	5	3	4	8	5	7	11	7	10
	Industrial	2	2	2	7	5	6	11	8	9	15	11	13
	Educational	1	1	1	5	3	4	8	5	7	11	7	10
	Institutional	1	1	1	5	3	4	8	5	7	11	7	9
Green Streets	Commercial	8	8	8	22	22	22	35	35	35	49	49	49
	Residential	8	8	8	22	22	22	35	35	35	49	49	49
	Rio Vistas	12	12	12	32	32	32	53	53	53	73	73	73
Subregional Infiltration (A/B) and Direct Use (C)		0	0	1	0	1	1	0	1	2	1	1	1

Table 21. Distributed Implementation Rates for the Aggressive Scenario

Program		5 Year: 2020 (%)			10 Year: 2025 (%)			15 Year: 2030 (%)			20 Year: 2035 (%)		
		A/B	C	Total	A/B	C	Total	A/B	C	Total	A/B	C	Total
On-site Infiltration (A/B) and Direct Use (C)	Single Family Residential	7	4	5	18	10	13	29	16	22	39	21	30
	Multi-Family Residential	7	4	5	18	10	14	29	16	22	39	21	31
	Commercial	7	4	5	17	9	14	28	15	23	39	21	31
	Industrial	7	4	6	19	11	16	31	18	25	42	24	35
	Educational	6	3	5	17	9	14	28	15	23	39	21	31
	Institutional	6	3	5	17	9	14	28	15	22	39	21	31
Green Streets	Commercial	12	12	12	32	32	32	53	53	53	73	73	73
	Residential	12	12	12	32	32	32	53	53	53	73	73	73
	Rio Vistas	18	18	18	49	49	49	74	74	74	100	100	100
Subregional Infiltration (A/B) and Direct Use (C)		3	1	2	9	3	6	15	5	10	21	7	14

7.3.2. IMPLEMENTATION BENEFITS

The implementation rates shown in the preceding table were input into the SCMP Framework to estimate the expected stormwater capture and ancillary benefits associated with these rates. The design BMP sizes were assumed to be the 85th percentile storm for Geophysical Category C areas, and 1.25 and 1.5 times the 85th percentile storm for Geophysical Categories B and A, respectively. The 85th percentile storm was selected as it is the current design storm for the LID Ordinance. The size was increased for A and B areas, because these are areas with higher capacity for infiltration, and it was considered likely that sizing requirements for BMPs could increase during the SCMP planning period.

Given the implementation rates and design storm depths, the Framework produced estimates of benefits for each program independently. However, each of the programs has overlapping drainage areas and therefore implementing multiple programs within a common drainage area would result in each program capturing slightly less volume than if each of these programs had been implemented independently. The overlap between programs is related to their implementation rates because the higher the implementation rates of two programs are, the more likely they are to have more drainage areas that overlap. Therefore, the degree of overlap between programs will vary between conservative and Aggressive Scenarios as well as after 5, 10, 15, and 20 years as implementation rates increase. To account for this, a discount factor was developed for each program, subcategory, and scenario in order to decrease the capture volume and corresponding pollutant load reductions.

The discount factor for each program and subcategory was calculated as one minus half the implementation rate of the overlapping program and subcategory (assuming a 50% overlap with another program). Discount factors were applied to on-site programs to account for overlap with subregional programs, and discount factors were applied to green street programs to account for overlap with subregional and on-site programs.

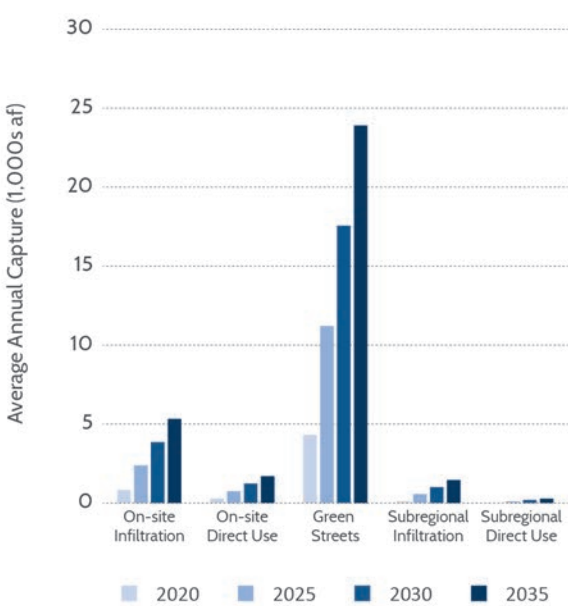

Figure 33. Distributed Capture by Program in the Conservative Scenario

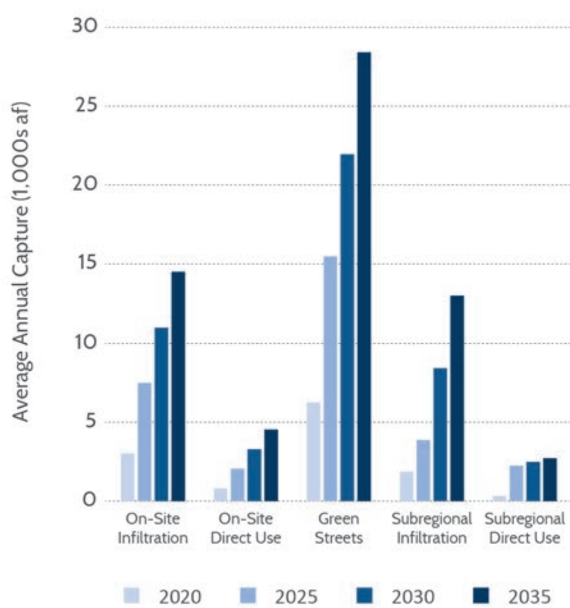

Figure 34. Distributed Capture by Program in the Aggressive Scenario

However, applying the discount factor to one of the programs because of overlap with another program may bias the effectiveness of the other program. It was therefore necessary to distribute the reductions in capture volume between the overlapping programs rather than just applying the reduction to one program. Therefore, the discount factors developed for each overlap type were weighted based on the capture volumes for each program and subcategory within a scenario. These flow-weighted discount factors were then used to adjust the original capture volumes for each program and subcategory.

After accounting for the overlap in drainage areas of each program, the capture of each program at each project milestone was calculated (Figure 33 and Figure 34). The Green Street Program accounts for the single largest contribution of stormwater capture by 2035, contributing 24,000 and 28,000 acre-feet per year in the Conservative and Aggressive Scenarios, respectively. This is nearly four times the average annual capture volume of the second largest contributing program, on-site infiltration, in the Conservative Scenario, and nearly two times on-site infiltration in the Aggressive Scenario.

Figure 35 and Figure 36 show the total potential of stormwater capture broken down by distributed program for each project milestone in both the Conservative and Aggressive Scenarios. By the end of the SCMP planning period, there is potential to capture between 33,000 and 63,000 acre-feet per year through the implementation of distributed type programs, the bulk of which would come in the form of recharged aquifers, with a much smaller portion being directly used to offset potable water demand. These capture targets are also presented below in Table 22.

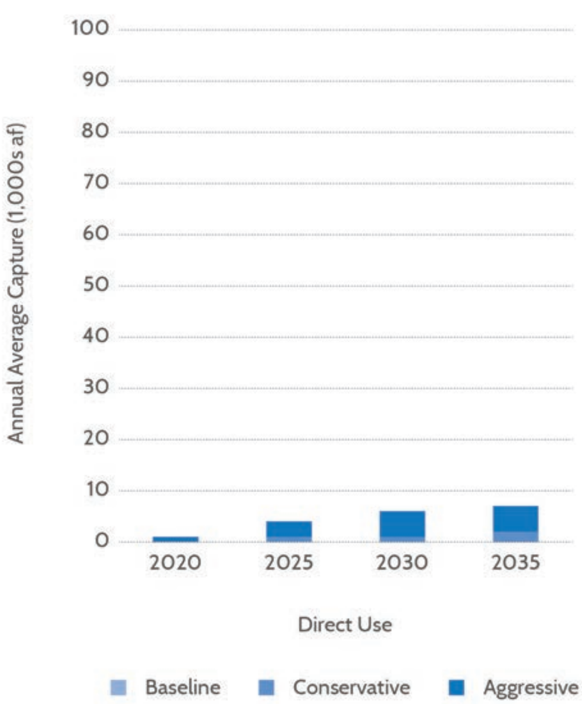

Figure 35. Distributed Capture Totals in the Conservative Scenario

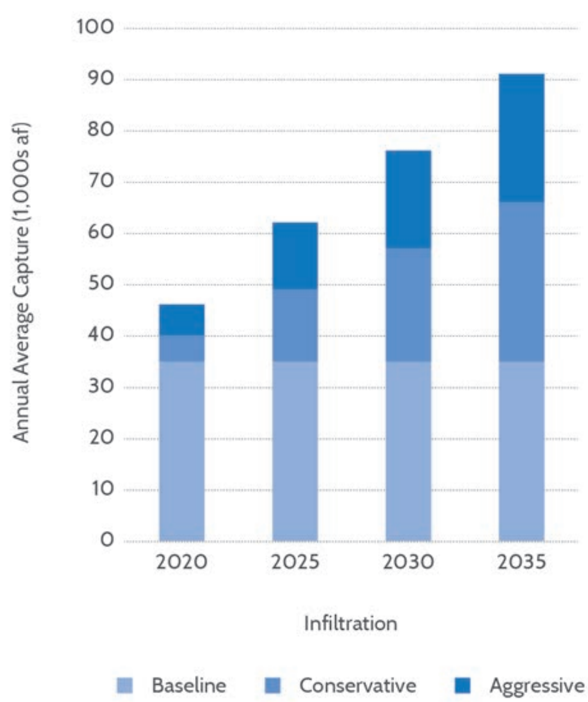

Figure 36. Distributed Capture Totals in the Aggressive Scenario

Table 22. Summary of Distributed Annual Average Capture Targets (af)

	Conservative			Aggressive		
	2020	2025	2035	2020	2025	2035
Baseline	63,000	63,000	63,000	63,000	63,000	63,000
Direct Use	-	1,000	2,000	1,000	4,000	7,000
Infiltration	5,000	14,000	29,000	11,000	27,000	56,000
Total	68,000	78,000	94,000	75,000	94,000	126,000

Figure 37 through Figure 42 present some of the additional benefits associated with this implementation of distributed programs, including water quality, green space, and peak flow reduction. These figures show that through implementing stormwater capture programs, there is potential to significantly reduce metal, nutrient, bacteria, and total suspended solid loading to surface water bodies, ultimately improving water quality at Los Angeles beaches, as well as help meet MS4 compliance requirements.

Additionally, through implementation of infiltration programs, which would involve installation of vegetated areas equal to the footprint of the BMP, the SCMP has the potential to add over 600 acres of green space in the Conservative Scenario, and nearly 1,200 acres in the Aggressive Scenario.

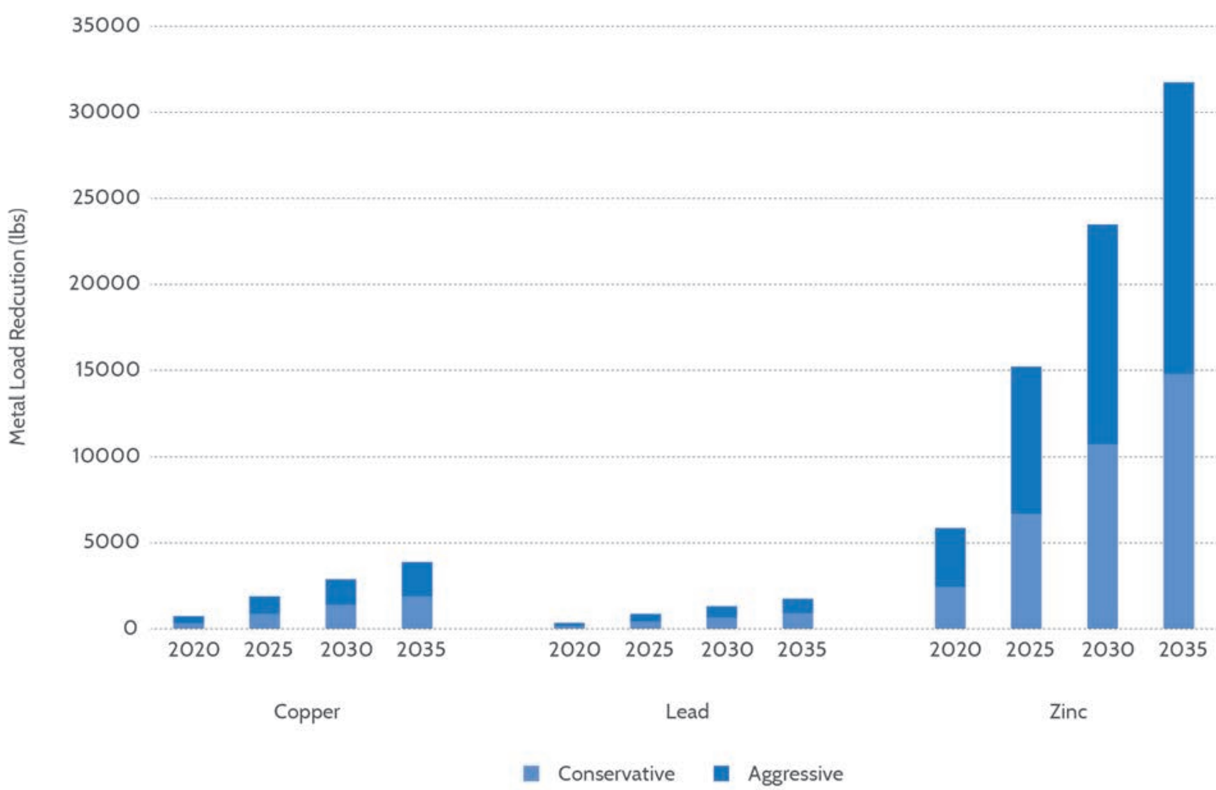

Figure 37. Metal Load Reduction

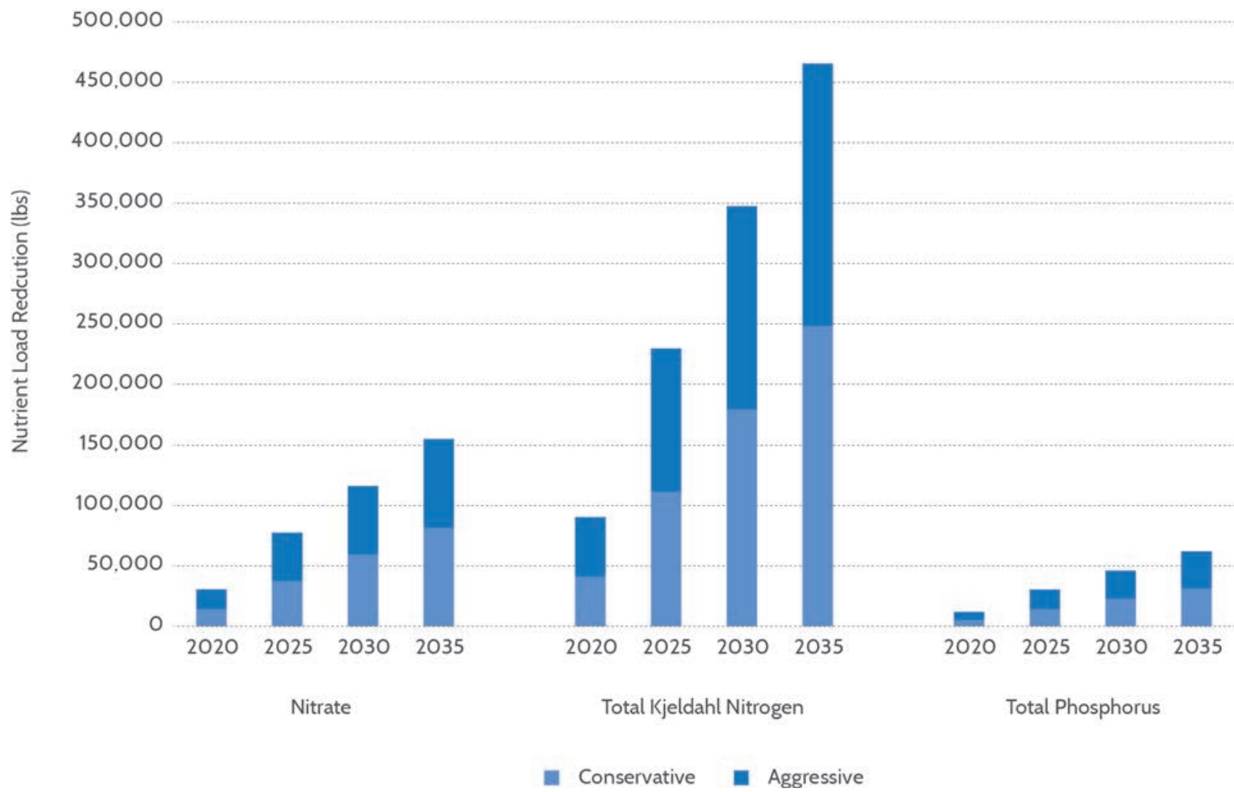

Figure 38. Nutrient Reduction

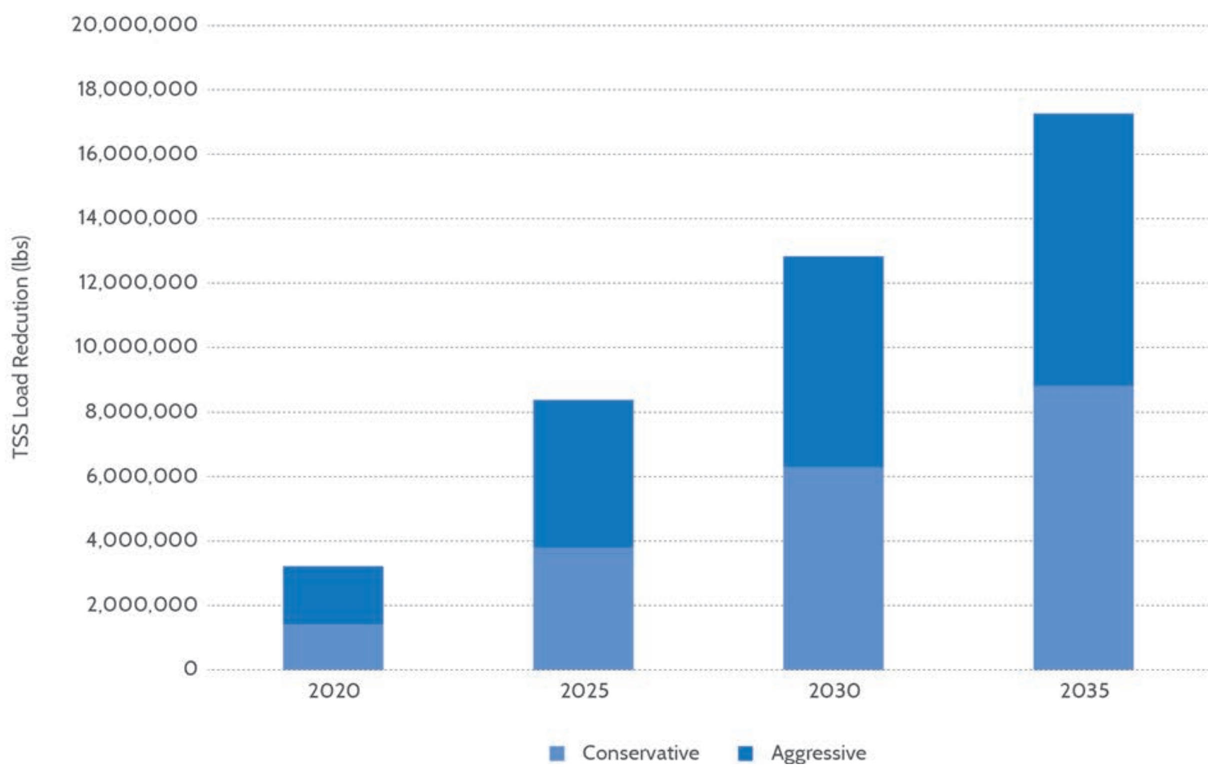

Figure 39. TSS Load Reduction

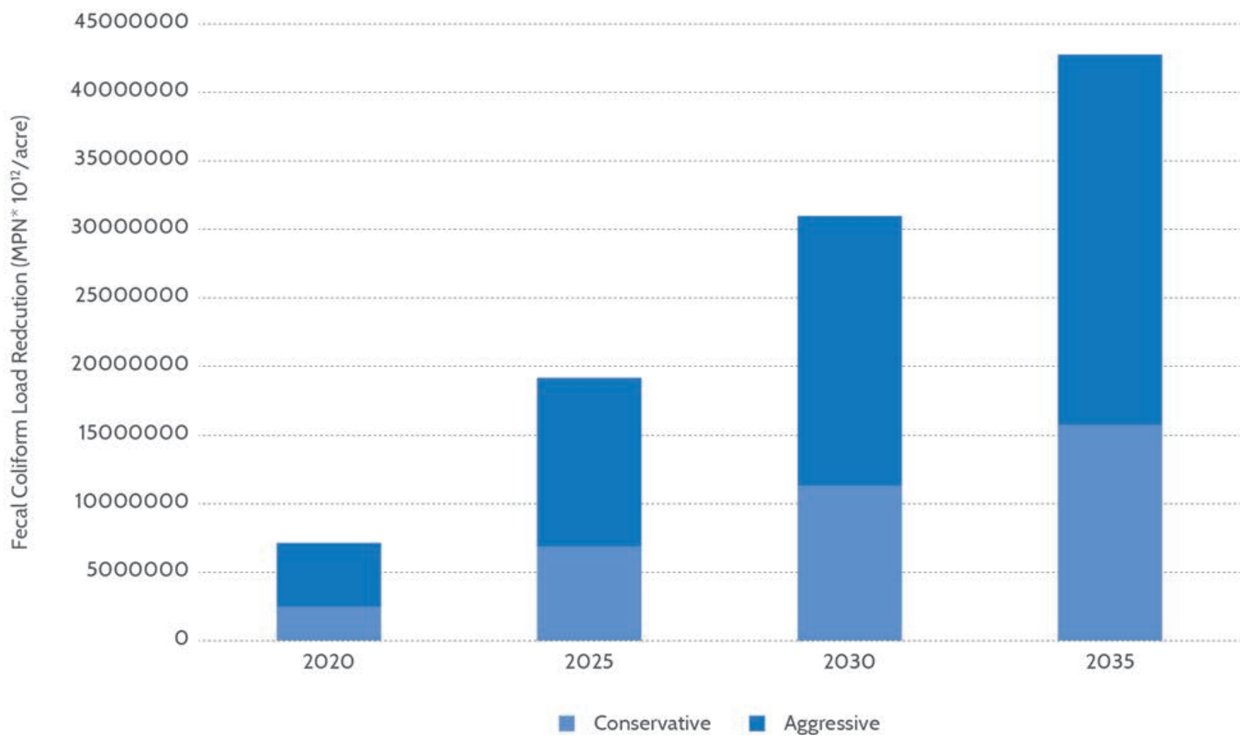

Figure 40. Fecal Coliform Load Reduction

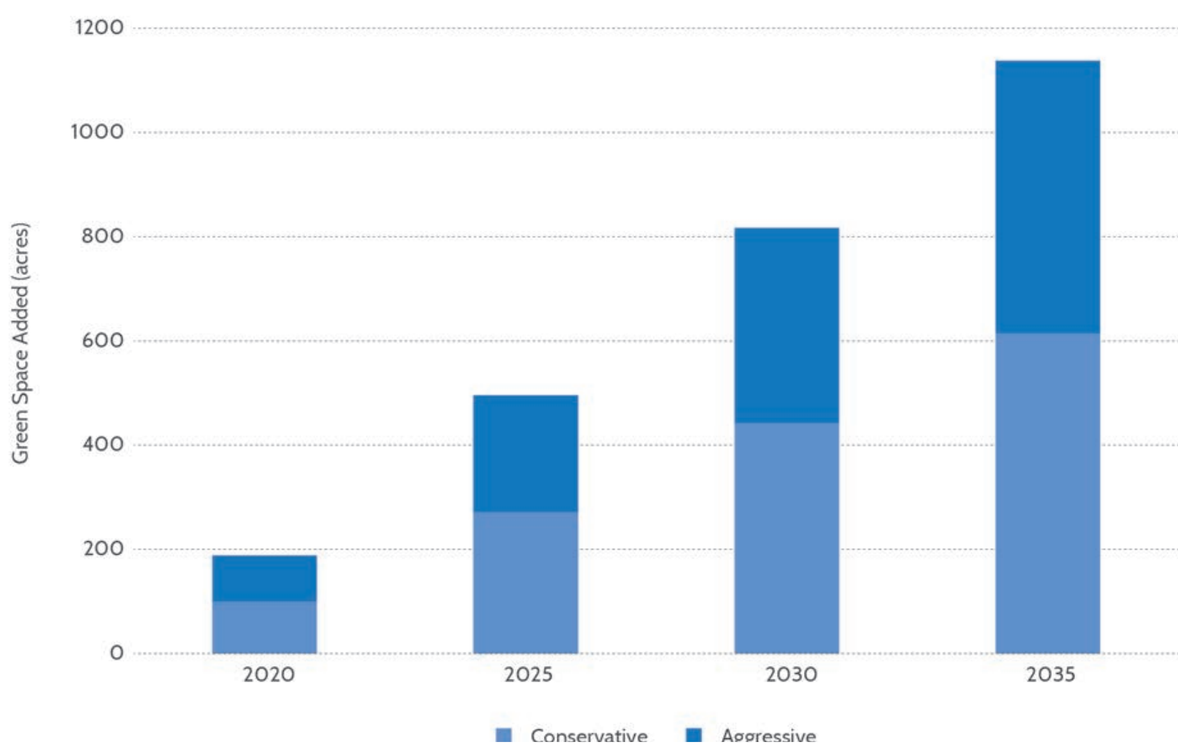

Figure 41. Addition of Green Space

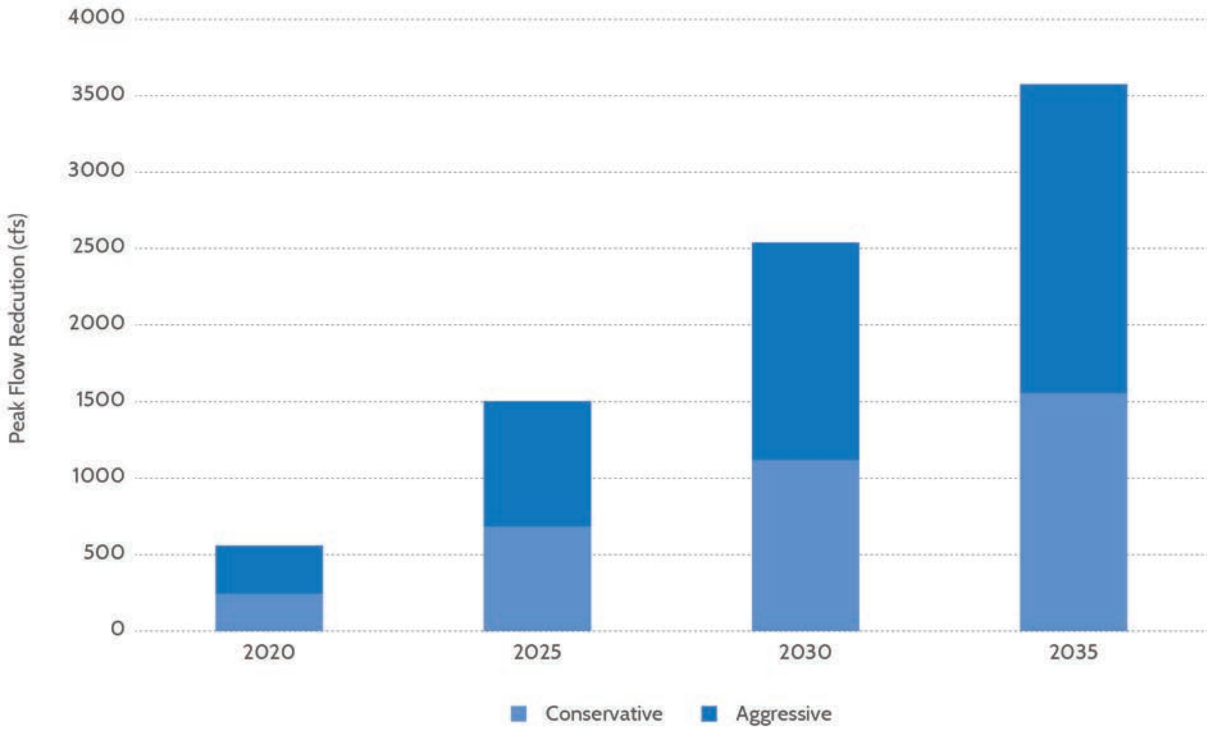

Figure 42. Peak Flow Reduction

The peak flow reduction potential in the Los Angeles River is 1,500 and 3,500 cfs in the Conservative and Aggressive Scenarios, respectively. This reduction could potentially be greater if programs included automated release valves that were linked to real time weather forecasting.

7.4. WATER SUPPLY SUMMARY

Through intensive implementation of both centralized projects and distributed programs, SCMP application would result in an annual average capture of 132,000 to 178,000 acre-feet per year. This includes the current baseline capture of 64,000 acre-feet per year; in other words, the SCMP could increase existing capture by an annual average of 68,000 to 114,000 acre-feet. These numbers include stormwater captured through infiltration type projects and programs that recharge aquifers as well as direct use programs that offset potable water demands, though the bulk of the capture is achieved through infiltration. Interim and final targets for both scenarios are presented in Figure 43 and Figure 44, as well as tabulated in Table 23.

Table 23. SCMP Interim and Final Capture Targets (af/yr)

		Conservative				Aggressive			
		2020	2025	2030	2035	2020	2025	2030	2035
Infiltration	Baseline	64,400	64,400	64,400	64,400	64,400	64,400	64,400	64,400
	Centralized Facilities	9,000	22,000	25,000	35,000	15,000	29,000	48,000	51,000
	Distributed: Infiltration	5,000	14,000	22,000	31,000	11,000	27,000	41,000	56,000
Direct Use	Distributed: Direct Use	-	1,000	1,000	2,000	1,000	4,000	6,000	7,000
	Total	***78,400***	***101,400***	***112,400***	***132,400***	***91,400***	***124,400***	***159,400***	***178,400***

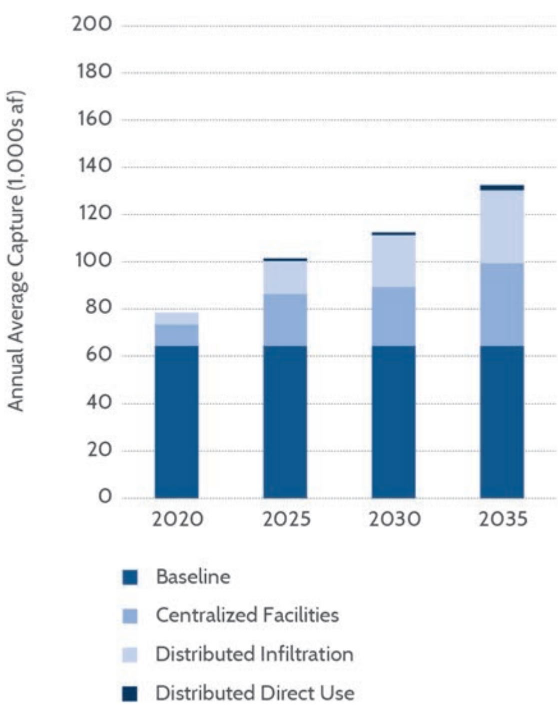

Figure 43. Capture Targets in the Conservative Scenario

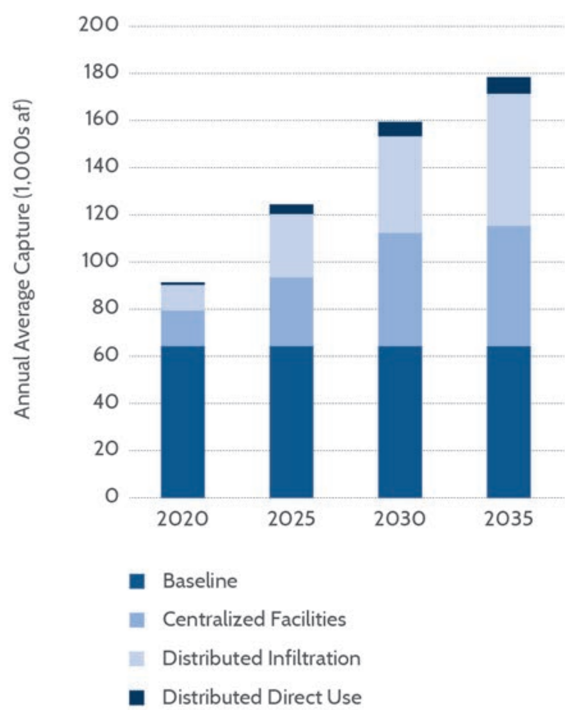

Figure 44. Capture Targets in the Aggressive Scenario

8. IMPLEMENTATION STRATEGY

This section provides a roadmap for how LADWP can increase stormwater capture in the City. General guiding principles that will inform actions to be taken by LADWP as well as more specific discussion on the recommended approach to funding and implementing specific projects and programs described in previous sections are discussed. Finally, a broader set of recommendations is provided for actions that LADWP can take to support the implementation of the plan.

8.1. GUIDING PRINCIPLES OF IMPLEMENTATION

The SCMP provides planning-level guidance on the projects and programs that LADWP should implement or support to increase stormwater capture. However, as this plan gets implemented, additional decisions will need to be made to select and prioritize specific projects. To guide LADWP in making these decisions, specific attributes will also be considered when evaluating individual projects. These are:

Sound Planning. LADWP is conservative in its approach to water supply planning–it is inclined toward more water and more storage. LADWP anticipates future regulations and policies, and how they may impact water supply planning. LADWP collaborated with the community and stakeholders throughout the development of the SCMP, and will continue to collaborate when proposing investments.

Appropriate Investment/Cost-Effectiveness. LADWP is committed to its ratepayers to ensure that it only implements projects that make good business sense. Investments must be based on clearly defined planning, reliability, and environmental and financial standards. However, while some projects may at first appear to have a high dollar-per-acre-foot price tag, by entering into partnerships with other agencies and co-investing in multi-benefit projects, LADWP may be able to reduce its share and make a defensible case for implementation of the project.

Reliable and Resilient Water Supply and Service. LADWP expects to continue to meet 100% of the demand 100% of the time. To accomplish this, LADWP needs to diversify its water supply portfolio to become drought and climate change resilient. While some individual projects may initially appear more costly, their additional expense in the near term may be warranted if they provide LADWP with a diversified water supply portfolio that is resilient in the face of anticipated threats to long-term water supply reliability.

Multi-benefit. Though cost-effectiveness is an important metric to be used for evaluating a project, projects with multiple benefits have an advantage over projects that only provide water supply benefits even though their total cost per acre-foot of captured water may be higher. LADWP looks to pursue multi-beneficial projects that address not only water supply, but water quality, localized flood protection, and open space. Multi-beneficial projects present the opportunity for collaboration and cost sharing, thus improving the cost-effectiveness of a project when viewed strictly as costs to LADWP.

Transparency and Collaboration. LADWP's goal is to provide easy-to-access information on policy decisions, outreach activities, and governance. LADWP encourages dialogue about LADWP standards with policy makers, community leaders, and the general public. Not only does collaboration potentially reduce LADWP's share of project costs, collaboration among agencies also contributes toward different goals that improve the City's overall efficiency.

Stormwater capture projects have the potential to provide non-water supply benefits as shown in Table 24. Projects that include multiple additional benefits should be prioritized over those that provide few or no additional benefits. Collaboration should be a fundamental element of all work associated with implementation of the SCMP. LADWP should work closely with other City agencies to develop coordinated strategies for meeting overlapping goals.

Table 24. Potential Benefits of Stormwater Capture Projects

Category	Benefit Potentially Provided by Stormwater Capture Project
Environmental	Flood Protection
	Water Quality Improvement
	Habitat Creation/ Restoration/Enhancement
	Heat Island Reduction
	Climate Adaptation/ Mitigation
Infrastructure	Street Repair
	Facility Upgrades
	River and Waterway Revitalization
Social	Recreation (Passive and Active)
	Neighborhood Revitalization
	Public Health Improvement
	Educational Opportunities
Economic	Job Creation

Consistent with being multi-benefit and collaborative, stormwater capture projects should also be prioritized opportunistically. While a given project may not be at the top of LADWP's priority list in a given moment, it may nevertheless be appropriate to implement if there are time limited circumstances that would work in favor of said project. For instance, if a green street project has been identified for future implementation and that street is slated to be repaired before the green street project is implemented, it may be worthwhile to adjust the timeline of implementation to coincide with the street repair. This not only has the potential to reduce project costs and improve the environmental sustainability of the project, but could also reduce disruption to the neighborhood and increase public goodwill for the project.

8.2. OPERATIONALIZING IMPLEMENTATION

To implement the SCMP, LADWP should work on multiple different tracks concurrently. These include:

Identifying project opportunities. LADWP has an established system for project identification that works well for identifying centralized and distributed project opportunities and potential project partners. However, to achieve the implementation rates proposed in this document, a systematic approach for identifying specific subregional and green street project opportunities should be developed so that distributed projects can be implemented more programmatically, rather than as individual projects. This should be done in close coordination with LASAN as it implements the EWMPs.

Managing project implementation. LADWP has been successfully managing multiple projects so that new stormwater capture projects are implemented in a cost-effective and timely manner. However, several new implementation mechanisms are proposed in this plan, such as Public-Private Partnerships and Joint Powers of Authority (see Section 8.4.1). which require LADWP to expand the current scope of project implementation management.

Developing/managing incentive programs. This plan relies on property owner implementation which would be incentivized through grants and financing offered by LADWP (see Section 8.4.4). Unlike LADWP-led implementation, LADWP does not currently have a framework for these programs, and therefore it is recommended that staff be dedicated to the development and management of these new programs.

Developing funding sources. Several funding sources are identified in this plan, some of them very familiar to LADWP, some of them newer or potential funding opportunities that may become available in the future (see Section 8.3). It is recommended that LADWP develop a coordinated approach to applying for funding and financing stormwater capture projects, researching new funding opportunities, and improving potential funding opportunities (see Section 8.5.2).

Working with policymakers. Much of the implementation of stormwater capture projects included in this plan will be done as a result of regulations that require developers to include stormwater capture projects in their developments (see Section 8.4.5). Ensuring that these regulations are enforced, strengthened, and enhanced will require LADWP to work with policymakers by providing information on how these regulations can benefit the reliability of the City's water supply, and offering input on how these regulations should be developed to provide the most water supply benefit. It is recommended that LADWP also work with policymakers to reduce impediments to stormwater capture implementation (see Section 8.5.1).

Conducting outreach and community engagement. A public that is well educated about the many benefits of stormwater capture will be an invaluable asset for the successful implementation of the SCMP. LADWP has an established public outreach office that has been successfully educating people about the City's water supply and promoting stormwater capture. LADWP's outreach office should incorporate the information provided in this plan to continue to educate the public on the potential that stormwater capture can contribute to the City's water supply portfolio, and continue to engage the public and seek public input throughout the implementation of the SCMP. Outreach efforts can leverage relationships established during the SCMP public outreach process (see Section 2) as well as from ongoing outreach efforts from the Recycled Water Advisory Group (RWAG) and Water Conservation initiatives. See Section 8.5.3 for more detailed recommendations on public outreach.

Periodically updating economic analyses. As the SCMP is implemented there will be a need for a more accurate and updated understanding of the economic value of stormwater to the City of Los Angeles (see Section 8.5.4), as this understanding informs how much LADWP should invest in stormwater capture projects. LADWP may conduct periodic economic analyses using staff or industry experts.

Conducting additional research. As LADWP moves forward with the implementation of the SCMP, there are areas of additional research that could support new approaches to stormwater capture, such as system optimization (see Section 8.5.4). LADWP may dedicate staff to conducting research internally, or provide support to others who are conducting, or may conduct, such research.

Tracking progress and revising approach. To ensure that the targets in this plan are achieved, it is critical that progress be tracked and the implementation strategies continually be revised to incorporate lessons learned in the implementation process and reflect the most current conditions that impact stormwater capture. The Framework Tool developed as part of this project will be a useful resource in tracking progress. LADWP should schedule regular (annual) intervals for assessing SCMP implementation progress and revising the SCMP implementation strategies, as appropriate.

8.3. FUNDING/FINANCING

Implementation of centralized facilities and distributed programs previously described will require funding, at least in part, by LADWP. Any proposal to use ratepayer monies for funding stormwater projects must be carefully evaluated. However, it is also important to consider that expenditures on these projects and programs will result in the development of a resource that has economic value to LADWP. If the cost of a project or program is less than the value of the captured water it provides, then implementation of this project could be considered good business and defensible to the ratepayer. Projects or programs that cost more than the value of the water they provide may still be worth implementing when the project's ancillary benefits are considered and/or other beneficiaries contribute to the cost of implementation.

It should be noted that implementing a portfolio of stormwater capture projects that can provide meaningful water supply benefits is a long-term investment, and therefore the long-term value of avoiding purchases of MWD water should be considered when evaluating these projects. Further, if project implementation is delayed until the cost of imported water is prohibitive (or imported water is simply unavailable), reliability of water supply will be threatened.

Given the value of captured water, there are a number of options available for LADWP to fund SCMP projects (bonds, state revolving funds, grants, etc.). Each funding source may be used in a variety of ways to implement different projects. For instance, grant funds secured by LADWP may be used to fund construction of a subregional infiltration project, or may be used to fund a rebate program to LADWP customers for construction of on-site infiltration projects. Further, many stormwater capture projects may be funded by multiple agencies, wherein LADWP would cover only a portion of the total-project costs based upon the benefit to LADWP, and other agencies would contribute to project implementation based upon additional benefits.

This section discusses the value of the water supply benefits provided by the projects and programs that make up the SCMP, as well as potential methods for financing them, with water supply benefits as the focus.

8.3.1. TRANSLATION OF VALUE OF STORMWATER

The capture of stormwater represents a resource value that is realized over time. This resource value to LADWP accrues as these projects generate water. LADWP can monetize this value by avoiding expenses of purchased water. In addition, due to the threats associated with continued availability of purchased imported water and LA Aqueduct supplies, there is value to LADWP in developing local supplies that are in excess of the value of the purchased water itself.

Monetizing the resource values in this manner can be translated into funding for potential projects in a variety of ways. For instance, debt proceeds may be used to fund design and construction costs, and the monetization of the value of captured water may be used to directly or indirectly support repayment of debt service costs throughout the life of the project. Understanding the economic value of water supply created by stormwater capture is a critical component to understanding how much LADWP should invest in a given project in order for the project to ultimately pay for itself.

8.3.2. VALUE OF WATER

The capture of local stormwater creates usable supplies that would not otherwise exist from any other source and helps avoid development of other options in the City's water supply portfolio. Many new supplies are developed by MWD and integrated into the rates and charges of MWD. As such, LADWP can realize the value of new water supplies by avoiding purchases of MWD's imported water. Over time, the rates and charges for this purchased water will go up, reflecting the cost of adding to MWD's portfolio with new water supplies. The vast majority of economically attractive stormwater capture projects are groundwater recharge projects, some of which will provide ancillary benefit to surface water quality, open space, and peak flow reduction. However, the primary value of these projects to LADWP is the value of the water supply that the projects create.

It is noteworthy that because LADWP relies upon MWD to develop supplies to supplement its local sources, it is incumbent upon LADWP to develop water supplies as a local resource that are less expensive than reliance upon MWD water. Conversely, if LADWP develops local water supplies that are more expensive than purchases of MWD water, then LADWP bears risk that the costs of these local water supplies will be borne by LADWP ratepayers, but much of the benefit will flow to other members of MWD because the lower-cost water supplies will become available for their use. In order to ensure that the sharing of benefits among MWD agencies does not discourage development of local supplies that are cost competitive compared to MWD's investment in new water supplies, MWD has in place a Local Resources Program (LRP) which offers subsidies consistent with the specific value of local water supply development.

8.3.2.1. Avoided Cost of Purchased Water

Economic values associated with the water supply created by stormwater capture are variable depending upon where in the production chain of delivery the supplies are realized. Projects that supply water for groundwater recharge, a source that must be pumped and treated (depending on water quality conditions), are less valuable than direct use projects that provide water sufficiently treated for their intended use. Moreover, water that is provided during off-peak use periods are less valuable than projects that provide water during high demand periods and potential shortage conditions. When viewed through the lens of avoided purchases of MWD water, the value of stormwater would vary depending upon the type of stormwater project. Infiltration projects that provide water during off-peak periods (winter, fall, and spring) are best represented by the MWD Tier 1 untreated rate. Direct-use projects supplying water in wet periods are likely represented by the MWD Tier 1 treated water rate. Only projects that produce water during high demand periods (summer) would offset purchases of MWD Tier 2 treated water.

These rates are expected to increase over time as demand for MWD water (and its sources) increases. Figure 45 shows the estimated MWD rates for Tier 1 treated and untreated water over the planning period of the SCMP. This projection is based on an assumed escalation of MWD rates of 5% per year, while general inflation (discount rate for assessing present value) is assumed to be only 2.5% per year. Escalating MWD rates at 5% is justified based upon prior history and an objective assessment of the high cost of marginal supplies compared to the average costs of existing supplies available to MWD.

Mid-point or average values from these constant dollar forecasts are useful as a representation of the current-dollar present worth of these potential revenue streams resulting from monetization of stormwater capture. The mid-point values for Tier 1 treated and untreated water are as follows:

- Groundwater Recharge/Infiltration Projects (Tier 1 Untreated) = $850/af
- Conservation/Direct Use Projects (Tier 1 Treated) = $1,300/af

It is noteworthy that any value assigned to water recharged into a groundwater basin depends upon the ability to pump and use this groundwater. Costs for groundwater recovery in the San Fernando Basin are abnormally high due to the widespread contamination of the basin by Potential Responsible Parties (PRPs). If these costs were included in the value of the recharge water, then it would suggest that the value of recharge water is exceptionally low. However, it is assumed that costs for groundwater treatment are being addressed independently of any stormwater implementation to be carried out by LADWP and therefore these costs do not impact the value of captured water.

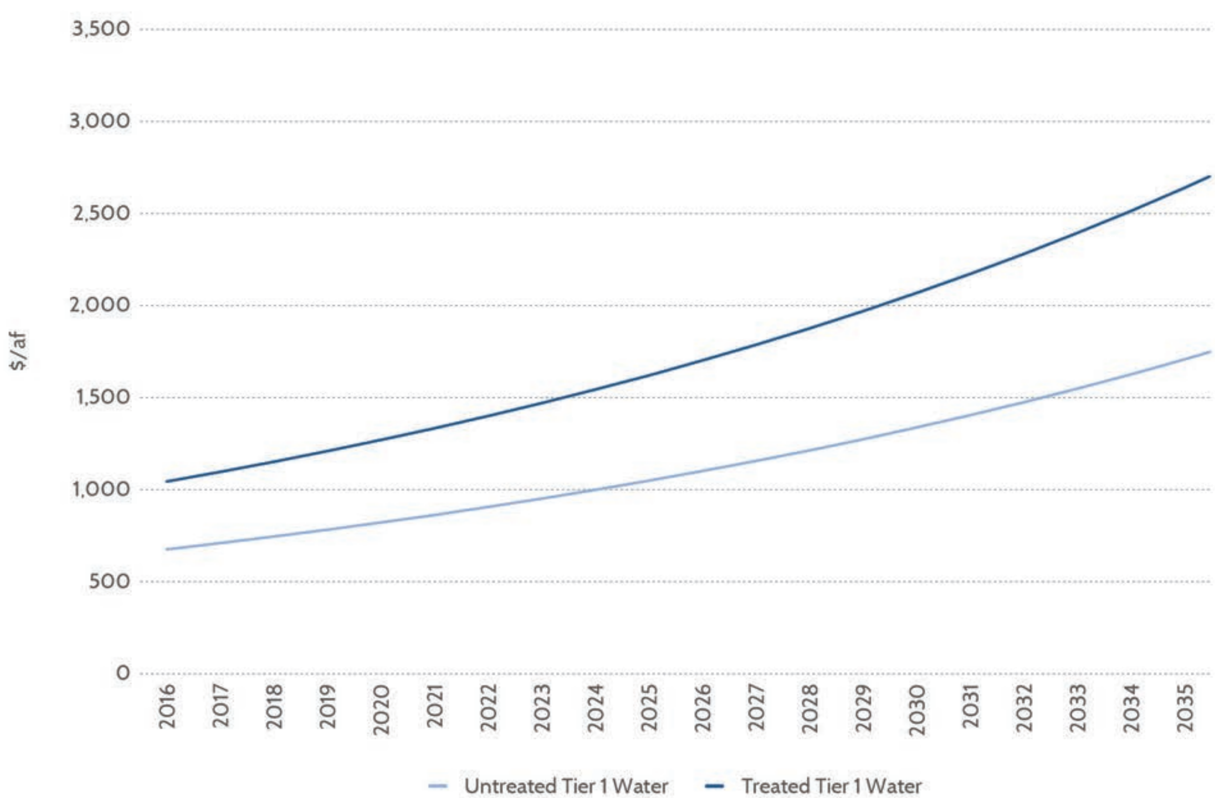

Figure 45. Projected Cost of MWD Water (Constant Dollars)

8.3.2.2. Value of Local Resource

In addition to the value of avoiding purchases of MWD water, stormwater capture projects benefit LADWP by providing a local, reliable water source. Assessing the value of this local water supply is highly complex.

MWD's LRP, a program that provides financial subsidies to water utilities for development of local water supply projects with water production for 25 years (MWD, 2014), was considered the best indicator of the additional value to LADWP of developing local water supplies that are not cost-justified based solely upon the avoided cost of purchasing MWD water. If stormwater capture plans can be developed sufficiently to demonstrate a reduction in the use of MWD water, then they eventually could qualify for the LRP. The LRP offers three payment structure options for receiving payments from MWD at the time of application:

- Sliding scale incentive up to $340/af with payment over 25 years (Option 1);
- Sliding scale incentive up to $475/af with payment over 15 years (Option 2); and
- Fixed incentive up to $305/af over 25 years (Option 3).

Because the payments are spread out over time, the dollars per acre-foot do not reflect the present value of the subsidy. Amortizing the payments for Options 1 and 2 results in a present value of approximately $200 for each option. Therefore, $200 is assumed to be the current value of the local resource. However, similar to MWD water rates, it is assumed that this LRP value will increase in real terms with time. Figure 46 shows the value of a local resource projected out over the 20-year planning period of the SCMP. Similar to the MWD rates, this projection is based on a 5% escalation in the value over time, with 2.5% inflation. This expectation that

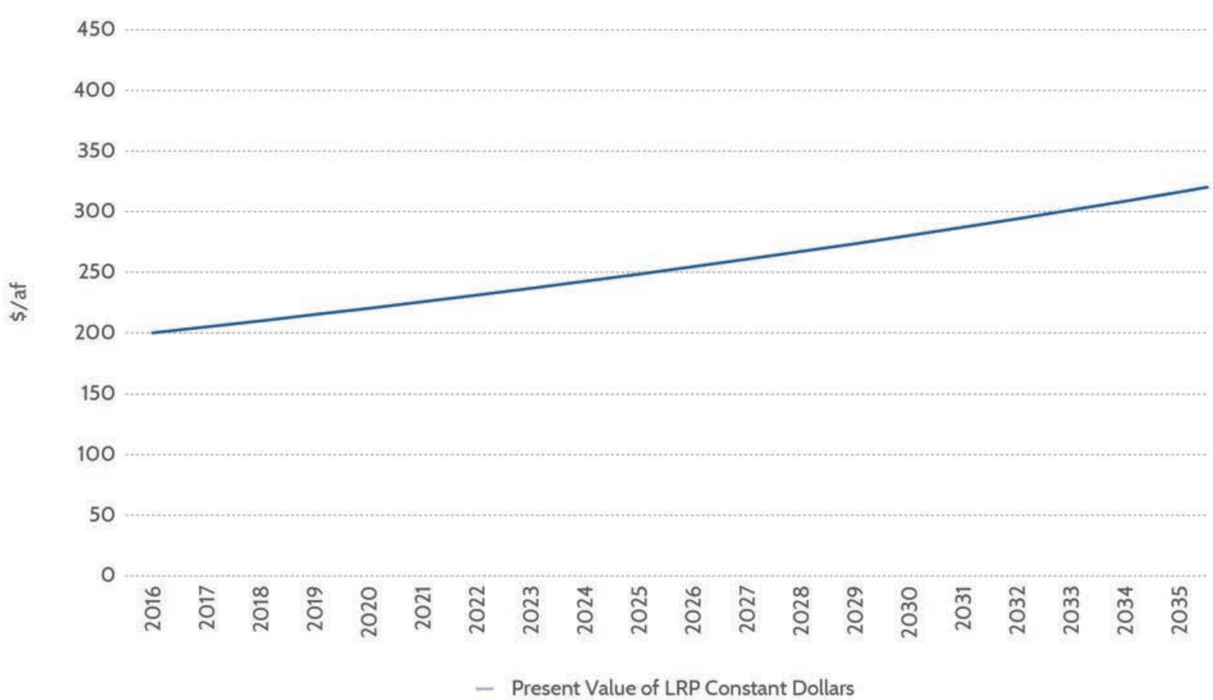

Figure 46. Value of Local Resource (Constant Dollars)

the value of the LRP and the associated value of developing supplies independent of MWD will also escalate at a rate higher than inflation results in an economic value for new local water supplies that is consistent with a number of city policies, including Executive Directives to reduce reliance on purchased imported water. The midpoint of escalating values over the 20-year planning period shows a value of approximately $250.

8.3.2.3. Total Value of Water

The MWD LRP would have the effect of adding to the avoided cost that is realized by avoiding purchases of MWD water as well as providing value to LADWP associated with having a local, reliable resource. Total valuation to LADWP of stormwater capture projects projected over the 20-year planning period is shown in Figure 47 and Figure 48 (which represent the value of recharged water and direct use water, respectively). The present value of investments that generate new water supplies over time is represented by a mid-point of the future avoided costs of water, plus the local resource value (as represented by the escalated LRP incentive). The mid-point of each of these charts is as follows:

- Groundwater recharge/infiltration projects (Tier 1 Untreated) = $1,100 /af
- Conservation/direct use projects (Tier 1 Treated) = $1,550 /af

These values are representative of how LADWP may monetize stormwater capture based upon new water supplies. Many projects and programs cost less than the value of the water they would capture, while others cost more than the value of the water supply benefit alone (Figure 49). However, these projects have benefits beyond water supply that could draw in partners willing to contribute to costs that are in excess of the value of the water captured. Although the projected value of water is based upon a constant

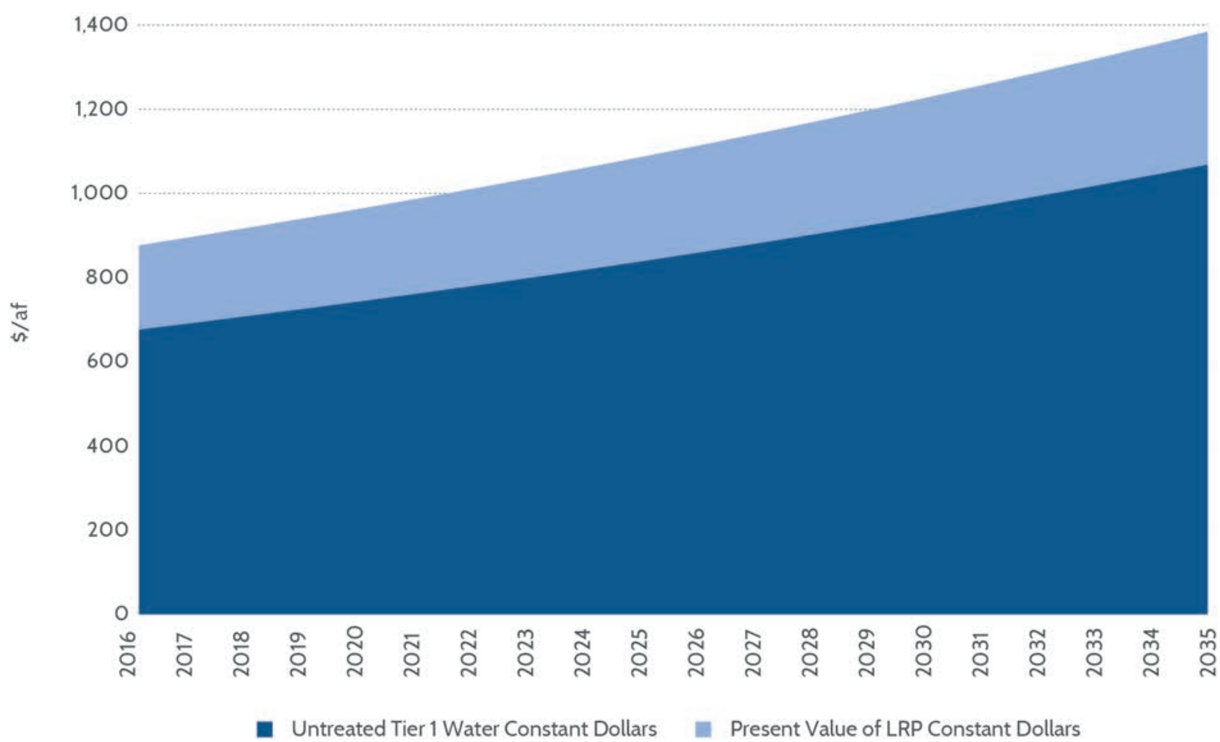

Figure 47. Value of Recharged Water to LADWP

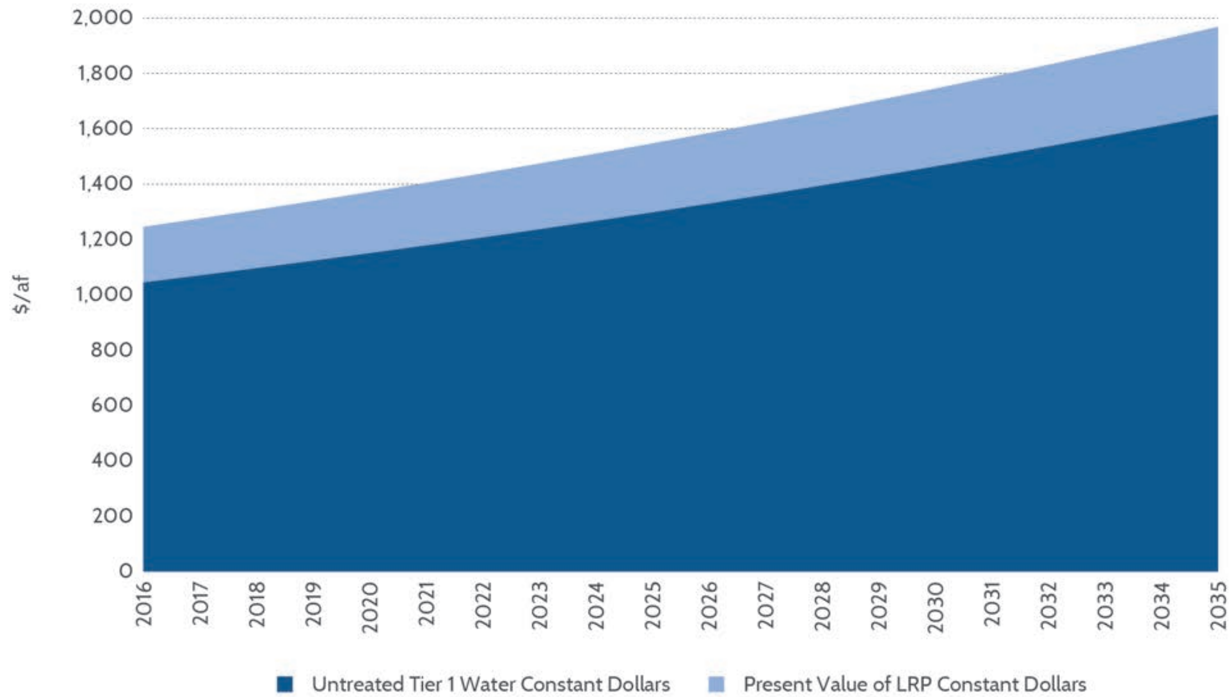

Figure 48. Value of Direct Use Water to LADWP

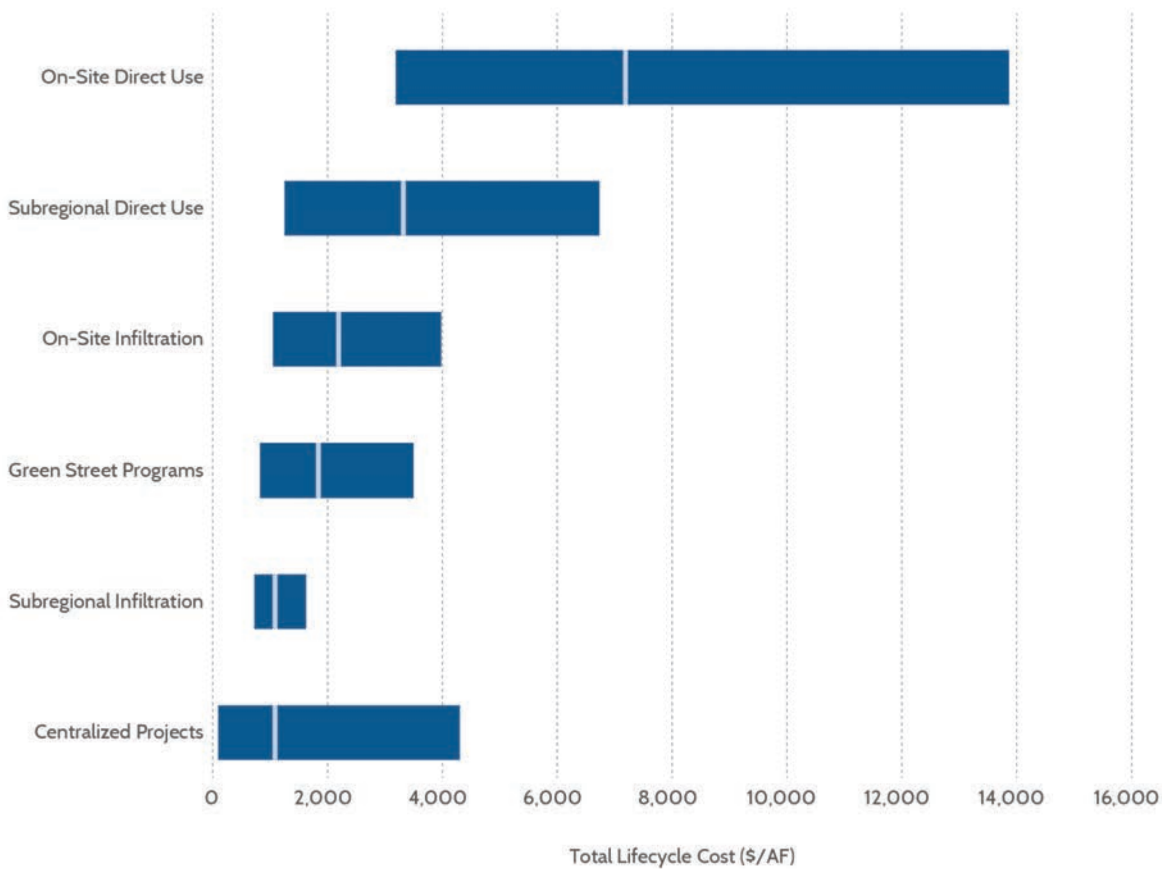

Figure 49. Cost-Efficiency of Projects and Program Types

escalation rate, in practice the escalation may be at relatively uneven rates over time. Thus it is important to periodically assess future expected values and their implication for current values.

These values can be applied in a wide range of strategies, including making payments for produced water from stormwater capture based upon then-current values or translating the anticipated values into other forms of financial contributions to projects.

8.3.3. FUNDING/FINANCING SOURCES FOR LADWP

Given the economic value of stormwater capture to LADWP, a business case can be made for funding projects that provide this resource for a cost that is less than or equal to the value of the water. SCMP projects could be funded using a "pay-as-you-go" approach, whereby LADWP's operating revenues are used to fund capital costs; however, it may be more suitable to leverage the value of the resources being generated to secure financing. Issuance of debt for water supply projects can greatly accelerate the capability to fund capital-intensive projects compared to "pay-as-you go" strategies because anticipated future savings can be applied to current capital costs.

Projects with costs that exceed the value of the of the water they generate may still be worth pursuing cooperatively with other agencies because projects that benefit water supply may also benefit other purposes, such as flood control or water quality enhancement. This may afford opportunities to obtain grant monies and to share project costs with other beneficiaries, and bring LADWP's share of project costs below the value they provide to LADWP.

Additionally, the value of the resource generated by stormwater capture projects can be translated to LADWP customers who may implement projects on their own, through on-bill financing and other financing schemes, as well as through recharge credits.

8.3.3.1. Financing

LADWP may want to use debt financing to leverage the revenue stream from potential stormwater capture projects into greater funding sources for the up-front capital portion of stormwater capture projects. Debt financing allows future anticipated revenues (including cost savings) to be applied to current investments.

Debt financing has two principal advantages. First, repayment occurs after project benefits begin rather than having to raise revenues in order to fund future savings. Second, future beneficiaries pay borrowing costs instead of burdening current ratepayers with these costs.

There are societal needs that must be carefully balanced in any decision to issue long-term indebtedness. But stormwater capture projects have long-term value that are seemingly appropriate uses of debt capacity. Moreover, the accrual of long-term benefits from current investments in stormwater capture justify financing to ensure that benefits are apportioned between current and future water users.

As described below, there are a number of options available to finance capital costs for stormwater capture projects and programs.

8.3.3.1.1. LADWP Bonds

Bond financing is an important financing source for local governments that can be used to finance capital costs of stormwater capture projects. In general terms, the pledge of a specific revenue stream (i.e. avoidance of purchased water) for a specific project (project-specific financing) may yield high-interest costs for the borrower. More often, agencies would use either taxation authorities or a broader pledge of operating revenues to issue debt financing. On the other hand, use of these broader sources of revenue may compete with a wide number of potential projects against overall limits on indebtedness that are imposed on an agency. Similar to other agencies, LADWP has limitations on the amount of outstanding additional indebtedness that can be issued.

General Obligation (GO) bonds, repaid through a property tax levy, were a common source of bonded debt prior to the limits of Proposition 13 requiring two-thirds voter approval for such forms of indebtedness. However, in some instances voters have approved new issuance of GO bonded debt with the required 2/3 majority voter approval. Because of the strong property valuation in the City, GO bonds are generally the highest rated debt (and thus the lowest borrowing costs to be issued by any city agency). The City currently uses GO bonds to fund stormwater projects under Proposition O Clean Water Bonds.

In addition to GO bonds, LADWP could also use its existing revenue-bond capacity to fund SCMP projects. Revenue bonds are repaid from revenues derived by water rates and charges to LADWP's customers. The bond issuance and the use of revenues derived from rates would need to be approved by the LADWP Board and potentially by a majority of property owners through a hearing under the provisions of Proposition 218. While it is possible to fund some projects through debt vehicles issued by LADWP, funding for stormwater capture projects would compete with a large number of LADWP's capital needs against the limits on overall indebtedness. Thus, it is unlikely that all of the worthwhile stormwater projects could be funded within the existing bond capacity of LADWP.

8.3.3.1.2. State Revolving Funds

The Clean Water State Revolving Fund (CWSRF) Program presently provides low-cost financing for water quality projects (EPA, 2014). Even though LADWP's participation in projects is based upon water supply benefits, since many of the projects proposed in the SCMP provide water quality benefits, these funds may provide a significant financing opportunity.

Borrowings through the CWSRF afford interest rates that are typically much lower than bond-market rates (e.g. 3% for a 20-year loan, instead of 6%). In fact, there are some historical instances of offering zero-interest loans. Moreover, the loans are a form of project-specific financing and can serve as a good financial resource for funding project design and construction. The cost-savings achieved from utilizing the CWSRF can vary between 17% and 25% of the total project costs compared to conventional loans (EPA, 2014; SWRCB, 2014). The maximum repayment term is 20 years. CWSRF financing may or may not affect an agency's total issuance of debt under existing bond covenants and/or other statutory/charter limits on total indebtedness. The CWSRF may be valuable to funding projects that are jointly implemented with other agencies.

The CWSRF also has an Expanded-Use Program that provides funding for stormwater treatment and diversion, sediment and erosion control, and stream restoration projects (CFCC, 2015). This special program offers interest rates at one-half of the State of California general obligation bond rate, with a repayment period of up to 30 years. There is no limit in terms of the amount an agency can borrow under this program. The principal limitation of the CWSRF is that, like most other forms of debt, funds cannot be used for project operation and maintenance purposes (EPA, 2013).

The Infrastructure State Revolving Fund (ISRF) Program, managed by the California Infrastructure and Economic Development Bank (IBank), provides financing for public infrastructure projects for environmental mitigation purposes (CFCC, 2015). Loans from this fund can be used for construction or modification of public infrastructure, including educational, cultural, and social facilities, purchase and installation of pollution control equipment, and parks and recreation facilities. The loan size can range from $50,000 to $25 million, with a maximum repayment period of 30 years. The interest rate is based on market rate but may be adjusted based on the social and economic status of the area where the project will be implemented. Like the CWSRF, loans from this source are a form of project-specific financing and may allow repayment structures that consider contributions from multiple partners.

8.3.3.1.3. Special Assessment Districts and Joint Power Authorities

Given the fact that many projects identified in this plan benefit multiple public agencies, and similar jurisdictions have similar needs for projects within their boundaries, there is an opportunity to create Joint Power Authorities (JPAs) or other special assessment districts for the primary purpose of financing stormwater projects. This opportunity creates new and potentially significant alternatives to bond issuance through the City. Bonds could be issued by JPAs or within special assessment districts, such as Mello-Roos Community Facilities District(s), Assessment Districts, Integrated Financing Districts, and Enhanced Infrastructure Financing Districts (EIFDs). These types of Assessment Districts, as their name implies, are formed to create new property assessments that can then be pledged to the repayment of bonded debt. It may be possible to issue various forms of revenue bonds through a JPA that can combine powers and revenues between themselves. The quality of revenue pledge is a key consideration in the rating of bonds issued by JPAs.

EIFDs are the newest type of special assessment district and represent a potentially useful opportunity for SCMP funding. EIFDs and the process for establishing them were defined under the provisions of SB-628-Enhaced Infrastructure Financing Districts. EIFDs can be established in specific areas, and these EIFDs can issue bonds to fund specific stormwater capture projects. Establishing an EIFD requires a 55% majority vote of the property owners within the EIFD. However, if a defined EIFD has fewer than 12 registered voters, then only a protest hearing is required to be conducted for landowners to get approval. The secure property-based revenue from these forms of debt generally yields high bond ratings and low interest rates.

8.3.3.1.4. Private Financing

Private financing is another potential source of funding implementation of the SCMP. This financing would take different forms depending on how a project was implemented. The following list provides a few examples of private financing as it might be applied to SCMP implementation:

- Many stormwater capture projects are expected to be implemented by property owners and developers because these projects provide long-term financial benefits. To secure the upfront costs to implement these projects, these parties may use a variety of financing mechanisms to fund stormwater capture projects (e.g. contractors may offer financing options for homeowners to install cisterns on their properties).
- There are substantial benefits to implementing some projects utilizing public-private partnerships. One consideration in these types of arrangements is the possibility of the private partner securing financing for capital costs rather than using public sources of financing.

- It is theoretically possible that LADWP could issue a previously unused form of indebtedness known as "private-purpose" bonds. These bonds would be taxable forms of financing managed by LADWP, but could be used for purposes beyond the public mandates of LADWP.

8.3.3.2. Cost Sharing

Stormwater capture projects identified in the SCMP can be used to provide multiple benefits that can assist other agencies and organizations in meeting their goals, which could translate to funding for stormwater capture projects provided by these agencies. Agencies that benefit from stormwater capture projects could either implement and/or fund projects independently of LADWP, or they could contribute funds to projects being implemented by LADWP, thereby reducing LADWP's total cost for that project. LADWP could also contribute funds to other agencies implementing stormwater capture projects, and this funding would have to come from one of the other sources mentioned in this section (e.g. bonds, state revolving funds, etc.).

Table 25 presents a list of representative potentially viable partnerships and the applicable benefits the SCMP project would provide to each project partner. This list is not intended to be exhaustive, as any given project could be an opportunity for countless ancillary benefits depending on the goals of the project proponents. The value of these additional benefits to each project partner may be determined on a case-by-case basis, or project partners could attempt to quantify the value of individual benefits similar to how the water supply benefit to LADWP is quantified in this document.

Table 25. Opportunities for Interagency Partnership for Stormwater Management

Potential Partners	Applicable Benefits of SCMP Projects
LACFCD	Flood protection/peak flow attenuation
	Climate change mitigation and adaptation
LABOE	Street improvements
Los Angeles River Office	Urban cooling
	Public health protection
LASAN	Potable water conservation through stormwater use for non-potable water purposes
LACDPW	Surface water pollution prevention
Local Municipalities	Groundwater recharge
	Increase non-potable water storage through installation of underground cisterns
	MS4 TMDL compliance
MWD	Potable water demand reduction
	Local supply
Coastal Commission	Terrestrial and marine habitat protection
Department of Fish and Wildlife	Water pollution prevention
	Erosion reduction
	TMDL loading reduction

8.3.3.3. Grant Funds

In addition to the value that new water supplies provide to LADWP, public sector or agency grants may be available, reflecting value to other entities from stormwater capture. A significant amount of state and federal grant funding is typically made available for flood control, drinking water, and watershed protection, but limited grants are designated for stormwater capture projects. For example, the State has planned to spend $7.5 billion under the Water Quality, Supply and Infrastructure Improvement Act (2014), of which only $200 million has been designated for stormwater capture projects statewide to enhance regional water reliability. LADWP might seek to increase the allocated grant funding.

A significant amount of the new grant funding will be used for projects involving water storage, watershed protection, and flood risk reduction. The projects in SCMP that can provide the above benefits might be eligible to apply for those grants, in addition to the $200 million grants designated for stormwater capture projects. LADWP could also consider partnering with flood control agencies (e.g. LACFCD and LABOE), MS4 permittees, as well as non-profits (e.g. TreePeople, The River Project, Santa Monica Bay Restoration Foundation, etc.) to apply for these new grants.

Grants are not expected to be the sole source of funding for SCMP given budget limitations and allocations, as well as the competitive nature of demands for government funds. For example, many grant funds do not cover 100% of first-in project costs, and quite often, cost sharing from local governments (as much as 50%) is required under grant provisions. Furthermore, grants typically cover only project capital costs, but do not cover ongoing O & M and infrastructure replacement costs.

Grants are already an important source of funding for a large number of LADWP-sponsored projects. In this regard it is important to note that pursuant to the provisions of SB-985-Stormwater Resource Planning enacted in 2014, local governments are required to have a stormwater resource plan and otherwise be in compliance with provisions of SB-985 in order to receive grants from a bond act approved by voters after January 1, 2014, such as the Water Quality, Supply and Infrastructure Improvement Act (2014). The County of Los Angeles' EWMPs could potentially be utilized as a functionally equivalent plan, but further clarification will need to be provided in the guidance document which is anticipated to be established by the SWRCB by July 1, 2016.

8.3.3.4. Regulatory Mandates

There are a number of regulatory processes that may lead to the implementation and funding of stormwater capture projects by others. There are many considerations as to how LADWP might consider its position relative to cost participation in projects that are mandated by others.

If other public agencies are required to implement stormwater capture to meet a regulatory mandate, then it may be beneficial for LADWP to coordinate with these agencies and pay some portion of the cost to help facilitate the rapid implementation of stormwater capture projects in a manner that most benefits water supply development. For example, if a public agency is complying with a mandate for stormwater cleanup and the project has water supply benefits to LADWP, then LADWP should offer that agency funding up to the full value of the water supply, in order to lessen the burden and accelerate the schedule.

On the other hand, stormwater capture projects that are required as part of development/redevelopment ordinances will be implemented regardless of LADWP's involvement, and therefore will require no funding on the part of LADWP, unless LADWP is the agency taking on the development/redevelopment. Some of the implementation of on-site stormwater capture projects will be paid for by private developers as a result of the LID Ordinance, and a significant portion of the green street projects will be financed by City departments (primarily the Bureau of Street Services) as part of the Sustainable

Streets Ordinance. The City's recent settlement with the Americans with Disabilities over their sidewalk lawsuit could potentially be another source of implementation of green streets. The settlement calls for the City to invest over one billion dollars over the next 30 years to fix broken sidewalks. Though it is currently not mandated that these improvements include stormwater capture features, it is possible that through the sustainable streets ordinance some stormwater capture feature will be included in sidewalk repairs.

8.3.4. FUNDING/FINANCING SOURCES FOR CUSTOMERS

Just as LADWP benefits from stormwater capture by avoided water purchases from MWD, retail customers of LADWP can avoid the purchase of treated retail service through the capture of stormwater and the use of water by themselves or by neighboring properties. In this manner, a retail customer can avoid purchases of LADWP supplied water and apply those savings to implement stormwater capture. However, even though the cost of the potential projects would be offset by the long-term benefits of a reduced water bill, the upfront capital cost may still be an impediment to many customers who wish to realize this benefit. Therefore, similar to how LADWP has several financing options to normalize project cost over the period of benefit accrual, financing options exist (or could be created) for customers.

In contrast to projects that reduce a consumer's use of LADWP water, infiltration projects do not directly provide a cost incentive to the customer, because they cannot use the water they infiltrate. However, the project would benefit LADWP, who would then be able to utilize this added groundwater resource. LADWP can provide an incentive for these infiltration projects either in the form of a one-time rebate or an ongoing stormwater credit.

Financing and incentive options aimed at the consumer are detailed below.

8.3.4.1. Customer Financing

The retail customer faces some of the same financial considerations as LADWP with regards to implementing stormwater capture projects that will result in avoided water purchases. It can be difficult for a property owner to justify expenditures for capital improvements that generate potential future benefits. Thus, offering financing options to retail customers can encourage these capital investments without increasing the economic costs of these programs.

A market for private sources of financing these types of improvements would likely develop over time. The same vendors that finance water conservation projects may finance stormwater capture projects. Additionally, LADWP could offer financing options to these consumers. Experience has shown that the demand created by offering financing programs can substantially increase the consumer demand for services. One benefit of encouraging the demand for new products is that the suppliers may also increase investment, and the price of new products like cisterns may actually come down.

Two financing schemes that have been applied in the energy sector that could be applied to stormwater capture projects include on-bill financing and PACE (Property Assessed Clean Energy), which have been shown to be effective ways for utilities to finance energy efficiency, renewable energy, and water conservation strategies implemented by their customers.

8.3.4.1.1. On-Bill Financing

On-bill financing refers to utility companies providing financing to individual customers to pay for specific projects while these customers agree to repay the utility through a surcharge over a fixed period. This kind of financing has been widely utilized by power utility agencies to encourage implementation of energy efficiency projects where costs can be recovered over time due to reduced energy bills. The financing provided to customers is often interest-free, low-interest, or at-cost-interest, and the terms are variable depending on the funding sources and the program structure. The advantage of the on-bill financing mechanism is that the cost for implementing specific projects will not affect other rate payers, but only the customers who opt for such a financing program.

LADWP could utilize an on-bill financing program to incentivize the implementation of on-site direct use projects. This would result in LADWP funding the up-front project costs, which would then be reimbursed by the customer over time. LADWP could apply the pay-as-you-go approach to fund the initial costs, or, alternatively, apply the financing options discussed previously in order to fund these types of loans to its consumers.

While on-bill financing can be a powerful tool for incentivizing on-site capture implementation, there are challenges to this approach that should be considered:

- The existing billing system used by LADWP may not allow for on-bill repayment. Changing the billing system to allow for implementation of on-bill repayment would require additional investment from LADWP.
- When loan-based financing is used, compliance with consumer lending laws would require significant human resource and legal support that can be costly. Additionally, the risk of incurring liability and "consumer dissatisfaction" would also need to be considered. A clear definition of who bears the risk for potential loan defaults should be established at the design phase of the program.
- Additional resources would be needed to administer and oversee these programs, which can last for many years.

8.3.4.1.2. PACE

PACE programs have been used for financing energy efficiency and renewable energy improvements on private properties. PACE programs allow local governments, state governments, or other inter-jurisdictional authorities, when authorized by state law, to fund the up-front cost of energy improvement on commercial and residential properties, which are paid back over time by the property owners through property taxes. PACE financing for clean energy projects is generally based on an existing structure known as a "land-secured financing district," often referred to as an assessment district, a local improvement district, or other similar phrase. In a typical assessment district, the local government issues bonds to fund projects with a public purpose, such as streetlights, sewer systems, or underground utility lines.

The recent extension of this financing model to energy efficiency (EE), renewable energy (RE), and water conservation upgrades allows a property owner to implement improvements without a large up-front cash payment. Property owners who voluntarily choose to participate in a PACE program repay their improvement costs over a set time period–typically 10 to 20 years–through property assessments, which are secured by the property itself and paid as an addition to the owners' property tax bills. Nonpayment generally results in the same set of repercussions as the failure to pay any other portion of a property tax bill.

A PACE assessment is a debt of property, meaning the debt is tied to the property as opposed to the property owner(s), so the repayment obligation may transfer with property ownership depending upon state legislation. This eliminates a key disincentive to investing in energy improvements, since many property owners are hesitant to make property improvements if they think that they may not stay in the property long enough for the resultant savings to cover the upfront costs.

8.3.4.2. Rebates and Credits for Infiltration Projects

Stormwater infiltration projects can increase the rate of aquifer replenishment in local open aquifers. However, generally speaking these projects do not result in a reduced use of LADWP-supplied water, and as such, the existing rate structure does not provide consumers incentive to implement these types of projects. Nonetheless, such increased groundwater recharge rates would benefit LADWP by recharging local groundwater aquifers. LADWP could incentivize such activities by providing water bill credits to participants located in those areas. The volume of stormwater infiltrated would need to be monitored, or possibly estimated based on the rainfall data and tributary area characteristics. The credit per unit volume of stormwater infiltrated could be linked to the value of the recharged water to LADWP, as described in Section 8.3.2.3.

As a complement to this strategy of offering billing credits for recharged water, the upfront cost of project construction could be financed by LADWP through an on-bill financing mechanism as discussed in Section 8.3.4.1. Alternatively, LADWP could estimate the expected long-term benefit of a given project (determined as a function of the lifetime capture volume of the project and the value of the captured water), and provide the customer with a one-time rebate or grant in some amount up to the total value of the

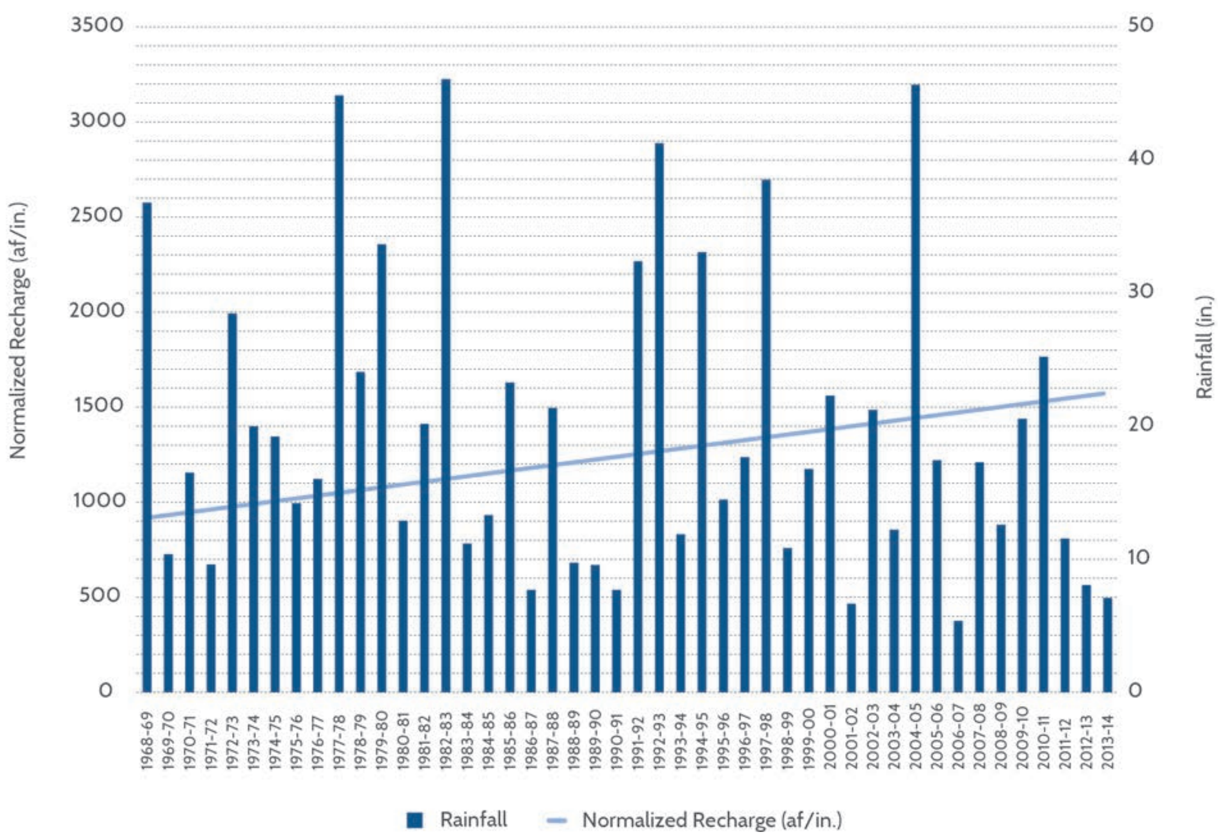

Figure 50. Increased Efficiencies in Centralized Facility Capture Over the Past Four Decades

project rather than an ongoing payment for the water generated each year. The property owner may only need to be provided with a small portion of the project costs to incentivize them to implement the project. As such, LADWP could limit the incentive they offer to be consistent with the value of the benefit the project generates, and still get projects with a higher dollar per acre-foot cost implemented by allowing the property owner to make up the difference.

8.4. RECOMMENDED PROJECT/ PROGRAM IMPLEMENTATION APPROACHES

Implementation of centralized and distributed projects and programs–and hence, increased stormwater capture over the past several decades (Figure 50)–is directly attributable to LADWP's growing focus on stormwater capture as a means of augmenting local water supplies. These increasing efforts toward identifying projects, welcoming project partnerships, and providing funding critical to the successful and timely implementation of projects is readily apparent in the increased role stormwater plays in the City's water supply portfolio. Even with LADWP's and their partners' sustained efforts, there remains significant untapped potential for additional recharge from both centralized and distributed projects. Realizing this potential will require LADWP to employ new strategies to allow projects and programs to get implemented at an accelerated pace.

To implement all of the programs laid out in the SCMP, a variety of approaches must be employed. Although there are many actions for LADWP to take, the projects and programs proposed in this plan are not expected to be solely implemented by LADWP. There are a variety of responsible parties who may direct and/or fund implementation, and there are different strategies for implementation that may be employed. Each project and/or program may be most suitably implemented by one or more of these approaches. The following section provides discussion of the implementation approaches considered to be most useful for implementing the SCMP, and how specifically these approaches should be applied to different projects and programs.

8.4.1. LADWP IMPLEMENTATION

In terms of stormwater capture implementation approaches, LADWP is most accustomed to identifying worthwhile projects and taking responsibility for implementation of these projects. This mechanism is generally suited to leading singular projects on properties owned by LADWP. However, this approach is limited by LADWP's internal capacity and available resources to manage projects. The very large number of projects proposed in this plan compared to the relatively short timeline for implementation of these projects suggests that LADWP must look to new means to implement projects. Historically, projects that have been implemented by LADWP have been implemented using the design-bid-build approach, whereby LADWP designs the projects, or has consultants design projects, and then has contractors bid on the construction of each project individually. LADWP should look at a number of alternative delivery mechanisms for these projects. Design-build delivery could be employed based upon standards and performance requirements. A JPA with other public agencies could be explored where a new micro-governance structure could encompass common goals and streamline project implementation. Public-private-partnerships (P3s) could allow LADWP to rely heavily on the private sector's expertise in executing complex project development.

Design-Build. Projects for which LADWP wishes to retain full responsibility and significant control over could be implemented using the design-build approach as an alternative to LADWP's typical approach of design-bid-build. The design-build approach involves letting out a concept to a single contractor who takes the project through design and construction. This approach can accelerate project implementation as compared to the design-bid-build approach, while still allowing LADWP to retain significant control over the project. This option would typically be limited to projects that are to be constructed on LADWP-owned land. Examples where this approach might be considered appropriate and beneficial to LADWP include the Valley Generation Station Pit Phase II and the Power Line Easement Projects described previously.

JPA. There are a number of projects identified in this plan where LADWP must take a leadership role in ensuring project implementation, but it is less clear that LADWP should take the lead on design and project management responsibilities. In these instances, some additional consideration should be given to creating new governance structures with project partners to oversee implementation. LADWP could consider a JPA with the LACFCD, or a similar structure with the LASAN. These would offer joint financing and clearer delineation of financial obligations and revenue sharing. Moreover, a new JPA could create streamlined procedures for contracting for design and construction services to minimize burdens on the existing agencies for what would amount to a huge new workload of projects.

The projects where a JPA could be most suitable include the large, non-government-owned parcels along the Tujunga and Pacoima Washes, such as the Sheldon Pit and Boulevard Pit, and the Cal Mat Pit located in the Sun Valley Watershed. Other projects where this may be applicable are the remaining projects identified within facilities owned and operated by Los Angeles County that have yet to be initiated, such as the Pacoima Spreading Grounds Project and the debris basin retrofits.

Public Private Partnerships. Considering the complexity of project development and the importance of achieving timely successes in stormwater capture at the pace described in this plan, a P3 implementation framework could be suitably employed to allow for rapid roll-out of stormwater capture projects and to achieve a large portion of the opportunity described in the SCMP. Under a P3 framework (working either for the City of Los Angeles, LADWP, or a JPA), a private consortium undertakes permitting, planning, and other aspects of project development and then may undertake design, construction, operations, and maintenance of a single facility or multiple facilities under a single contract umbrella. Often the P3 framework may include outside financing. The P3 describes a contract and details performance criteria for the projects as specified by the enabling public agency or agencies. Payment for the services is entirely contingent upon the complete satisfaction of the performance metrics, with penalties for under-performance.

Any strategic asset management effort should consider P3s for project implementation and alternative delivery of the planned programs and projects. Traditional private sector participation in such programs or projects implemented by LADWP has historically been limited to separate planning, design, construction, operations, or maintenance contracts on a fee-for-service basis based upon sequential procurement steps, and following largely the public funding allocations and service specifications. Integrating more than two of these activities into a single, bundled, aggregated service carries many potential advantages. In addition to bundling services for a single project, P3s could involve the aggregation or bundling of multiple projects to drive down permitting time, costs, staging, and other material costs. P3s have the potential for accomplishing more individual projects faster than LADWP's traditional design-bid-build approach.

If LADWP is able to manage the process necessary to issue bids and award criteria, then there would be significant leveraging of development expertise that exists in the private sector. One example to compare to is the issuance of Requests for Offers (RFOs) to developers of power generation projects which have a proven track record of successes. The SCMP has identified a number of conceptual projects, but development may include complex coordination including site identification, real property acquisition (or use agreements), environmental compliance, major permit management, approval by the Watermasters and courts, zoning, design, construction management, operations, maintenance, and monitoring. In the case of power generation, private developers have been afforded the opportunity to compete for temporary ownership interests in power generation facilities. The process has resulted in cost-effective and timely delivery of projects that likely exceed the capability of regulated public utilities to manage these projects.

There are key policy considerations for the evaluation of P3s. It may be best for LADWP to retain ownership of public assets like water rights and service authorities. Moreover, structuring how the private partner may own certain assets, may transfer assets over time, etc., are key considerations. It is very important to develop in a public process how the developers would be rewarded, how bids would be compared, what financing vehicles would be considered and how they would be compared. There are thus fundamental questions that need to be addressed in any effort to pursue P3s. Nonetheless, these are critically important to successful implementation of these vital projects.

Projects most suitable to a P3 type of delivery mechanism are those that are least defined, whose development carries substantial risk, and that are identified in this master plan as having significant potential benefits. These would include many of the subregional infiltration and direct use programs, any airport project, the Los Angeles Forebay projects (in the Upper Ballona Creek watershed and also along the Los Angeles River between downtown and the City of Vernon), green streets projects, and options for storm drain mining.

Many of the centralized and subregional projects for groundwater recharge are very cost-effective, yet their implementation requires substantial planning and development steps which could substantially delay their implementation. We recommend that LADWP take innovative steps to speed implementation:

1. Develop up-front documents and analyze alternative forms for Requests for Proposals (RFPs) for all projects describing the concepts, public assets that are to be offered, and the basis for compensation to the developers, including methods to evaluate competing costs and structure payments to successful bidders.
2. Explore the formation of JPAs or other new governance structure to undertake management of the projects that make sense, given the multiple benefits and jurisdictions involved in stormwater capture projects. In particular, it is recommended that LADWP investigate the possibility of forming a JPA with LACFCD to oversee projects on flood control and recharge facilities, as well as the possibility of forming a governance structure with LASAN to oversee projects needed to achieve MS4 compliance that provide water supply benefit.

3. Actively consider the various forms of P3 alternative delivery routes for both centralized and subregional projects. There are a number of steps that can be undertaken to consider P3s, without a full commitment to this delivery method until LADWP is satisfied that the purported benefits will be realized under this method. All the while that LADWP is considering alternative delivery routes, it should continue with its traditional path to program implementation without deviating from its current course.

   LADWP can issue an RFP whereby private bidders would be solicited for creative, innovative ideas for bundling any or all of the projects or programs given the funding and financing sources available. Proponents would be asked to demonstrate the economic, financial, and programmatic benefits to LADWP in their nonbinding responses. LADWP would then be able to evaluate these P3 delivery methods as viable options to more rapidly–and possibly more affordably–drive, implement, and manage the program. The RFP would contain sufficient questions to solicit meaningful responses that would discuss in more detail the feasibility, practicality, and benefits of using P3 alternative delivery methods for LADWP's formal consideration.

4. Develop project descriptions and proposals for the Water Replenishment District's Water Rights Panel in Central Basin and West Coast Basin, and offer other agencies an opportunity to participate in projects to increase yield. The prospect of competition between various entities and proposals could substantially confuse and delay projects with similar elements and aims. LADWP could create a framework for a process to ensure evaluation of all related proposals and selection of the most effective implementation strategies.

   Solicitations to all potential project developers (including agencies and P3s) could be approved in advance by the Water Rights Panel, and Water Rights Holders would be afforded the opportunity to opt in or opt out of these programs, and development contracts could be awarded for the most desirable means to achieve these projects.

5. Create a communications/outreach plan where new ideas for project delivery are vetted through the stakeholders and governance boards.

8.4.2. AGENCY/ORGANIZATION (NON-LADWP) IMPLEMENTATION

Where projects must access broader beneficiaries and funding partners in order to achieve success, and the project is not by itself an economically attractive means of achieving water supply, it is less appropriate for LADWP to assume the lead role in development and dictate processes for project implementation. It is nonetheless beneficial to LADWP to appropriately cooperate and offer financial support to other agency/organization actions as they relate to stormwater as a water supply, since many entities are implementing worthwhile projects within the City's boundaries. Beyond the core partners of LASAN, LABOE and LACFCD, there are many other agencies and organizations who have an interest in implementation of stormwater capture projects (e.g. TreePeople, the Los Angeles River Revitalization Corporation, the Friends of the Los Angeles River, the Trust for Public Lands, Pacoima Beautiful, the River Project, etc.). These agencies and organizations identify projects based on their own project selection and implementation criteria, though they may seek partnerships with other agencies and organizations that would benefit from their project. Historically, LADWP has contributed significant funds to numerous projects undertaken by other agencies and organizations when these projects provide a water supply benefit.

As stated previously, it is recommended that LADWP examine new structures to implement projects with core partners. If it is determined that a new governance structure is not desired, then there should still be a strategic plan for coordinated project implementation.

It is also important to note that while it is recommended that LADWP take a leadership role in exploring and developing projects with LASAN and LACFCD and developing new methods of delivery for these types of projects, it is important that historic methods of delivering them are not abandoned. Thus, these historic types of arrangements where LADWP would contribute to projects undertaken by others would likely continue. Projects such as the South LA Wetlands, Aliso Creek Confluence Park, Water LA, and the Rio Vistas projects could all fall under this category.

For non-core partners, LADWP should continue to examine project proposals on a case-by-case basis and identify how LADWP assistance could encourage other agencies or organizations to implement a project earlier than they might have otherwise scheduled it for implementation and/or achieve significantly greater water supply benefits. These types of interagency/inter-organization partnership projects would continue to enhance the potential social, environmental, and economic benefits ('triple bottom line') provided to the community, while optimizing local government funding efficiency.

It is anticipated that many of the distributed projects could be implemented in this way, including individual green street projects, or neighborhood-wide on-site implementation programs (e.g. the River Project's Water LA program). Additionally, this implementation method would include projects not named within this plan at all. This is because organizations that are looking through lenses of these other societal benefits are likely to identify projects where water supply is a secondary benefit that may not have been identified in this plan, where water supply is the primary focus.

Where LADWP's role is one of providing supporting funds, specific funding arrangements could vary depending on the needs of each partner. LADWP could contribute a certain percentage of a project's capital construction cost, or alternatively, LADWP could establish a contractual agreement with the partnering agency to "purchase" the stormwater captured by the project. "Purchasing" captured water is an attractive option for some projects as it would provide an alternative stable revenue source for agencies or private entities undertaking stormwater capture to cover part of their financing and O&M costs for the projects. As other agencies identify the value of stormwater capture projects with regards to the benefits they provide to each agency's mission, partnerships and cost sharing agreements can be more easily facilitated, thus increasing the rate of project implementation.

There is much work that defines LADWP's cooperative role with other agencies, and participation in new plans and organizational studies is still warranted. However, the benefits identified in this master plan can be used on an interim basis to help fund substantial and significant new projects and programs. It is recommended that LADWP:

1. Continue to support and participate in the City of Los Angeles' One Water LA program, to integrate stormwater and recycled water master plans.
2. Continue to contribute funds to projects and programs being implemented by other agencies and organizations that provide valuable water supply benefits. There should be a standardized formula for

the contribution of ratepayer monies for projects that generate water supply for the benefit of LADWP. Cost sharing formulae should be reviewed with the Office of Ratepayer Advocates.

3. Encourage other agencies that accrue benefits from stormwater capture projects to describe the value of those projects to their respective agencies and organizations. By creating a clear and transparent system where each agency and organization understands the respective values of the multiple benefits these projects bring to each other, cooperative funding agreements can readily be developed. This, in turn, allows for these partners to actively seek supplemental funding from outside sources to fill any budgetary gaps that remain.
4. Continue to share data with agencies, such as LABOE, in order to opportunistically identify projects that meet multiple agency needs (e.g. unmet drainage needs).
5. Develop standard MOUs with common partners to streamline participation in projects. Since cooperative agreements require significant effort to develop, review, and approve, a standard template with boiler plate language for the common terms and conditions should be developed jointly with partnering entities.
6. Pursue cooperative agreements with the municipalities that have the capability to access potable water from the Hollywood and Santa Monica Groundwater Basins.
7. Monitor scheduled projects of other agencies to identify opportunities to accelerate projects or shift priorities among projects to take advantage of favorable conditions created by others.
8. Work with Los Angeles Unified School District (LAUSD) to develop a program to allow for the installation of subregional capture projects on their campuses.

8.4.3. COORDINATION WITH EWMP IMPLEMENTATION

Implementation of the EWMPs will undoubtedly require programmatic regional, subregional, and distributed stormwater capture efforts within the City on an unprecedented scale. However, successful implementation of the EWMPs faces many significant challenges, not the least of which is funding. Effective coordination between LASAN and LADWP during the implementation of the EWMPs could produce substantial increases in stormwater capture for the City and assist both agencies in meeting their respective goals.

Coordination between LASAN and LADWP has already been initiated during the development of the SCMP and the EWMPs, and this common understanding of the methods used to develop both plans will prove a useful basis for continued collaboration.

Many of the recommendations provided above apply to how LADWP should coordinate with LASAN in EWMP coordination, but they are presented here as well with specific emphasis on how they may be applied to this particularly strategic partnership. It is recommended that LADWP:

1. Offer funding support to EWMP implementation consistent with the water supply benefits as described above. Since LADWP has defined an approximate value of stormwater, both as recharged groundwater and for beneficial direct use, LASAN should be able to openly approach LADWP to assist with project implementation.
2. Explore the preparation of structures for an EIFD with LASAN to create mechanisms

for financing and cost participation in joint SCMP/EWMP implementation.

3. Closely coordinate and collaborate with LASAN for subregional program[6] and green street development, including sharing data and maps to allow for comparison of prioritized project areas, thus facilitating identification of opportunities for project collaboration. Both the SCMP and the EWMPs rely heavily on subregional implementation to meet target capture volumes, so coordinated implementation of these projects could help overcome funding challenges and improve efficiency of implementation.
4. Develop a streamlined approach to project identification and partnering agreements. Through this plan, LADWP has clearly identified the areas that are priorities for stormwater capture projects for water supply, as well as a tool for estimating project benefits. These estimated benefits, paired with the estimated value of water presented herein, can be used to develop cost-sharing agreements between LADWP and LASAN.
5. Encourage LASAN to produce a similar statement regarding the priorities under the EWMPs and the value to them of captured stormwater.

8.4.4. PRIVATE PROPERTY OWNER IMPLEMENTATION

Projects located on private property (i.e. on-site infiltration and on-site direct use) are not ideally suited to be implemented by LADWP directly. However, private property owners fund and implement stormwater capture projects for a number of reasons, including regulatory requirements, water conservation, and a desire to be environmentally responsible. Sometimes these projects are undertaken by the owner, but much more often, the design and construction work is undertaken by private contractors. Willingness to implement projects can be greatly influenced by a number of factors including education programs, rebates and incentives, financing opportunities, design assistance, and ease of permitting.

The recommended actions for LADWP to encourage property owner implementation of stormwater capture projects are consistent with the premise that the existing rate structure offers sufficient economic incentives for on-site direct use programs, but those can be improved with financial incentives which would not increase costs for ratepayers. For infiltration projects, new economic and financial incentives are appropriate.

To encourage property owner implementation of on-site programs, it is recommended that LADWP:

1. Offer the following credits/grants/financing options to property owners:
    a. On-bill credits for measurable infiltration increases implemented by these projects. These credits should be equal to the value of the infiltrated water as described above, plus grant monies that can be obtained for such projects.
    b. One-time grants/rebates in the amount of the present value of the infiltrated water that would be generated over the lifetime of the project.
    c. On-bill financing to customers wherein LADWP would offer to finance the up-front costs of on-site stormwater infiltration or direct use projects based upon their estimated water savings with repayment by the consumer on a schedule not to exceed the anticipated useful life of the improvement.

6. Projects termed subregional in the SCMP are referred to as regional projects in the EWMPs.

2. Develop standard terms for maintenance and monitoring of infiltration projects that would be required in order to be eligible for credits and grants.
3. Work with LADBS to:
    a. More accurately map areas where infiltration is applicable or not applicable due to liquefaction or expansive/collapsible soils.
    b. Implement plan check procedures to estimate the increased stormwater capture that can occur from these types of projects in different areas of the city.
    c Reduce impediments to permitting of on-site infiltration and direct use projects, including encouraging the exploration of the feasibility of non-potable indoor use of captured stormwater.
    d. Develop design guidance for on-site infiltration and direct use projects.
4. For future landscaping conservation rebate programs that LADWP participates in (like MWD's expired turf removal rebate program), add provisions that require stormwater capture programs be included in all landscape conservation projects, or increase the grant amount if stormwater capture projects are included.

8.4.5. REGULATED IMPLEMENTATION

Developers fund and implement projects largely as a result of regulatory mandate. This can be private developers constructing on private properties, as required by the LID Ordinance, or in public ROW by private developers and public agencies, as may be required by the Sustainable Streets Ordinance.

To encourage regulated implementation of on-site programs, it is recommended that LADWP:

1. Support strengthening of LID Ordinance requirements. Specifically, encourage the requirement of larger design storm volumes in areas well suited to infiltration.
2. Provide political support for efforts to improve enforcement of LID Ordinance.
3. Investigate the development of a stormwater capture retrofit ordinance that would require stormwater capture projects to be installed in homes upon resale.
4. Participate in the development of the Sustainable Streets Ordinance and associated guidance manual. Encourage maximization of design storm volume requirements, particularly in areas well suited to infiltration.

8.5. SUPPORTING IMPLEMENTATION

The section above lists recommendations for implementation of each of the proposed project and program types contained within the SCMP. Achieving the targets laid out in this plan will also require a broader effort aimed at supporting the general landscape of stormwater capture.

8.5.1. REDUCE IMPEDIMENTS

To reduce impediments to widespread adoption of programmatic stormwater solutions, it is recommended that LADWP:

1. Continue with the groundwater clean-up efforts in the San Fernando Basin to ensure that LADWP ratepayers' investments in infiltrated groundwater can be recovered cost-effectively for use in the LADWP potable system. Ensure that the groundwater basin's ability to store and recover water is not compromised in the remedy for contamination.
2. Develop procedures to measure, model, or estimate distributed infiltration projects' contributions to local groundwater supplies, and seek approval of these quantification procedures with the

Watermasters in the ULARA, Central Basin, and West Coast Basin.

3. Work with LABOE and LADBS to:
   a. Refine currently designated zones of liquefaction. Currently many infiltration projects are hampered by ill-defined zones where liquefaction may occur. Since the time these zones were defined, new technologies and techniques have been developed to better define them. In addition, groundwater levels have declined. Given these new techniques and conditions, new mapping should occur.
   b. Create high-resolution maps of areas where expansive and collapsible soils exist. In some areas of the City, it may be appropriate to avoid saturation of these soils to protect surface structures. However, in most areas of the City, new programs to retain and recharge stormwater would not have adverse consequences. Implementation of on-site, green streets, and subregional infiltration projects are continually being hampered because concerns regarding these geologic risks are not clearly defined and thus are more conservatively addressed .
4. Collaborate with all agencies that have permitting authority to streamline permitting of stormwater capture projects. An example where this has occurred in another arena is on the Los Angeles River. Led by LABOE and LACFCD, the Los Angeles River Cooperation Committee (LARCC) was formed to provide a pre-approval process for many LA River related projects.
5. Seek advice on creative approaches to limit the liability landowners inherently accept for actively diverting stormwater generated offsite onto their properties for capture and recharge. There is a concern that by taking offsite water on-site, pollutants commonly found in stormwater could accumulate over time, creating a hazardous condition requiring expensive cleanup.
6. Seek cooperation from LASAN, LABSS, LACFCD, etc. on securing funding streams for adequate maintenance of stormwater capture projects.

8.5.2. IMPROVE FUNDING OPPORTUNITIES

While there are currently many options for LADWP to leverage funding for projects included in the SCMP, there are actions that LADWP can take to increase or improve these opportunities. To this end, it is recommended that LADWP:

1. Develop comprehensive infiltration and recovery programs for stormwater to help ensure that MWD offers LRP subsidies for stormwater capture.
2. Encourage the state to increase the funding allocation for stormwater in the Water Quality, Supply and Infrastructure Improvement Act, which represents a significant source of potential funding for SCMP projects. Alternatively, rely on the multiple benefits of stormwater capture projects to allow projects to be funded from other allocations in this fund (e.g. groundwater sustainability, regional water reliability, and watershed protection and ecosystem).
3. Review and comment on the guidance document to be developed for SB-985-Stormwater Resource Planning (anticipated to be established by the State Water Resource Control Board by July 1, 2016) to ensure that these plans can be utilized as a prerequisite for obtaining all forms of funding.

8.5.3. PUBLIC EDUCATION/ ENGAGEMENT

A public that is well educated about the many benefits of stormwater capture is an invaluable asset for the successful implementation of the SCMP. An informed public helps garner political and funding support for bold decisions and large investments LADWP will need to take to implement the plan and encourage property owners to implement parcel-based retrofits on their properties. It is recommended that LADWP conduct public outreach campaigns aimed at:

1. Educating the public on the importance of stormwater capture in improving the reliability of the City's future water supply, including programs targeted specifically to school-age children.
2. Educating the public on the successful implementation of programs and projects and the multiple benefits they provide.
3. Encouraging private property owners to take advantage of incentives to implement on-site stormwater management projects. This should involve an approach with strategies developed based on past research, consumer/marketing data, etc., to ensure that stormwater capture projects are not only installed properly, but then actually used and maintained by their owners. Community Based Social Marketing is a model for this type of outreach that has shown to provide a high return on investment for outreach dollars spent, which LADWP may consider employing.
4. Educating the public on the cost of stormwater capture projects as they compare to the value of the water supply benefit they provide.
5. Soliciting input and approval for new forms of project governance and project implementation.
6. Soliciting input and educating the public on new regulations, laws and ordinances related to stormwater capture.

Where appropriate, LADWP should lean on NGOs, as well as bodies such as the Neighborhood Council Sustainability Alliance, to support public education and engagement.

8.5.4. ADDITIONAL RESEARCH

As LADWP moves forward with the implementation of the SCMP, there are areas of additional research that could support new approaches to stormwater capture and increased understanding of the economic value of stormwater projects. It is recommended that LADWP:

1. Conduct continued research into the value of stormwater capture supply benefits with input from other utilities. All results from this analysis should be periodically updated with current information on MWD projected water rates.
2. Encourage research or perform the aforementioned spreading grounds optimization study to understand the potential increase in capture efficiency, water quality enhancements, and peak flow reduction benefits of incorporating real-time system automation and optimization into large-scale linked centralized and distributed stormwater capture projects. This concept would further increase the benefits of existing and proposed projects, such as the Tujunga Spreading Grounds and the potential debris basin retrofits.
3. Encourage research into the feasibility and potential stormwater capture and water quality benefits of diverting water from MS4 systems into the wastewater collection system to allow more efficient treatment solutions and recovery of water in water recycling projects and programs.

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9. CONCLUSION

With increased pressure on traditional water resources, LADWP is undertaking a significant effort to augment its local water supply portfolio with increased stormwater capture. This effort is directly in line with its mission of providing a safe, reliable, and environmentally sensitive water supply for the City of Los Angeles. Stormwater has historically contributed a significant amount of water for the City. Currently LADWP and its partners actively recharge the local groundwater aquifers with approximately 29,000 acre-feet per year, while another 35,000 acre-feet per year is recharged into those same aquifers by incidental infiltration through mountain front zones and unpaved surfaces. Now, with the SCMP development process complete, it has been demonstrated that an additional 68,000 to 114,000 acre-feet per year could be realistically captured over the next 20 years through the implementation of a suite of centralized projects, and the adoption of distributed programmatic approaches. The approximate value of this water to LADWP over the same 20-year time period is $1,100 per acre-foot for recharged water and $1,550 per acre-foot for directly used water, which represents a sound investment in the City's future water supply portfolio.

To achieve these goals, immediate, significant, and sustained efforts on behalf of LADWP and its partners, in particular LACFCD, LASAN, and other City agencies, is required. These efforts include diligent tracking of funding opportunities, increased integration of common functions between agencies with similar charges, and exploring creative new mechanisms of project implementation. As this plan to increase the capture of this valuable local water supply is realized, additional benefits to the City will be gained, including water quality improvements, improved green spaces for habitat and recreation, and reduced peak flows in the region's waterways.

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