

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

July 2026



Division of Water Quality, State Water Resources Control Board



Prepared by Office of Water Programs | California State University, Sacramento

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

TABLE OF CONTENTS

Executive Summary	1
Intent and Content.....	1
Inventory Development	1
Model Development	2
Results.....	2
Considerations for Future Estimates	4
Intent and Content	6
Background.....	6
General Approach for Estimating Baseline Capture	8
Purpose of This Document	8
Data Acquisition	9
Outreach	9
Data Collection and Compilation	9
Large and Moderate-Scale Capture Infrastructure Data.....	9
Climate Data	12
Infiltration Rates	13
Model and Methodology.....	15
Model Background	15
Model Composition.....	17
Model Assumptions.....	18
BMP Types.....	18
BMP and Impervious Area Sizes.....	19
BMP Performance	19
Aquifer Connectivity	19
Resources for Future Use of the Capture Model.....	20
Results	21
Capture Model Results	21
Watershed Reporting Adaptive Management & Planning System Capture Volumes.....	23

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Los Angeles Department of Public Works Capture Volumes	25
Fresno Municipal Flood Control District Capture Volumes.....	27
Other Sources	29
C/CAG Green Infrastructure Tracking Tool.....	29
City of Modesto Storm Drain System.....	29
Rain Barrel Rebate Programs.....	29
Limitations.....	30
Incompleteness.....	30
Inaccuracy	30
Bias	31
Other Constraints and Assumptions.....	31
Summary of Existing Stormwater Capture.....	32
Considerations for Future Estimates.....	35
Improving the Data Inventory	35
Improving the Modeling Framework for Future Five-year Updates	37
Increasing Capture and Setting Local Targets.....	38
References.....	40
Appendix A: Master Inventory of Stormwater Capture BMPs (Electronic Only).....	A1
Appendix B: Capture Estimate Workbooks (Electronic Only).....	B1
Appendix C: Phase II LID Sizing Tool SWMM Inputs and Outputs.....	C1
SWMM Inputs and Sources	C1
Rainfall and Evaporation Data.....	C1
Subsurface Saturated Hydraulic Conductivity.....	C2
BMP Types and Attributes	C3
Ratio of BMP to Impervious Area Footprints	C4
SWMM Output	C5
Appendix D: Rain Barrel Rebate Programs.....	D1

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

FIGURES

Figure 1. Graphical representation of the descending nature of stormwater capture.....	7
Figure 2. Spatial extent and distribution of climate stations used in the Capture Model.....	13
Figure 3. LID Sizing Tool components	16
Figure 4. Components of the Statewide Capture Estimate Model.....	17
Figure 5. Potential fates of captured stormwater	20
Figure 6. BMP locations in Northern and Central California included in the Statewide Capture Estimate Model	22
Figure 7. BMP locations in Southern California included in the Statewide Capture Estimate Model	23
Figure 8. Volume of stormwater and imported water infiltrated per year by FMFCD infiltration basins (Adapted from FMFCD's report to their Board of Directors)	28
Figure 9. Climate data locations for the CA Phase II LID Sizing Tool	C2
Figure 10. Schematic of a bioretention cell simulated in SWMM.....	C4
Figure 11. Screenshot of bottom 45 rows of the exported SWMM database	C5
Figure 12. Infiltration volumes for various sizes of rain gardens in soils with an infiltration rate of 0.3 in/h for Sacramento, CA	C6

TABLES

Table 1. Capture BMP types, definitions, and alternative names for this project.....	10
Table 2. MS4 permittees that responded to the data request or had publicly available data	11
Table 3. Infiltration rates from soil hydrologic groups	14
Table 4. Capture Estimate Workbook results	21
Table 5. Record of estimated stormwater capture in LA County	24
Table 6. Comparison of Los Angeles Flood Control District annual capture volume with relative climate trends	25
Table 7. Record of stormwater used for recharge in DPW's spreading grounds as recorded by Annual Hydrologic Reports.....	26
Table 8. Comparison of DPW's annual capture volume with relative climate trends	27
Table 9. Total baseline capture estimates.....	33
Table 10. Infiltration rates based on hydrologic soil groups	C3
Table 11. BMP types and configurations.....	C3
Table 12. BMP to impervious area ratios	C4

EXECUTIVE SUMMARY

Intent and Content

California's Water Supply Strategy (Supply Strategy) calls for making new water available for use by capturing stormwater. The Governor's office has established goals of increasing stormwater capture in cities and towns annually by at least 250,000 acre-feet (ac-ft) by 2030 and 500,000 ac-ft by 2040 (CA DNR et al. 2022). In February 2026, the state launched development of the California Water Plan 2028, which introduced broader interim statewide planning goals to identify 9 million ac-ft of additional water supply by 2040 and to help align state, regional, and local water supply actions. To support these efforts, a baseline estimate of existing local stormwater capture throughout California is needed.

Urban stormwater is primarily captured (intentionally collected) by stormwater management agencies holding National Pollution Discharge Elimination System (NPDES), Municipal Separate Storm Sewer Systems (MS4) permits. These agencies do not consistently report stormwater capture amounts or capture infrastructure, so a framework for estimating statewide capture was developed, including an inventory of existing capture infrastructure and a tool for modeling capture across the state. During project scoping the project team determined that populating the statewide inventory without a mechanism to compel data submission would be a larger and more time-consuming effort relative to model development. In addition, the Supply Strategy requires re-evaluation of the baseline estimate every five years, offering future opportunities to improve the data inventory and collection mechanisms. So, though both efforts proceeded, model development was prioritized. To fill in the expected data gaps for this first baseline effort, a rudimentary extrapolation of the estimate resulting from the model (and limited inventory) was applied to generate a statewide estimate.

This document summarizes the capture estimate framework, including the tool and the inventory, and the results (both with and without extrapolation), as well as recommendations for updating the estimate and incentivizing more capture in the future.

Inventory Development

Outreach was conducted to representatives of the California Regional Water Quality Control Boards (Regional Water Boards) and municipal entities that own and operate stormwater capture infrastructure, devices, or best management practices (BMPs; also referred to as stormwater control measures [SCMs]). To acquire BMP data, a data request

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

in the form of a Microsoft Excel spreadsheet was distributed in Fall 2024 to all 675 MS4 permittees via coordination with State Water Quality Control Board (State Water Board) staff, Regional Water Boards staff, and the California Stormwater Quality Association (CASQA). A one-page fact sheet and two webinars were provided to support the data request. The request was supplemented with web searches for publicly accessible BMP data. Between these two methods, data was acquired for 27 of the 675 MS4 permittees (4 percent). As was expected, the small representation was due to the lack of data historically and currently collected by permittees, as well as the lower priority agencies place on submitting such data relative to the many other responsibilities they have.

Model Development

A Microsoft Excel based model, Statewide Capture Estimate Model (Capture Model), was developed to estimate statewide capture volumes using BMP data. The Capture Model leveraged previous work that created the Phase II Low Impact Development Sizing Tool (LID Sizing Tool) by integrating with the Environmental Protection Agency's Storm Water Management Model (EPA SWMM). The Capture Model adapted the LID Sizing Tool's SWMM model to estimate the volume of runoff and subsequent infiltration at each BMP over a recent period (2020–2025). The continuous simulation mechanism of SWMM allowed for full water balance accounting by tracking infiltration, rainfall, runoff, bypassed flow, and evaporation volumes. It also accounts for changes in intensity, duration, frequency, and seasonal variation inherent to California's precipitation regime, which is required for future recurring analysis based on the latest available precipitation data (OWP 2025a and 2025b). Furthermore, the occurrence of wet or dry years and related variations in volume of precipitation under the existing regime is accounted for by the Capture Model's continuous nature.

Results

The Capture Model was applied to six BMP types. Based on recent precipitation data, simulations of almost 1,300 individual BMPs estimated infiltration of approximately 6,200 ac-ft of stormwater in an average year. This is known to be a vast underestimate of total capture statewide (as mentioned, only four percent of MS4 permittees provided inventories for the Capture Model). Modeled capture can be extrapolated to other permittees based on assumptions of construction rates relative to population, but it comes with extreme uncertainty. The following unknown variations between reporting and non-reporting permittees contribute to this uncertainty:

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

- Timing of required compliance with post-construction stormwater capture requirements
- Post-construction stormwater capture BMP sizing requirements
- Land disturbance thresholds within post-construction stormwater capture requirements
- Site-specific soil infiltration rates
- Differing portfolios of capture versus non-capture technologies for post-construction BMP requirements

The simplest extrapolation without adjustment for the existing variability applies a multiplier to the model estimate. Because 4 percent of the MS4 permittees provided inventories and assuming that all permittees capture approximately the same volume annually, a multiplier of 25 ($1/0.04$) can be applied to the 6,200 ac-ft that were modeled. This results in a highly uncertain total statewide modeled estimate of 155,000 ac-ft.

In addition to the Capture Model estimate, capture volumes from larger centralized systems were obtained from three sources:

- Los Angeles County Department of Public Works (DPW)
- The Watershed Reporting Adaptive Management & Planning System (WRAMPS2) that reports on all systems in Los Angeles County not operated by DPW
- Fresno Metropolitan Flood Control District

These large-scale basins capture and infiltrate approximately 440,350 ac-ft of stormwater in an average year. Compared to both modeled and model-extrapolated capture, this much larger volume (3 to 7 times more) is not unexpected because of the following unique factors that apply to these areas:

- There is a long history of using infiltration basins in these regions to mitigate flooding risk and of reserved space for infiltration prior to more recent competition from urban development and subsequent escalation of land costs
- The soils in these regions are conducive to infiltration
- LA County has the highest amount of runoff potential of any area in the state based on its extremely large impervious footprint

When adding in the estimate from the Capture Model from these areas, the total estimated annual average amount of baseline captured urban stormwater is approximately 446,000 ac-ft. When adding the extrapolated and highly uncertain

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

modeled estimate, the total estimated annual average amount of baseline capture is very roughly estimated at 600,000 ac-ft.

Considerations for Future Estimates

As previously stated, the Supply Strategy directs the State Water Board to re-evaluate the baseline estimate of statewide urban stormwater capture every five years. The re-evaluation is intended to track progress towards the Supply Strategy's goals to increase capture in cities and towns by 250,000 acre-feet per year (ac-ft/y) in 2030 and by 500,000 ac-ft/y in 2040. To estimate progress toward these goals, the inventory of BMPs should be updated to include newly constructed BMPs. A potential mechanism to collect data on newly constructed BMPs is the asset management reporting requirements being considered in the upcoming MS4 permit reissuances.

The BMP inventory could also be updated to include existing BMPs that were not reported in this initial effort to improve the baseline estimate. However, populating the inventory for missing infrastructure may not be worth the expense because the Supply Strategy charge is an increase in capture, not an aggregate, and so the accuracy of the baseline is immaterial. The agencies involved might consider comparing the value in having a more accurate baseline against the cost of collecting (or compelling the collection) of data that may be poorly kept by permittees. The agencies may find that resources could be better used on further incentivizing capture, as well as the structures and policies necessary to collect data on new infrastructure as it is built.

Future estimates should also consider addressing unknowns related to changes in two important areas: capture performance for modeled BMPs (particularly deterioration), and climate (particularly drought). Both unknowns will impact achievement of the Supply Strategies 2030 and 2040 capture goals. Some suggestions on how to address these unknowns are provided within the main report.

Finally, to further incentivize capture infrastructure investments, the following suggestions are offered:

- Determine whether total maximum daily loads (TMDLs) and infiltration policies have unintended and negative impacts on incentivizing capture
- Promote the monetary value of stormwater capture projects
- Create cost-effective guidance to increase capture when water supply is not a particular community need but can still add value

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

- Explore how state government and trade associations can meet the needs of MS4s, which are often restricted in advocating for local funding measures

INTENT AND CONTENT

Background

California's Water Supply Strategy calls for making new water available for use by capturing stormwater. The Governor's office has established goals of increasing stormwater capture in cities and towns annually by at least 250,000 acre-feet (ac-ft) by 2030 and 500,000 ac-ft by 2040 (CA DNR et al. 2022)¹. In February 2026, the State launched California Water Plan 2028, which introduced a broader interim statewide planning goal to identify 9 million ac-ft of additional water supply by 2040 as well as help align state, regional, and local water supply actions. To support these efforts, a baseline estimate of existing local stormwater capture throughout California is needed. The California State Water Resources Control Board's (State Water Board's) Strategy to Optimize Resource Management of Stormwater (STORMS) unit contracted with the Office of Water Programs (OWP) at California State University, Sacramento, to establish the baseline.

For purposes of this project, urban stormwater capture and use refers to the intentional collection of urban stormwater runoff (generated in cities and towns, as stated in the Supply Strategy) to augment surface water supplies by making the collected stormwater available for irrigation and aquifer recharge. While this definition aligns with the Supply Strategy, it differs from the definition of urban runoff provided in the STORMS 2018 Enhancing Urban Runoff Capture and Use report (State Water Board 2018), which included support of ecosystems as an intended use and dry weather runoff as a source of capture. It is also important to note that there is a significant difference between the amount of urban stormwater runoff generated, the amount captured by infrastructure, and the amount of captured runoff that is made available for use, as shown in Figure 1.

Urban stormwater capture is primarily practiced by stormwater management agencies holding National Pollution Discharge Elimination System (NPDES), Municipal Separate

¹ The Water Supply Strategy notes that a 30-year stormwater capture and use average for the South Coast was 324,000 ac-ft/y, with a high of 900,000 ac-ft/y in 2004–2005, although no references are provided for this data. The Water Supply Strategy does not provide any other references or discussion as to how the 205,000 ac-ft (2030) and 500,000 ac-ft (2040) goals were developed. Past estimates of stormwater capture and use in California from other literature range from 1,300 to 3 million ac-ft/y (SCWC 2018; SCCWRP 2020; PI 2022; 2nd Nature 2024; PI 2024). DWR (2019) established targets for urban stormwater capture at 105,000 ac-ft/y for 2020 and 250,000 ac-ft/y for 2030.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Storm Sewer Systems (MS4) permits. These agencies do not consistently report capture amounts or capture infrastructure, so a framework for estimating statewide capture was needed. The development of the estimate requires an inventory of existing capture infrastructure and a tool for modeling capture across the state. During project scoping, the project team determined that, without a mechanism to compel data submission, populating the statewide inventory was a larger and more time-consuming effort relative to model development. In addition, the Supply Strategy requires re-evaluation of the baseline estimate every five years, offering future opportunities to improve the data inventory. So, though both efforts proceeded, model development was prioritized. To fill in the expected data gaps for this baseline effort, a rudimentary extrapolation of the estimate resulting from the model (and limited inventory) was applied to generate a statewide estimate.

The scope of this project is to estimate the portion of generated runoff that is captured. Estimating the volume of capture that is available for use (particularly for groundwater recharge and recovery) could be modeled in future assessments, but would require extensive resources to map flow paths, as well as track real recharge and extraction volumes.

This document summarizes the capture estimate framework, including the tool and the inventory, and the results (both with and without extrapolation), as well as recommendations for updating the estimate and incentivizing more capture in the future.

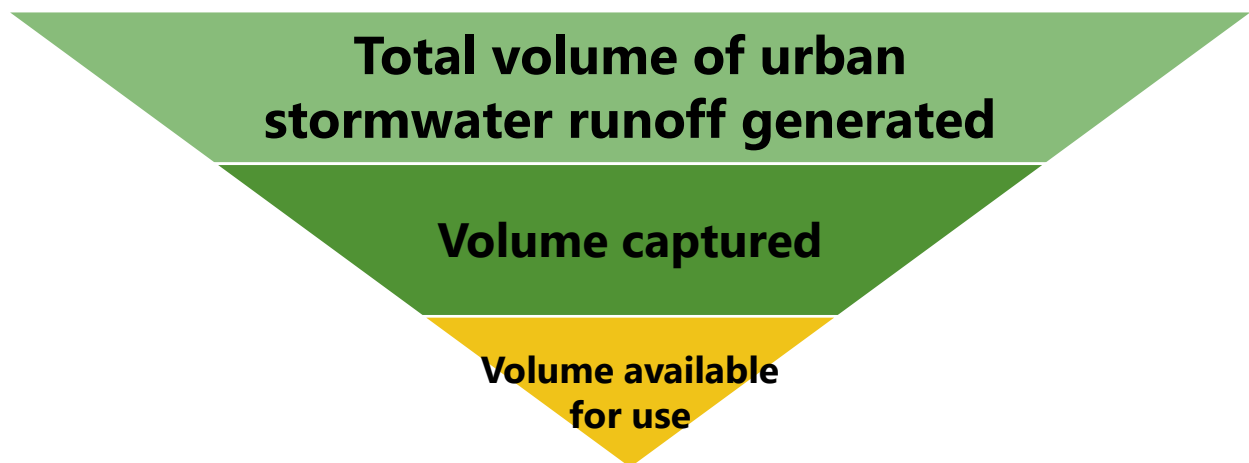


Figure 1. Graphical representation of the descending nature of stormwater capture

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

General Approach for Estimating Baseline Capture

The baseline for the statewide existing urban stormwater capture volume was estimated by modifying an existing tool to simulate rainfall, runoff, and capture for infiltrating best management practices (BMPs) throughout California. This resulting capture volume was then combined with other capture volume data that was self-reported by entities that own other urban runoff capture devices, such as regional spreading grounds.

Purpose of This Document

This document summarizes the development and implementation of a methodology for estimating existing statewide capture, including compilation of a statewide urban stormwater capture inventory. This document also provides recommendations for expanding the inventory and associated capture estimates in the future. Finally, limitations of the capture estimates are discussed, along with factors that may affect future estimates.

DATA ACQUISITION

Outreach

As part of comprehensive outreach efforts, representatives of the Regional Water Boards and municipal entities that own and operate stormwater capture infrastructure, devices, or BMPs (also referred to as stormwater control measures [SCMs]) were contacted directly. Informal discussions related to the project and data gathering method were also conducted during monthly meetings of California Stormwater Quality Association's (CASQA's) Stormwater Capture and Use Subcommittee. This outreach was intended to fill two gaps related to finalizing a broader data request: 1) understand data availability and capture estimate practices for spreading grounds and capture BMPs; and 2) beta-test a data request template for a variety of stormwater capture BMPs.

Data Collection and Compilation

Three tiers of urban stormwater capture infrastructure were of interest for this project:

- Large, regional-scale spreading grounds
- Moderate, neighborhood-scale capture BMPs
- Smaller, residential-scale BMPs

Large and moderate-scale capture data was obtained by submitting a data request to stormwater capture entities and practitioners, as well as conducting online research. Smaller, residential-scale capture infrastructure was approximated via compiling a list of municipal programs that provide rebates to customers for purchasing and installing rain barrels or cisterns. Finally, soil characteristics and historic climate data were collected for modeling capture from the moderate-scale capture devices. The remainder of this section describes the data collection efforts.

Large and Moderate-Scale Capture Infrastructure Data

To obtain large-scale and moderate-scale capture infrastructure data, OWP developed a data request that was distributed in Fall 2024 to all 675 Phase I and Phase II MS4 permittees via coordination with STORMS staff, Regional Water Boards staff, and CASQA. OWP and STORMS staff also conducted two webinars to familiarize recipients with the data request and overall project. The data request included definitions for types of capture BMPs of interest, as shown in Table 1. In addition to requesting data submittals, OWP performed web searches to obtain data available online.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Table 1. Capture BMP types, definitions, and alternative names for this project

BMP Type	Definition
Bioretention Planter	Bioretention planters are depressed landscapes into which runoff is directed and allowed to pond, filter, and infiltrate. <i>Alternative Names: Bioretention Cell, Bioretention Basin, Vegetated Filters, Biotreatment, Infiltrating Stormwater Planters</i>
Infiltration Basin	Infiltration basins are shallow basins designed to provide storage and promote infiltration of runoff into the underlying native soils. They may be vegetated. <i>Alternative Names: Retention Basin, Spreading Grounds, Dry Basin</i>
Infiltration Gallery	Infiltration galleries are engineered structures that provide storage and facilitate infiltration of runoff into the subsurface. They consist of one or more horizontal or vertical perforated containers. <i>Alternative Names: Infiltration Vault</i>
Infiltration Trench	Infiltration trenches are engineered structures that provide storage and facilitate infiltration of runoff into the subsurface. Infiltration trenches are typically long and narrow and filled with aggregate. <i>Alternative Names: Rock Swale</i>
Porous Pavement	A paved pervious surface underlain by a gravel storage zone. The pavement may consist of larger aggregates than traditional concrete or asphalt, providing larger pore spaces that allow for temporary storage of runoff. <i>Alternative Names: Pervious Pavement, Permeable Pavers, Porous Pavers, Porous Asphalt, Permeable Asphalt, Porous Asphalt, Porous Concrete</i>
Capture and Use Storage	Any lined and covered BMP that captures and temporarily stores runoff for later use. <i>Alternative Names: Rain Barrel, Cistern, Above-Grade Container, Below-Grade Container, Wet Vault</i>
Dry Well	A gravity-fed excavated pit lined with a perforated casing and backfilled with gravel or stone to allow for infiltration of stormwater. <i>Alternative Names: Underground Injection Control</i>

Table 2 displays the 18 MS4 permittees that submitted data, the seven permittees with datasets available online, and the two permittees that indicated to OWP they did not have relevant data to submit. In general, permittees did not submit data because: 1) MS4 staff do not maintain an easily accessible inventory of BMPs with the parameters needed for modeling capture, and 2) MS4 staff did not have the resources to respond to requests outside of regulatory requirements.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Table 2. MS4 permittees that responded to the data request or had publicly available data

Permittee Name	Permit Type	Was Data Submitted?	Data Type
City of Citrus Heights	Phase I MS4	No—No relevant BMPs	Not Applicable (NA)
City of Dinuba	Phase II MS4	Yes	BMP Inventory
City of Laguna Woods	Phase I MS4	Yes	BMP Inventory
City of Oakland	Phase I MS4	Available Online	BMP Inventory
City of Paso Robles	Phase II MS4	Yes	BMP Inventory
City of Riverbank	Phase II MS4	Yes	BMP Inventory
City of Culver ¹	Phase I MS4	Yes	BMP Inventory
City of Elk Grove	Phase I MS4	Yes	BMP Inventory
City of Escondido	Phase I MS4	Yes ²	BMP Inventory
City of Lincoln	Phase II MS4	Yes ²	BMP Inventory
City of Modesto	Phase II MS4	Available Online	BMP Inventory (count of devices only)
City of Oakley	Phase I MS4	Yes	BMP Inventory
City of Poway	Phase I MS4	Yes	BMP Inventory
City of Sacramento	Phase I MS4	No—No relevant BMPs	NA
City of San Juan Capistrano	Phase I MS4	Yes	BMP Inventory
City of South Lake Tahoe	Phase I MS4	Available Online	BMP Inventory
City of Stockton	Phase I MS4	Yes ²	BMP Inventory
City/County Association of Governments of San Mateo County (C/CAG)	Phase I MS4	Available Online	Estimated Capture Volumes
County of Orange	Phase I MS4	Available Online	BMP Inventory
County of San Luis Obispo	Phase II MS4	Yes	BMP Inventory
County of Santa Cruz	Phase II MS4	Yes	BMP Inventory
County of El Dorado	Phase I MS4	Available Online	BMP Inventory
County of Los Angeles Department of Public Works (DPW) ¹	Phase I MS4	Yes	BMP Inventory, Measured Capture Volumes
County of Los Angeles Flood Control District (LAFCD) ¹	Phase I MS4	Available Online	Estimated capture volumes
County of Placer	Phase I MS4	Available Online	BMP Inventory
County of Placer (R5)	Phase II MS4	Yes	BMP Inventory
County of Placer (R6)	Phase II MS4	Yes	BMP Inventory
County of San Diego Department of Public Works	Phase I MS4	Available Online	BMP Inventory
Fresno Metropolitan Flood Control District	Phase I MS4	Yes	BMP Inventory, Estimated Capture Volumes

¹Permittees regulated by the same Phase 1 MS4 permit for coastal watersheds of Los Angeles County.

²Permittee's data had insufficient detail to be incorporated into the stormwater capture master inventory.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Submitted datasets vary in format and completeness. Most permittees that responded to the data request submitted BMP type, some form of location information, and varying amounts of the requested design attributes, including drainage area served or BMP footprint. DPW submitted data for smaller-scale projects but also directed OWP to access DPW's Annual Hydrologic Reports to obtain measured volumes of stormwater captured and directed to spreading grounds. The Fresno Metropolitan Flood Control District (FMFCD) submitted a complete inventory of their infiltration basins and provided several years of estimated capture volumes. BMP data submittals were compiled into a spreadsheet, which is attached to this report as Appendix A, Master Inventory of Stormwater Capture BMPs.

Most submitted datasets were received by December 2024, although additional datasets were incorporated into the model through September 2025.

Climate Data

OWP developed a model (described in the next section of this report) to estimate capture from moderate-scale BMPs of interest (Table 1). The model uses climate data, specifically precipitation and evaporation data, to simulate rainfall, runoff, evaporation, capture, and infiltration from moderate-scale capture devices. To obtain the necessary climate data, records for 86 climate stations were downloaded from the National Centers for Environmental Information (NCEI) Local Climatological Data summaries. The data was used for modeling rainfall, runoff, and stormwater capture.

Figure 2 displays the spatial extent and distribution of these climate stations. Hourly precipitation data from water years 2020 through 2025 were used. The closest climate station for a given BMP was identified using a geographic information system (GIS) and the BMP coordinates. Often the coordinates of the BMP were not available, but the street address was. In these cases, the addresses were converted to coordinates using geocoding.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report



Figure 2. Spatial extent and distribution of climate stations used in the Capture Model

Infiltration Rates

The Capture Model also relies on soil infiltration rates. However, such rates for the native soil underlying a BMP were rarely provided by data request respondents. To fill this gap, the BMP coordinates were intersected in ArcGIS with a map of soil hydrologic groups provided by the Natural Resources Conservation Service (USDA 2007). The resulting intersection was used to select a typical saturated hydraulic conductivity for a given soil hydrologic group as shown in Table 3.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Table 3. Infiltration rates from soil hydrologic groups

Soil Hydrologic Group	Typical Saturated Hydraulic Conductivity, in/h
A	1.5
B	1
C	0.32
D	0.03

Some permittees reported their native soil's infiltration rate as greater than 5 inches per hour (in/h). In these cases, these values were reduced to 5 in/h to fit within the model framework. The model could be modified to more accurately simulate infiltration rates above 5 in/h; however, it is expected that simulating infiltration rates greater than 5 in/h would not meaningfully influence the statewide capture estimate. BMPs are sized for hydrologic factors (e.g., a percentile storm) and soils merely change the drain time of that volume.

In some jurisdictions, the volume can be adjusted for drain time when sizing is based on a continuous simulation (e.g., annual average percent capture). In both cases, the volume is set and a change in soil infiltration is merely changing drain time. In a continuous simulation using historical rainfall data, the volume capture increase caused by a faster drain time is based on the occurrence of a rainfall event immediately following a basin-full event, where immediately is defined as the period that the basin is draining faster. For example, a BMP with a ponding depth of 50 inches and a 5 in/h infiltration rate empties in 10 hours. If the underlying soil had an infiltration rate of 10 in/h, the BMP would drain in 5 hours. The difference in drain time would be 5 hours. Then the additional capture would only count rain within the 5 hours after a basin-full event. This is a very rare occurrence in California. To demonstrate numerically, the tool was used to estimate capture of a vegetated infiltration basin for a 1 ac drainage and a BMP with a 0.04 ac footprint at 1 in/h and 5 in/h (selected within the current constraints of the tool). The resulting capture was 1.48 ac-ft/y and 1.49 ac-ft/y, respectively. The difference was 0.01 ac-ft/y or less than 1 percent.

MODEL AND METHODOLOGY

Model Background

To estimate existing urban stormwater capture in California, OWP developed an Excel-based model: the Statewide Capture Estimate Model (Capture Model). The Capture Model is based on the California Phase II Low Impact Development (LID) Sizing Tool, which relies on EPA's Stormwater Management Model (SWMM), a dynamic, hydrologic model that can run long-term, continuous simulations to estimate the quantity and quality of urban runoff over time. Notably, only the volumetric aspects of SWMM are used for the Sizing Tool and the Capture Model.

OWP developed the LID Sizing Tool in 2015 through a grant from the State Water Board to support practitioners in sizing LID BMPs that comply with California's 2015 Phase II MS4 permit. The Sizing Tool consists of a website that is linked to a database through a server as shown in Figure 3. The database stores precipitation and evaporation data for multiple geographic locations throughout California, pre-defined parameters for multiple BMP types and soil types, and pre-solved rainfall, runoff, infiltration, and evaporation volumes for each scenario. After the user enters project information into the Sizing Tool's website, the server queries the database, performs calculations, and tabulates the areas required for various LID BMP types. The Sizing Tool also reports annual average volumes across a 30-year simulation of rainfall, runoff, infiltration, and storage. For the Capture Model, the infiltration and storage volume outputs are considered to represent the volume of stormwater captured.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

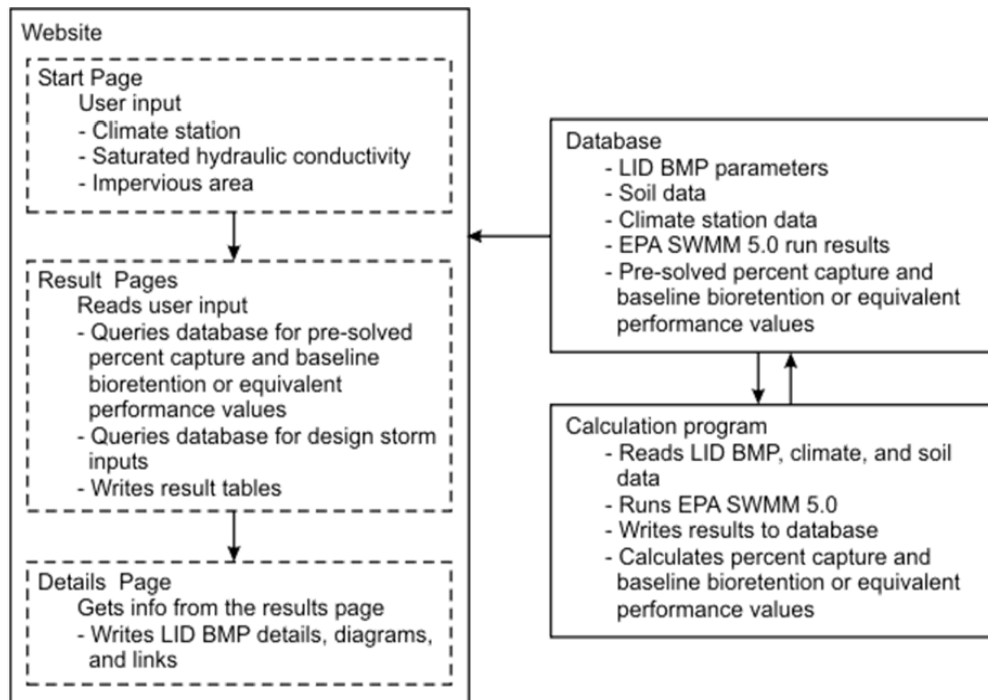


Figure 3. LID Sizing Tool components

The LID Sizing Tool and its background model SWMM were selected as the basis for the Capture Model, to leverage an existing, state-funded tool and to minimize the time and labor needed to create new programs or inputs. Previously, the Sizing Tool used over 30 years of precipitation data (1970 through 2006) to estimate annual average volumes of rainfall and evapotranspiration, as well as the volume of runoff generated, runoff captured, and runoff that overflowed or bypassed BMPs. For the Capture Model, the SWMM simulations were rerun to only include the last five years of precipitation data (2020 through 2025) to produce contemporary estimations of runoff generated and captured, which aligns with the five-year assessment interval established in the Water Supply Strategy.

Another benefit of using the LID Sizing Tool and SWMM as a basis for the Capture Model is that future simulations can account for changing precipitation regimes. The continuous simulation mechanisms possible through SWMM allow for full water balance accounting by tracking infiltration, rainfall, runoff, bypass flow, and evaporation volumes and will account for changes in intensity, duration, frequency, and seasonal variation of California's precipitation regime because future recurring analysis will be based on the latest available precipitation data (OWP 2025a and 2025b). Furthermore, the occurrence of wet or dry years and related variations in volume of precipitation under the existing regime is

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

accounted for by the Capture Model's continuous nature. The Capture Model can estimate volumetric capture regardless of whether a given five-year interval is comprised mostly of wet or dry years. However, the Capture Model currently aggregates the five-year data and produces a yearly average of precipitation for the given period, as opposed to the range of capture estimated for each of the five years. The Capture Model can be modified in the future to report the range of capture estimated across the five-year simulation, which may be more helpful for future water use planning.

Model Composition

The Capture Model consists of one Capture Estimate Workbook for each type of capture BMP relevant to this project (6 in all), the Master Inventory, and the Master Lookup Table. Figure 4 shows a general schematic of the Capture Model.

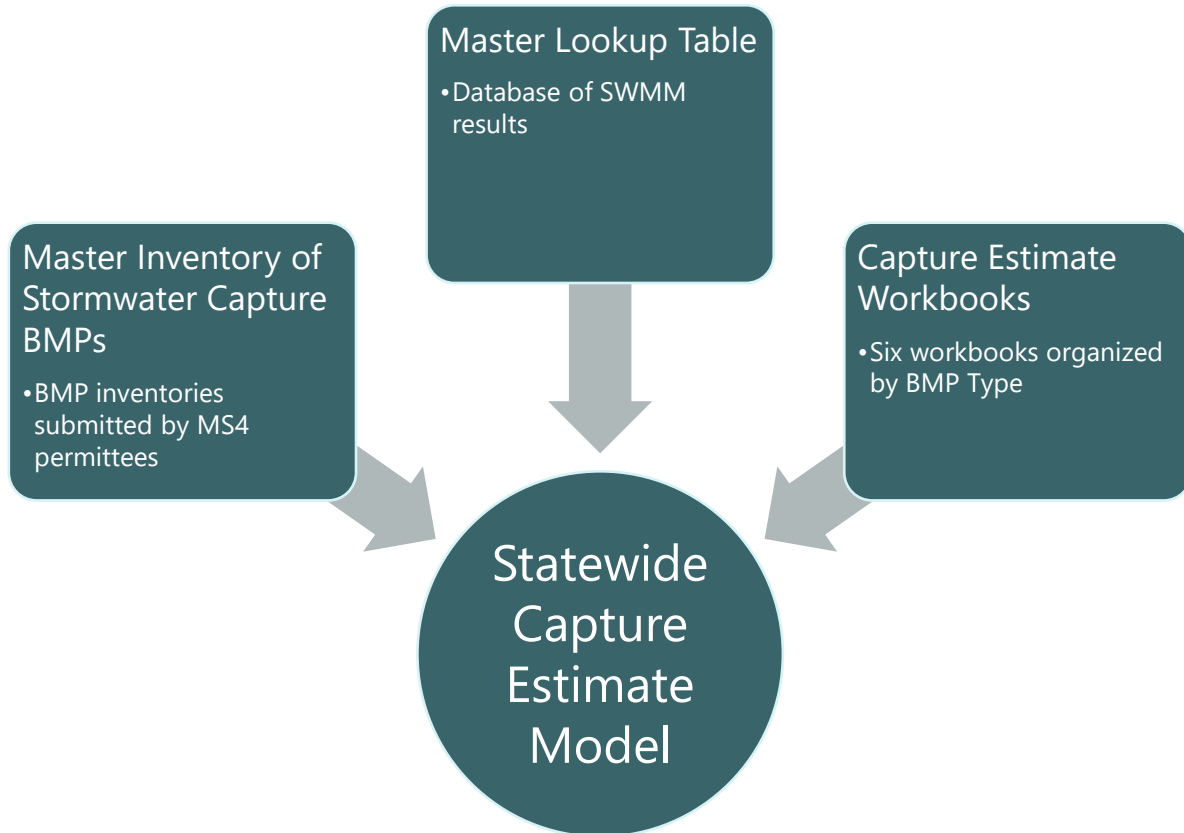


Figure 4. Components of the Statewide Capture Estimate Model

The Master Inventory tabulates all moderately-sized urban stormwater capture devices and relevant attributes, while the Master Lookup Table contains capture volume results for rainfall-runoff-capture simulation of various BMP types, locations, and soil infiltration

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

rates. Notably, the Master Inventory does not tabulate spreading grounds sized for regional use.

Each Capture Estimate Workbook consists of four worksheets: 1) a Calculations worksheet that includes BMPs with sufficient data reported in the Master Inventory and the attributes needed to estimate capture volumes; 2) a Graphs worksheet used to visualize the volume of water infiltrated versus the footprint of the BMP, classified by hydrologic soil group and based on the calculations performed in the first worksheet; 3) the Master Lookup Table; and 4) a Geospatial worksheet that joins each modeled BMP to its nearest precipitation gage and the hydrologic soil group the BMP overlies.

Each Calculations worksheet includes columns of cells that look up and record the respective capture volumes from the Master Lookup Table worksheet based on the BMP's attributes. Each Calculations worksheet also includes columns of cells that query the Geospatial worksheet for the appropriate precipitation gage, and if not provided previously in the data submittal, the saturated hydraulic conductivity of the hydrologic soil group each BMP overlies.

Model Assumptions

Data gathered for this project from municipalities across California were used as inputs to the Capture Model. The following subsections describe the limitations of the gathered data and the assumptions made when the gathered data was incomplete.

BMP Types

BMPs vary in their design based on site-specific factors such as drainage area, impervious area, hydraulic head, native soil type, ponding depth, amended soil depth, or gravel storage depth. For porous pavement and infiltration galleries, the Capture Model assumes gravel depth depends on the native soil infiltration rate. In these BMPs, the gravel depth will be deeper in well-draining soils since the increased hydraulic conductivity allows the BMP to store and infiltrate larger volumes of water without bypassing it. For example, when a municipality did not provide the depth of ponding, soil, and gravel, the bioretention cell design stipulated in the 2013 MS4 Permit for Small Systems (State Water Board 2013) was used. The typical bioretention cell is sized to hold six inches of water and has 18 inches of soil and 12 inches of gravel storage.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

BMP and Impervious Area Sizes

When a municipality did not provide the areal extent of a BMP, aerial imagery was used to determine its size. If the area could not be determined from the imagery, then the average size of nearby BMPs of that type was used instead. Impervious drainage areas are more difficult to determine from aerial imagery since they depend on subtle changes in slope. When the municipality did not provide the areal extent of impervious surface draining to a BMP, it was calculated using the assumption that the BMP area is four percent of the impervious area. This is based on the guidance provided in the 2013 MS4 Small System Permit (State Water Board 2013).

In all cases, the Capture Model assumes that the area draining to the BMP is comprised of 100 percent impervious areas such as rooftops, parking lots, roadways, and sidewalks. This means that in the Capture Model, no vegetated or other permeable surfaces drain to the BMP. Though the Capture Model overestimates the amount of runoff generated in the drainage area to the BMP, the amount overestimated would still be captured on site by the pervious surfaces within the drainage. However, the overestimated volume likely would have been captured in most cases by infiltrating through permeable surfaces and have a similar fate as the runoff infiltrated through the BMP. To add site-specific data representing the true percentage of impervious area, the SWMM model would need to be updated to include the percentage of impervious area as a variable and then run again for each possible combination described in previous sections.

BMP Performance

The Capture Model assumes BMPs are performing as designed. While some infrastructure may require more maintenance than others, all require some degree of maintenance to preserve their intended level of performance. Typically, inspections are required to verify continued BMP performance. In some systems, additional measurements might be needed to verify actual BMP performance. MS4 permits currently require reporting of inspection and maintenance, but this project was not scoped to collect that data.

Aquifer Connectivity

Data on the direct connectivity of a given BMP to underlying aquifers is not readily available and so the model results only represent the amount of urban runoff that is captured; not what portion of capture is being used. Site-specific investigations would be required to verify whether the BMP recharges an aquifer used by municipalities for water supply or if it simply infiltrates water that eventually contributes to baseflow instead. Such

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

investigations, however, are outside the scope of this assessment. Figure 5 demonstrates the potential fate of captured stormwater.

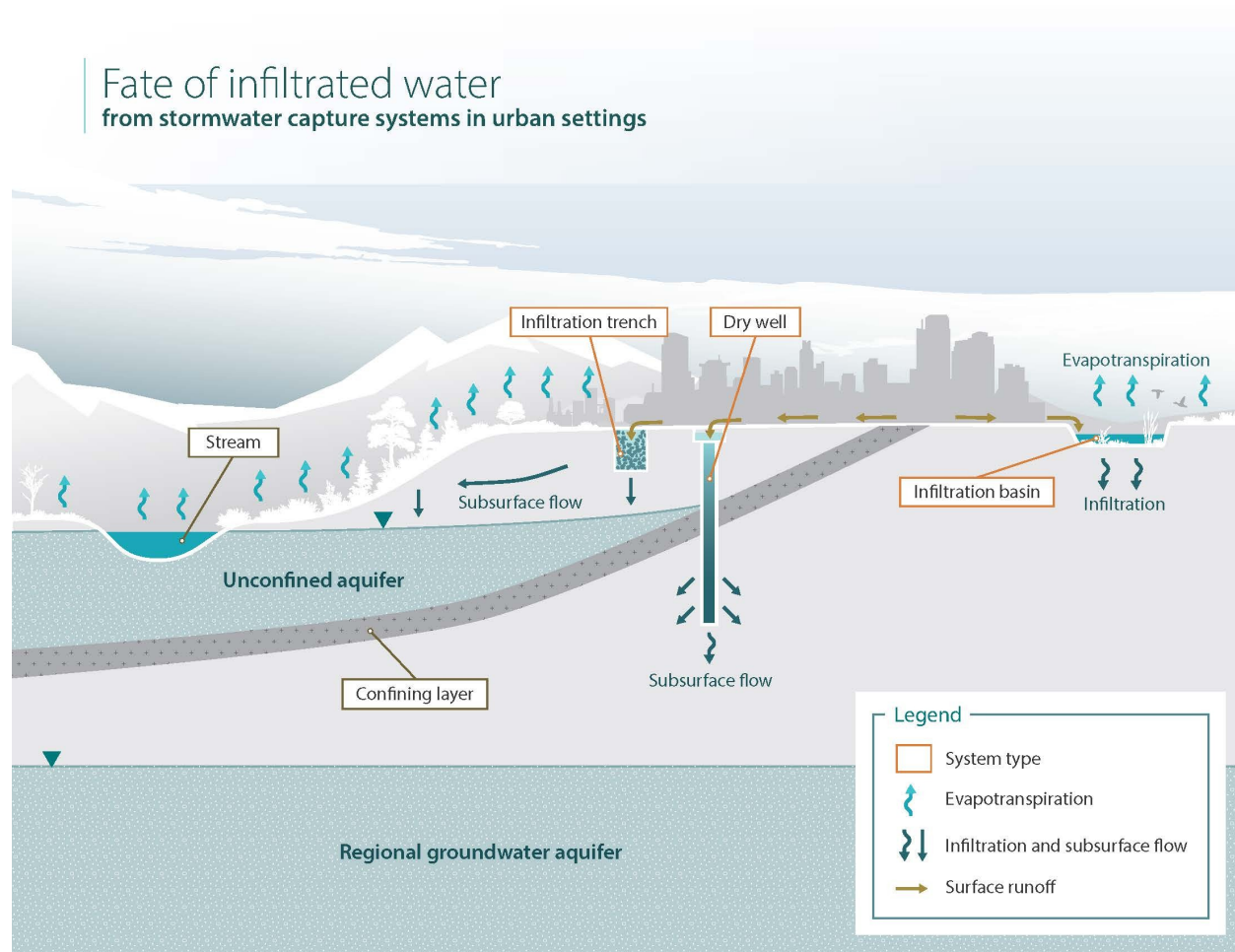


Figure 5. Potential fates of captured stormwater

Resources for Future Use of the Capture Model

Several resources are appended to this report for future use of the Capture Model. Appendix B consists of the Capture Estimate Workbooks. SWMM input, sources, and outputs are provided in Appendix C.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

RESULTS

The results below are presented according to the source of the data, which covers five categories:

- Simulated results from the Capture Model
- Estimates from the Watershed Reporting Adaptive Management & Planning System
- Estimates from Los Angeles Department of Public Works
- Estimates from Fresno Metropolitan Flood Control District
- Other data sources without easily quantifiable data

Capture Model Results

Table 4 summarizes the results from the Capture Estimate Workbooks. In total, nearly 1,300 BMPs were estimated to infiltrate approximately 6,000 ac-ft/y. This volume, however, only represents capture infrastructure from about four percent of MS4 permittees in California. (See previous discussions on challenges regarding data inventory collection.) Figure 6 and Figure 7 show the Northern/Central California and Southern California locations of these BMPs, along with other BMPs submitted for the inventory but excluded from simulations due to data incompleteness.

Table 4. Capture Estimate Workbook results

BMP Type	Number of BMPs in Master Inventory	Number of BMPs Modeled¹	Estimated Volume Captured per Year, ac-ft
Capture and Use	31	31	128 ²
Dry Wells	41	0 ³	0
Infiltration Basin	484 ²	188	3962
Infiltration Gallery	37	37	20
Infiltration Trench	377	206	55
Porous Pavement	72	67	148
Rain Garden	956	760	725
Total	1,998	1,289	6,192

¹Fewer BMPs were modeled than the number of BMPs available in the Master Inventory due to insufficient data (missing geospatial information, drainage area, and/or BMP footprint) and provided capture data that did not need to be modeled.

²Fresno Metropolitan Flood Control District (FMFCD) provided estimated capture volumes for the 157 infiltration basins the district owns and operates.

³Data submitted for dry wells was insufficient to include in the Capture Model.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

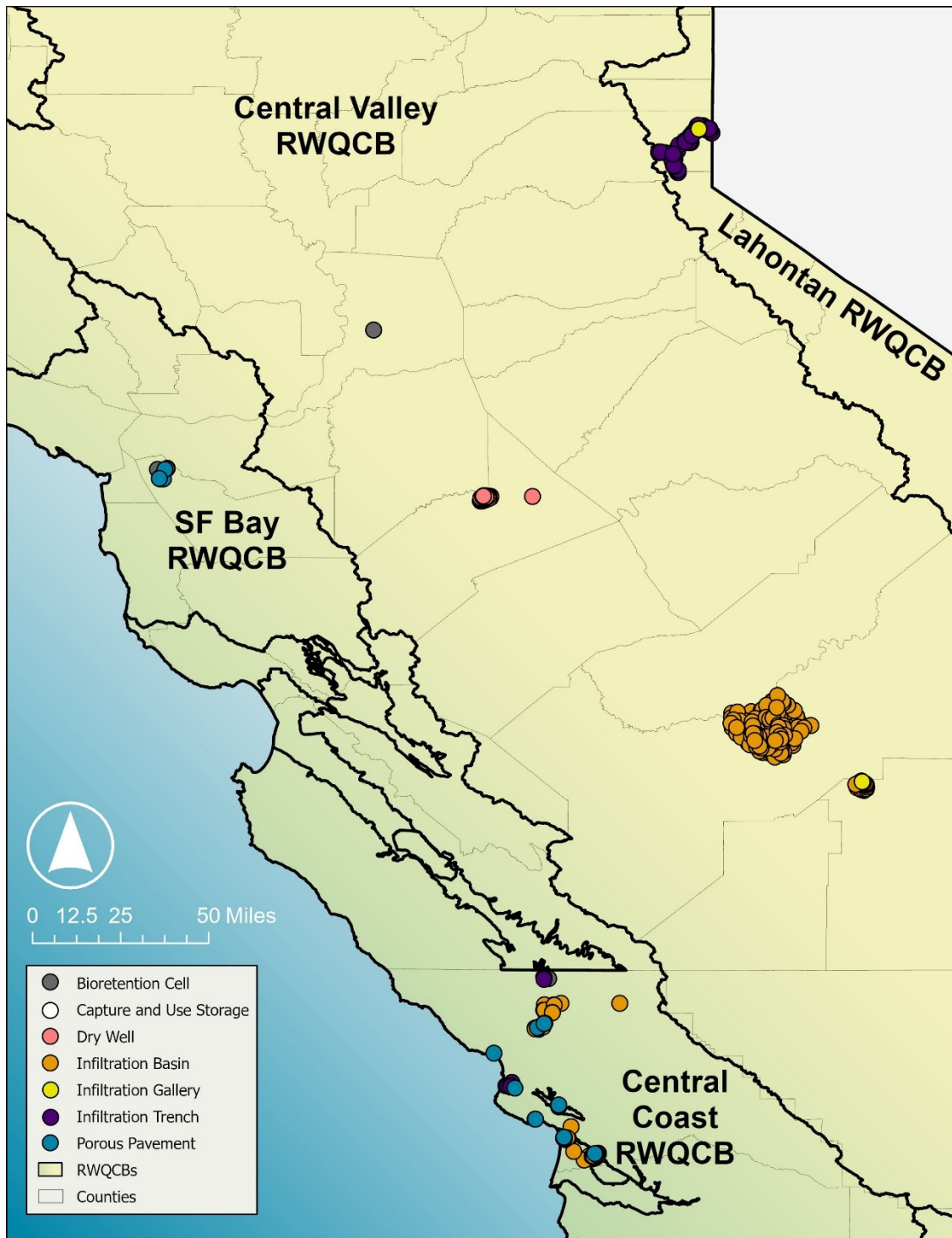


Figure 6. BMP locations in Northern and Central California included in the Statewide Capture Estimate Model

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

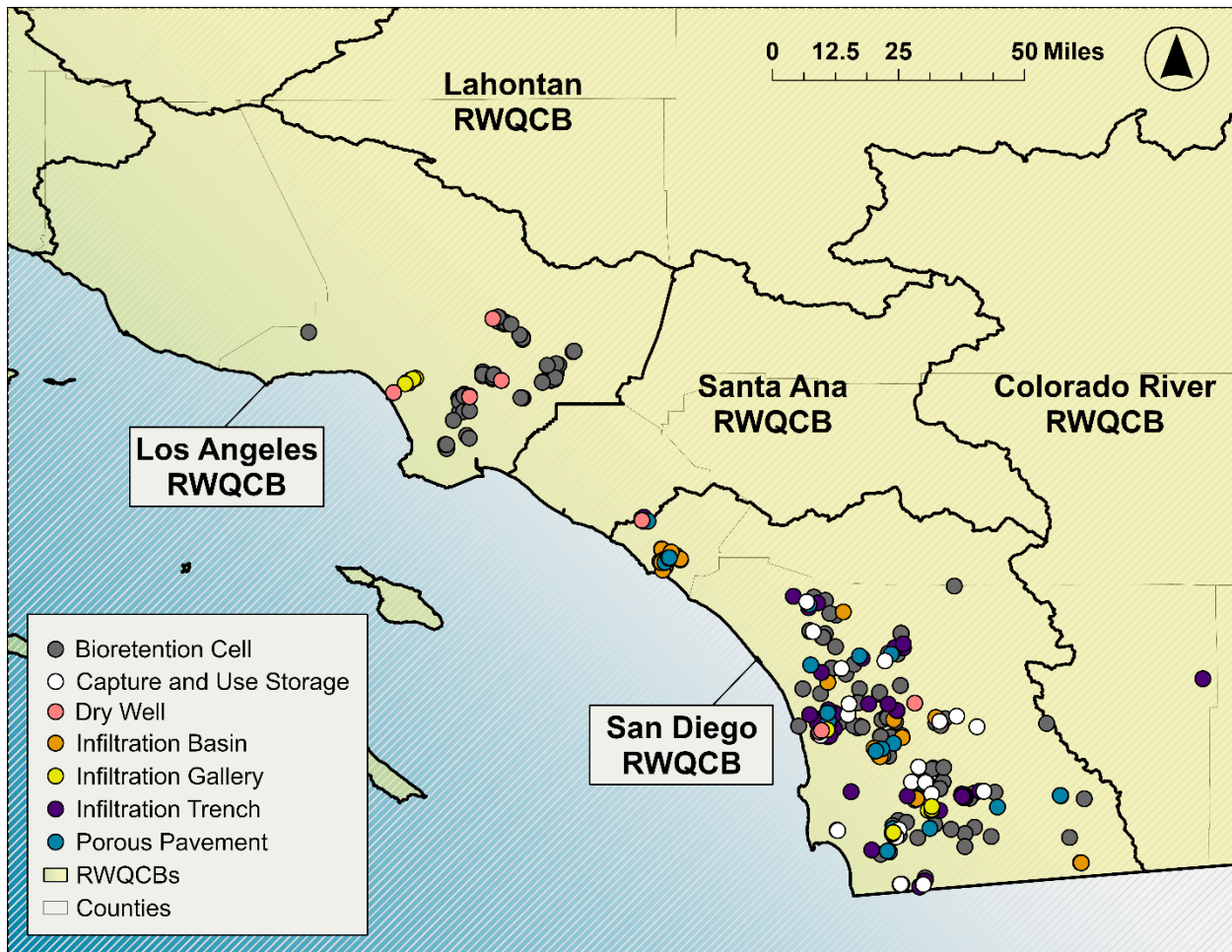


Figure 7. BMP locations in Southern California included in the Statewide Capture Estimate Model

Watershed Reporting Adaptive Management & Planning System Capture Volumes

The Los Angeles County Flood Control District maintains the Watershed Reporting Adaptive Management & Planning System (WRAMPS2) that tracks and reports stormwater capture activities conducted by the 86 permittees listed in the Los Angeles County Phase 1 MS4 permit. WRAMPS2 reports estimated capture values for structural control measures (SCMs; equivalent to BMPs), spreading grounds, and low flow diversions. However, WRAMPS2 reports data inconsistently both through time and by project type, with only three years of capture values made available. For example, there is no capture reported at spreading grounds for the 2024–25 year. It is possible that this data exists and is held by MS4 permittees, but it is unknown why data is inconsistently reported through the system. Available capture values are reported both in aggregate for

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

each of the previously described categories and for individual projects, though project specific data is tedious to extract from the interface. Notably, the spreading grounds tracked by WRAMPS2 do not include the spreading grounds operated by DPW that are discussed in the following subsection. Finally, the low flow diversions tracked by WRAMPS2 are not within the scope of this capture estimate effort and are excluded from the assessment.

Table 5 details the volume of stormwater captured by BMPs and spreading grounds for the 2017–18, 2023–24, and 2024–2025 water years. WRAMPS2 does not provide data for water years before 2017–18 or for water years 2020–21 through 2022–23. Table 6 compares water year capture volumes with cumulative water year rainfall and ranks the climate trends. Notably, water year 2017–2018 was relatively dry (9.22 inches below the historic average), but had a relatively high amount of capture from the spreading ground (154,000 ac-ft) compared to that captured in water year 2023–2024 (80,200 ac-ft, about half of the 2017–2018 spreading ground capture), which was an extremely wet year (18.84 inches above average). The SCM capture trend better follows the dry and wet water years, with SCMs capturing a relatively small volume (2,000 ac-ft) in the 2017–2018 dry water year compared to 22,100 ac-ft in the extremely wet 2023–24 water year. Like water year 2017–2018, water year 2024–2025 was relatively dry (7.88 inches below average), with comparable capture by SCMs (2,700 ac-ft).

Table 5. Record of estimated stormwater capture in LA County

Project Type	2017–18 Stormwater Capture Reported, ac-ft	2023–24 Stormwater Capture Reported, ac-ft	2024–25 Stormwater Capture Reported, ac-ft	Total Stormwater Capture Reported, ac-ft
Structural Control Measures	2,000	22,100	2,700	26,800
Spreading Grounds	152,000	80,200	n/a ¹	232,200
Total	154,000	102,300	2,700	259,000

¹WRAMPS2 did not report any stormwater capture for spreading grounds in this water year.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Table 6. Comparison of Los Angeles Flood Control District annual capture volume with relative climate trends

	Water Year 2017–18	Water Year 2023–24	Water Year 2024–25
Total Reported SCM Capture, ac-ft	2,000	22,100	2,700
Total Reported Spreading Ground Capture, ac-ft	152,000	80,200	n/a ¹
Total Regional Rainfall, in²	7.56	35.62	8.90
Rainfall Above/Below Historic Annual Record, in^{2,3}	-9.22	+18.84	-7.88
Relevant Climate Trend	Dry	Extremely Wet	Dry

¹WRAMPS2 did not report any stormwater capture for spreading grounds in this water year.

² LA Almanac 2026

³ Historic averages from 1933–2024

Los Angeles Department of Public Works Capture Volumes

DPW operates 2,435 acres of spreading grounds that replenish groundwater with stormwater runoff, imported water, and recycled water. An additional 925 acres are operated by other agencies within the county and are not represented by the stormwater capture volumes discussed in this section. Each year, DPW details the amount of stormwater runoff infiltrated into the subsurface in their Annual Hydrologic Report (DPW 2025). Table 7 details the amount of stormwater used for recharge by year since the 2020–21 water year through the 2023–24 water year. This period was chosen to reflect the period used in the Capture Model, though the 2024–25 water year data was not available at the writing of this report. The average annual amount of stormwater infiltrated by DPW's spreading ground facilities during the same period is approximately 296,000 ac-ft/y. As a comparison, DPW's Stormwater Capture Master Plan estimated approximately 29,000 ac-ft/y of centralized capture as of 2015 (DWP 2015). Since all basins were constructed between the 1930s and the mid-20th century, it is uncertain as to why the reported volume has increased substantially over the past decade. Also of interest, the Stormwater Capture Master Plan noted that stormwater capture projects did not contribute a significant volume of recharge (presumably in 2015), with the document's

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

figures indicating less than 1,000 ac-ft of annual capture from these devices. The Master Plan also reported (again, presumably for 2015) an estimate of 35,000 ac-ft/y of incidental distributed capture, which was defined as “capture that is a result of passive infiltration into pervious areas..., rather than through stormwater capture projects.” The capture estimates for this statewide effort did not include this type of capture.

Table 7. Record of stormwater used for recharge in DPW's spreading grounds as recorded by Annual Hydrologic Reports

Groundwater Basin Recharged	2020–21 Stormwater used for recharge, ac-ft	2021–22 Stormwater used for recharge, ac-ft	2022–23 Stormwater used for recharge, ac-ft	2023–24 Stormwater used for recharge, ac-ft
Main San Gabriel Basin	22,986	52,059	295,193	100,894
Upper San Gabriel Canyon Basin	21,814	19,003	54,286	44,814
Lower San Gabriel Canyon Basin	0	311	1,682	1,572
Wayhill Basin	66	125	673	128
Foothill Basin	336	704	8,555	10,700
Glendora Basin	93	276	3,694	3,452
San Dimas Basin	0	0	838	252
Raymond Basin	253	929	7,677	5,725
Central Basin	1,432	24,839	181,551	126,478
San Fernando Main Basin	2,769	10,596	108,665	67,567
Total	49,749	108,842	662,814	361,582

Relevant trends for each water year's total reported capture volumes followed cumulative rainfall trends for those same water years. Table 8 compares water year capture volumes

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

with cumulative water year rainfall. A relatively small amount of capture was reported in Water Year 2020–2021 (approximately 50,000 ac-ft), which was a fairly dry water year (12.03 inches below the historic rainfall average). More capture occurred in Water Year 2021–2022 (approximately 109,000 ac-ft), which was only moderately dry (3.27 inches below the historic average). Substantially more runoff was captured in the extremely wet water years of 2022–2023 (approximately 663,000 ac-ft, 20.32 inches above the historic average) and 2023–2024 (approximately 362,000 ac-ft, 18.84 inches above the historic average).

Table 8. Comparison of DPW's annual capture volume with relative climate trends

	Water Year 2020–21	Water Year 2021–22	Water Year 2022–23	Water Year 2023–24
Total Reported Capture, ac-ft	49,749	108,842	662,814	361,582
Total Regional Rainfall, in¹	4.75	13.51	37.10	35.62
Rainfall Above/Below Historic Annual Record, in^{1,2}	-12.03	-3.27	+20.32	+18.84
Relevant Climate Trend	Dry	Moderately Dry	Extremely Wet	Extremely Wet

¹ LA Almanac 2026

² Historic averages from 1933–2024

Fresno Municipal Flood Control District Capture Volumes

FMFCD operates 157 infiltration basins that total approximately 2,419 acres and replenish groundwater supplies with captured stormwater runoff and imported water from Fresno Irrigation District. According to the Fresno-Clovis Storm Water Quality Management Program Annual Progress Report (FMFCD 2020), FMFCD's basins capture, on average, approximately 92 percent of annual rainfall in the area. Approximately 70 to 85 percent of that captured runoff is then recharged into groundwater. Figure 8 shows the reported volume of stormwater and imported water infiltrated via the basins by water year from 2009 through 2023. Over the 15-year period presented, approximately 246,900 ac-ft of stormwater was infiltrated into the subsurface with an average of 16,460 ac-ft per year. In the 2019–20 through 2022–23 water year period, approximately 61,200 ac-ft of stormwater was infiltrated with an average of 15,300 ac-ft per year.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

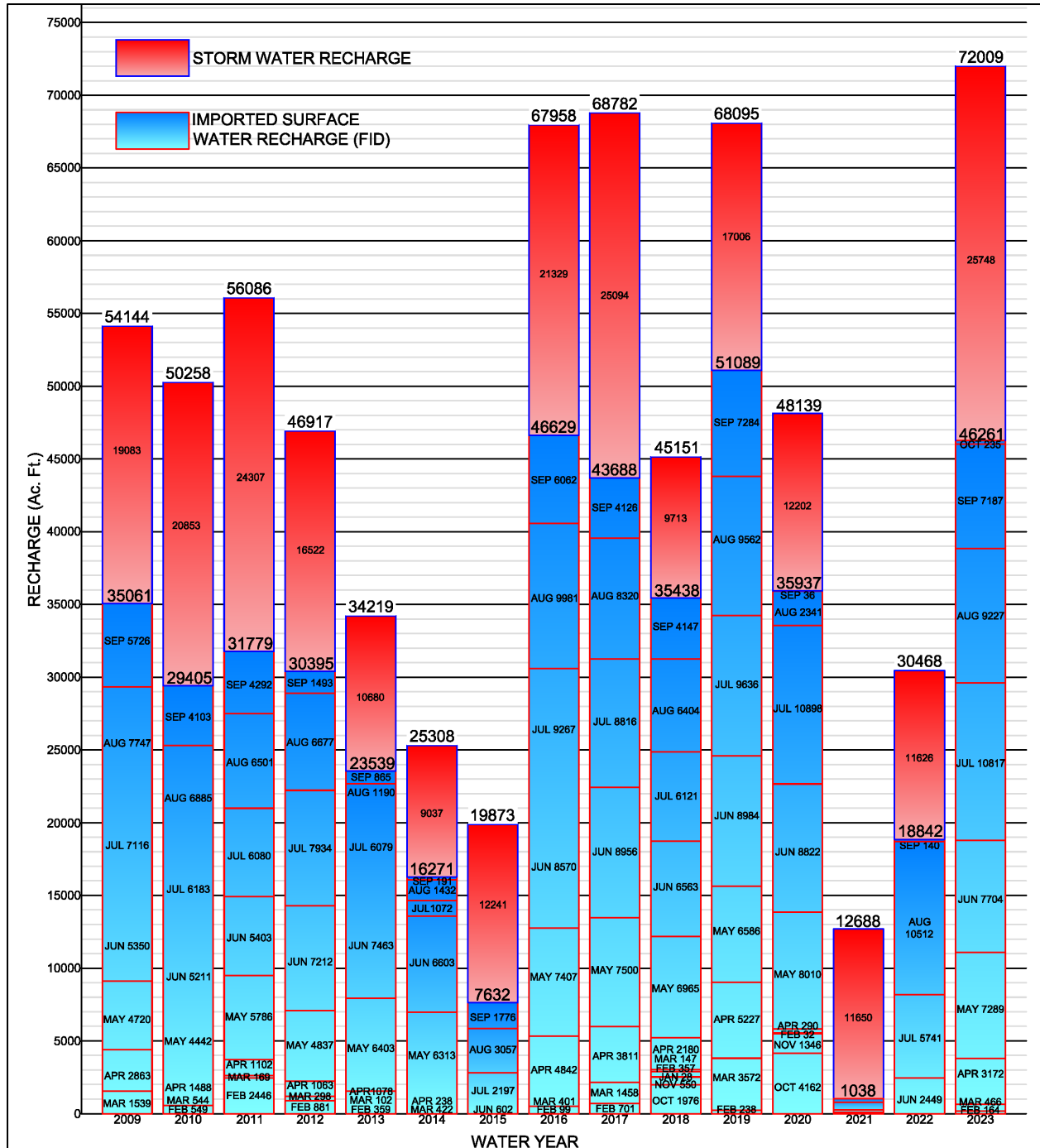


Figure 8. Volume of stormwater and imported water infiltrated per year by FMFCD infiltration basins (Adapted from FMFCD's report to their Board of Directors)

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Other Sources

C/CAG Green Infrastructure Tracking Tool

The City and County Association of Governments of San Mateo County maintains a Green Infrastructure Tracking Tool that displays over 700 public and private projects that manage stormwater runoff (C/CAG 2026). Each project is simulated by the tool to provide estimates of the volume of stormwater that is retained and infiltrated onsite or treated and passed offsite, as well as volumes that bypass projects entirely. The tool also provides catchment areas for the impervious and pervious surfaces treated by each project, in addition to future capture projections based on a range of global climate change models. However, the projects are not available for download in a tabulated format and thus significant effort is required to extract information that could be included in this inventory of BMPs in the Capture Model.

City of Modesto Storm Drain System

The City of Modesto reports using approximately 10,500 rockwells as a portion of their stormwater management system (Modesto 2026). Each rockwell is between 20 and 75 feet deep, but no other information is provided on their locations, diameters, or structures (e.g., if the wells have screened intervals). Since this information was not available, the rockwells were not included in the Capture Model.

Rain Barrel Rebate Programs

Small, residential-scale BMPs like rain barrels are widely subsidized by various water districts, utilities, municipalities, and special districts through rebate programs available to their customers. However, these programs do not regularly report the number of rebates given, nor do they track whether the rain barrel is continuously used. Privately owned rain barrels are therefore not included in the Capture Model. Instead, Appendix D tabulates rebate programs by county and agency throughout the state. In many cases, multiple agencies engage in collaborative, regional partnerships like Socal Water\$mart to both share costs and pursue shared regional water conservation goals. In future capture estimates, the State Water Board may consider engaging with these regional programs or associated water supply agencies to obtain information about the number and location of rain barrels provided.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Limitations

The methodology used to develop the Capture Model has limitations that affect the quality of the Master Inventory and volume capture estimates. These limitations are associated with incompleteness, inaccuracy, bias, and other constraints and assumptions. The Master Inventory is a first-of-its-kind effort to compile an inventory of stormwater capture devices throughout the state, along with parameters indicative of volume captured. OWP understands that STORMS intends this project to develop methods for creating a baseline of stormwater capture throughout the state, with a larger more comprehensive effort to follow that incorporates lessons learned from this first effort. The Master Inventory and total capture estimates developed and submitted for this project are subject to the following data quality limitations.

Incompleteness

A limited number of stormwater capture practitioners (four percent of MS4 Phase I and Phase II permittees) responded to the data request or had data available online, resulting in an incomplete inventory of existing capture devices throughout the state. Thus, the count of BMPs and statewide capture volume reported here is underestimated. In addition, data submitted for incorporation into the Master Inventory often omitted entries to some or several data fields for a variety of reasons, such as the information was not known or easily accessible. In these cases, OWP used professional judgement to determine whether reasonable assumptions can be made to populate the missing data, or if the device needed to be excluded from inclusion in the statewide capture volume estimate. Where data was assumed or overwritten, the values were conservatively assigned such that the resulting volume calculations are underestimates. This avoids estimating greater than actual volumes of capture. The Master Inventory includes notes where data fields were missing and assumed values were assigned.

OWP submitted the data request to MS4 permittees, CASQA members, and other practitioners. Notably, many MS4 permittees do not retain records of privately owned and operated stormwater capture systems that were installed as part of new or redevelopment, so these stormwater capture devices are not included in the Inventory.

Inaccuracy

All data and models are subject to errors affecting accuracy. For this project, it was expected that respondents may have unintentionally mistranscribed data values from their internal data sets to this project's data request form. Additional errors in the Master

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Inventory may have resulted from errors in the respondents' existing data sources. It is unknown whether such errors resulted in a general over- or under-estimation of statewide capture volumes. As data was received, OWP reviewed submittals for errors such as excessively large or small values and followed up with respondents for clarification. OWP also evaluated if the values could be updated with more reasonable values. When values were overwritten, the replacement values were conservatively selected to minimize deviation from actual volume captured. The Master Inventory includes notes where data fields were missing and assumed values were assigned.

Bias

Bias in received data may have been influenced by myriad factors including geography, geology, or responsiveness of contributing agencies and municipalities. Infiltration of captured stormwater occurs most frequently in areas reliant on groundwater for water supply. Some agencies or municipalities may appear to have an outsized contribution of capture when compared with other areas of the state because they have systems in place to quantify capture infrastructure, perhaps due to interest from local water supply jurisdictions. However, capture occurs to some degree throughout the state because of statewide installation of post-construction BMPs associated with new development and redevelopment standards in the Construction General Permit and MS4 permits.

Other Constraints and Assumptions

The methods used for developing the Master Inventory and developing and running the Capture Model have other limitations associated with modeling constraints and assumptions. As noted previously, any assumptions used to develop the inventory or estimate statewide capture volumes were conservative in nature to underestimate the calculated totals and avoid misconceptions or other expectations.

Estimates of volumetric capture are limited by uncertainty associated with the percentage of infiltration that reaches aquifers. Quantifying these values requires significant hydrogeological modeling and is beyond the scope of this project. This is a significant data/knowledge gap in estimating actual groundwater recharge. When respondents submitted data with a degree of certainty that infiltration estimates are directly contributing to groundwater recharge, the inventory documents that certainty. This is also the case when the likelihood of recharge is unknown or otherwise uncertain. Regardless of certainty, each modeled volume was included in the estimation of capture.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

The project is intended to estimate existing capture for water supply, specifically non-potable reuse or groundwater recharge. Any capture intended to moderate downstream flows (dams and reservoirs) or support flood control (where there is no extra infiltration or storage other than flood control) was excluded from the Master Inventory and capture estimate. The methods also exclude capture of dry weather flow, as the source of such capture is not stormwater/precipitation. Capture from rural areas is also omitted per previous STORMS reports² and to align with the Governor's direction to estimate capture in cities and towns.

Finally, the methods excluded collection of data relevant to runoff out of bioretention devices from overflows and underdrains. It is assumed these contributions are negligible.

Summary of Existing Stormwater Capture

A methodology was developed to estimate capture of urban stormwater for use (e.g., groundwater recharge or irrigation) at existing BMPs submitted by Phase I and Phase II MS4 permittees throughout California. The results are known to be an underestimate, mostly due to the lack of existing urban stormwater capture inventory. The results are also subject to other limitations associated with incompleteness, as well as inaccuracy, bias, and physical and social constraints. A summary of the estimated capture is provided in this section. The following section provides considerations for improving estimates and promoting urban runoff capture in the future.

The nearly 1,300 BMPs simulated by the Capture Model infiltrate approximately 6,200 ac-ft of stormwater in an average year based on recent precipitation data. This is known to be an underestimate, as only approximately four percent of Phase I and Phase II MS4 permittees provided inventories for the Capture Model.

In addition to the Capture Model estimate, capture volumes from larger centralized systems were obtained from three sources: DPW, WAMPS2, and FMFCD. These large-scale regional basins capture and infiltrate approximately 363,800 ac-ft of stormwater in an average year. When combining this with the estimate from the Capture Model, the total estimated annual average amount of captured urban stormwater used for groundwater

² The State Water Board (2018) states, "In the West, the infrastructure for rural runoff capture for transport to regions of need is well-developed, often due to massive investment at federal, state, and local levels. In contrast, local use of urban runoff has not reached its full potential. To address this potential, this project [STORMS project 1.a and b] focuses on urban runoff capture."

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

recharge or in-lieu use is approximately 370,000 ac-ft, as displayed in Table 9. Minimum and maximum annual capture volumes reported by each entity are also tabulated. Because these entities do not report capture consistently for each water year, total maximum and minimum annual capture volumes across all three service providers are not available.

Table 9. Total baseline capture estimates

Estimate Source	Average Volume Captured per Year, ac-ft	Min Volume Captured per Year, ac-ft ^{1,2,3}	Max Volume Captured per Year, ac-ft ^{1,2,3}
Capture Model⁴	6,200	-	-
DPW	296,000	49,749 (2020–2021)	662,814 (2022–2023)
WRAMPS2	52,500 ⁵	2,700 ^{5,6} (2024–2025)	102,300 ⁵ (2023–2024)
FMFCD	15,300	11,650 (2020–2021)	25,748 (2022–2023)
Total	370,000	-	-

¹ Annual capture volumes were not recorded by the Capture Model.

² Min and max values based on available data spanning water year 2020–2021 through water year 2024–2025 (see Table 5, Table 7 and Figure 8).

³ Not all entities reported data for each water year, so min and max values could not be calculated for each water year.

⁴ The Capture Model simulated moderate, street-scale BMPs listed in Table 1.

⁵ For water year 2017–2018 (Table 5), 154,000 ac-ft/y was reported, which overrides the 2023–2024 max and would increase the annual average to 86,333 ac-ft/y if it been included. Data for 2017–2018 was excluded here for consistency with the time period used for the Capture Model.

⁶ Represents capture only from SCMs; no capture from spreading grounds reported.

For context, the Supply Strategy reported an average of 324,000 ac-ft/y for the South Coast over the last 30 years (CA DNR et al. 2022). This is approximately 24,500 ac-ft/y less than the sum of DPW's and WRAMPS2's reported annual average capture volumes that was used in this study (348,500 ac-ft/y). It is unknown if this increase is due to infrastructure investments or changes in rainfall patterns. The Supply Strategy is based on 30 years of data, presumably through water year 2020–2021 based on the August 2022 publication date. DPW's reported capture from this study covers water years 2020–2021 through 2023–2024, with the last two water years being extremely wet relative to historic rainfall since 1933 (see Table 7). WRAMPS2's reported capture covers water years 2017–2018, 2023–2024, and 2024–2025, with the first and last water years being relatively dry

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

and water year 2023–2024 again being extremely wet (based on rainfall since 1933; see Table 6).

Finally, the list of residential-scale rain barrel rebate programs included as part of this inventory suggests that a small level of capture occurs through these BMPs. Capture volumes from these BMPs were not quantified in this effort; instead, the information is made available to inform future capture estimates conducted by State Water Board.

CONSIDERATIONS FOR FUTURE ESTIMATES

Improving the Data Inventory

The Governor's Water Supply Strategy directs the State Water Board to re-evaluate the baseline estimate of statewide stormwater capture and use every five years to track progress towards the increased capture goals for cities and towns of 250,000 ac-ft/y in 2030 and 500,000 ac-ft/y in 2040. To do so, the State Water Board will need to expand the inventory of BMPs to include both newly constructed BMPs and BMPs not reported in this initial effort.

To expand the inventory, the State Water Board may consider a range of potential reporting mechanisms. Data acquisition strategies and the mechanisms used will vary depending on whether the infrastructure exists or whether data can be collected in real time as future infrastructure is built. For existing infrastructure, data must be extracted from existing systems, as was the case with this project. The State Water Board may also consider whether voluntary reporting is sufficient or whether reporting should be compelled by regulatory mechanisms.

There are likely many potential methods to improve the amount and quality of data extracted from existing systems. Discussion with MS4 permittees and other agencies close to this data may be insightful. One potential avenue is to query the State Water Board's Stormwater Multiple Application Report Tracking System's (SMARTS) Notice of Intent (NOI) documents that describe post-construction BMPs for Construction General Permit (CGP) coverage. These reports may contain information about privately owned and operated stormwater capture systems but are likely to be highly varied in organization and content making manual review time intensive. Data scraping tools and artificial intelligence models might be helpful in extracting useful data more efficiently. Additionally, the State Water Board may consider engaging with regional rain barrel rebate programs and associated water supply agencies to obtain information about the number and location of rain barrels provided.

Similarly, there are records of state-funded infrastructure that are stored in various databases. The inventory of existing capture infrastructure may benefit from automated data scraping of these databases. In all cases, it may still be difficult to differentiate between urban and non-urban drainage areas. A detailed process would need to be

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

developed to ensure that only urban capture is counted and avoid counting non-urban capture that is accounted for in other water supply categories of the Supply Strategy.

Future reporting improvements could be tied to funding mechanisms. The state can use funding approved through propositions to require reporting in the proposition guidelines. Alternatively, as in the case of Proposition 4, regulations governing the fund can mandate reporting. The required reporting could include the data needed to model capture volumes. State funding can also come through partnerships with regulated agencies like the California Department of Transportation (Caltrans). These projects tend to be at a scale worthy of including in the infrastructure inventory. Limited project information is available online in the State Highway Operation and Protection Program (SHOPP), but additional details may be needed to estimate capture. The SHOPP runs on a two-year cycle. Additional investigation might be necessary as the drainage area description may only report the Caltrans portion, which is the necessary metric to justify investment. To avoid double counting of infrastructure, the State Water Board may consider checking the other reporting mechanisms because both proposition-funded and Caltrans-funded projects are usually implemented by the local drainage authority. This approach would provide an interim option for partial reporting of existing data until the establishment of a more comprehensive infrastructure reporting program.

Another possible improvement is to request asset management records from drainage system owners. This is likely the most comprehensive accounting of drainage assets, but there may not be sufficient data for estimating capture.

These state and local reporting systems could be improved to ensure data sufficiency moving forward. For future projects, the State Water Board might consider compelling use of the same systems to collect infrastructure construction in real time. For SMARTS, in addition to the NOI post-construction upload, mandatory fields for each BMP type's total drainage area could be added. The State Water Board could also consider adding this specificity to the Notice of Termination (NOT) documentation, which likely better matches as-constructed conditions. To ease reporting, one record can be reported for the aggregate of all metrics for installations of a particular BMP type. For example, a project with multiple infiltration trenches could be reported as a single infiltration basin. If the BMPs are 20 infiltration trenches that are each three feet deep with a collective footprint of one acre and they treat a range of drainage sizes that total 40 acres, the single entry in SMARTS would be:

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

- BMP Type = Infiltration Basin
- BMP Depth = 3 feet
- BMP Footprint = 42,560 square feet (1 acre)
- Drainage Area = 40 acres

The downside to aggregating BMP information by type is that changes in performance over time would not be attributable to a particular BMP installation.

For asset management systems, much of the necessary data should exist because this information is critical to valuing each asset and assessing its condition. One critical data attribute that might not typically be included in asset inventories is drainage area, so this might need to be explicitly added as a reporting requirement.

For both SMARTS and asset management systems, the minimum data fields necessary to estimate capture include BMP type, coordinates, date of construction, drainage area served by the BMP, and the footprint of the BMP. Each of these fields should be mandatory. If future MS4 permits require asset management, which is under consideration by the upcoming Phase II MS4 Permit Reissuance (the Reissuance), then the additional reporting burden may be marginal. Section D4.9 of the Reissuance states that "the Permittee shall conduct stormwater asset management activities and establish intended level of service for their MS4...." All structural controls and BMPs and their descriptions, installation dates, types, sizes, and capacities should be included in the permittee's asset inventory (State Water Board 2024). Currently, asset management systems typically do not include infrastructure that is not maintained by the MS4 because it was built on private land, which may limit the available information.

Improving the Modeling Framework for Future Five-year Updates

The current modeling framework uses queries of actual precipitation from a network of gauges across the state to present a five-year average annual capture. What is missing is an evaluation of the last five years of data relative to expected precipitation in all areas of the state. Future estimates may give a distorted view of progress towards the capture targets if drought cycles are not considered. Regional rainfall totals are available in updates to the California Water Plan; however, this information is not aligned with analysis from the modeling framework. To provide context for actual capture compared to typical, the model can simply be run over an extended time. Thirty years of data is available for most rain gauges. Another option is to perform analysis based on the date of construction.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

In this option, the last five years of rainfall records would be run on the current BMP inventory as of the end of the five-year analysis cycle as well as a run on this 2026 baseline inventory. Modeling this 2026 baseline inventory vs. current inventory (i.e., the baseline inventory plus newly constructed capture infrastructure) for the same five years of rainfall records will give a more accurate picture of the impact of additional infrastructure on stormwater capture amounts. Future estimates (2028, 2033, 2038, etc., assuming alignment with the Water Plan) would always be accompanied by an estimate of capture for this 2026 baseline inventory.

Another improvement in estimating capture would include a performance factor to account for changes in capture performance for modeled systems. For example, infiltration capacity could decrease over time, so a percentage of the initial infiltration rates could be used as a performance factor. Performance could also be addressed by asset management tools. Performance assessment is not needed for monitored systems that are directly reported by the local agency. As stated earlier, tracking performance requires location-specific infrastructure rather than aggregate totals for a region or jurisdiction.

Increasing Capture and Setting Local Targets

As work proceeds following the passage of State Bill 72, both physical and social factors should be considered in setting local stormwater capture targets. While there are limitations to controlling or addressing physical factors, social factors can be assessed to enhance capture. Toward that end, recommendations from the California Department of Water Resources (DWR) and State Water Board, as documented in the State Water Plan Update (DWR 2024), address many of the factors. Of the factors reviewed in this project, the following recommendations could also enhance installation of capture infrastructure:

- Regulatory considerations—Determine whether total maximum daily loads (TMDLs) and infiltration policies have unintended and negative impacts on incentivizing stormwater capture. If so, explore whether permitting terms that allow volume management as a surrogate for both load- and concentration-based TMDLs would increase desired capture.
- Economic and financial considerations—Promote the monetary value of stormwater capture projects, particularly given that California’s precipitation pattern is changing from substantial snowfall that is “stored” as snowpack in mountainous regions to less frequent, more intense, warmer storms with higher

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

proportions of rain that must be captured and stored as groundwater. This may include developing evaluation tools to support long-term and sustainable capture funding that matches the benefits derived over time.

- Multi-benefit considerations—Sometimes water supply resilience is not a community need. For other primary drivers (e.g., localized flooding), cost-effective guidance may increase capture when capture is a secondary objective. Practically, state funding guidance for grants could require justification for using high-cost technology such as porous pavement.
- Public education, engagement, and involvement considerations—MS4s are restricted in advocating for local funding measures. State government and trade associations might explore how they can meet this need.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

REFERENCES

- 2ND Nature. 2024. The California Stormwater Opportunity website. Accessed June 2024. <https://www.2ndnaturewater.com/interactive-map/ca-stormwater-opportunity-story-map/>
- California Department of Natural Resources, California Department of Water Resources, California State Water Resources Control Board, California Environmental Protection Agency, & California Department of Food and Agriculture. 2022. "California's Water Supply Strategy – Adapting to a Hotter, Drier Future." August 2022.
- California Urban Water Agencies. 2016. "The Potential for Urban Stormwater as a Water Supply."
- California Stormwater Quality Association. 2024. "The Socioeconomic Value of Urban Stormwater Capture."
- Los Angeles County Department of Water and Power. 2015. "Stormwater Capture Master Plan."
- California Department of Water Resources. 2024. "California Water Plan Update 2023. Urban Stormwater Runoff Capture and Management Resource Management Strategy,"
- Gershunov, A., Tamara Shulgina, and Rachel E. S. Clemesha. 2019. "Precipitation regime change in Western North America: The role of Atmospheric Rivers," *Sci Rep* 9(9994). <https://doi.org/10.1038/s41598-019-46169-w>
- Intergovernmental Panel for Climate Change. 2023. "Climate Change 2023 Synthesis Report: Summary for Policymakers." <https://doi.org/10.59327/IPCC/AR6-9789291691647>.001
- Safe Clean Water Program. 2025. "Los Angeles County." Accessed December 2025. <https://safecleanwaterla.org/>.
- State of California. 2025. "How California has Captured Water from Storms." Accessed December 2025. <https://www.gov.ca.gov/2024/02/21/how-california-has-captured-water-from-storms/>Office of Water Programs at California State University, Sacramento. 2019. "American River Basin Storm Water Resource Plan." April 2019.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

- Office of Water Programs at California State University, Sacramento. 2025a. "Tools and Methodologies for Estimating Stormwater Capture." April 2025.
- Office of Water Programs at California State University, Sacramento. 2025b. "Stormwater Capture Estimates in Cities and Towns." October 2025.
- Pacific Institute. 2024. "Untapped Potential: An Assessment of Urban Stormwater Runoff Potential in the United States."
- Porse, E., Cristina Poindexter, Christian Carleton, and Michael Stephens. 2021. "Climate Change Risk and Adaptation Costs for Stormwater Management in California Coastal Parklands." *Sustainable and Reliant Infrastructure* 8(3): 293-306. <https://doi.org/10.1080/23789689.2021.1996811>.
- California State Water Resources Control Board. 2013. "State Resources Control Board Water Quality Order No. 2013-0001-DWQ National Pollutant Discharge Elimination System (NPDES) General Permit No. CAS000004 Waste Discharge Requirements (WDRS) for Storm Water Discharges From Small Municipal Separate Storm Sewer Systems (MS4s) (General Permit)."
- California State Water Resources Control Board. 2018. "Final Report: Enhancing Urban Runoff Capture and Use."
- California State Water Resources Control Board. 2024. "State Water Resources Control Board Informal Draft Water Quality Order No. 20XX-00XX-DWQ NPDES General Permit No. CAS0000004 Waste Discharge Requirements (WDRS) for Storm Water Discharges From Municipal Separate Storm Sewer Systems (MS4s) (General Permit)."
- Southern California Water Coalition. 2018. "Stormwater Capture Enhancing Recharge & Direct Use through Data Collection."
- Southern California Coastal Water Research Program. 2020. "Evaluating Potential Methods to Quantify Data Collection."
- County of San Diego. 2018. "Stormwater Capture and Use Feasibility Study."
- UN Framework Convention on Climate Change. 2015. "Paris Agreement." December 12, 2015.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

United States Department of Agriculture, National Resource Conservation Service. 2007. National Engineering Handbook. Part 630 Hydrology, Chapter 7, "Hydrologic Soil Groups."

Wang, A., Francina Dominguez, and Arthur Robert Schmidt. 2019. "Extreme Precipitation Spatial Analog: In Search of an Alternative Approach for Future Extreme Precipitation in Urban Hydrological Studies." *Water*, 11(5), 1032. <https://doi.org/10.3390/w11051032>

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

APPENDIX A: MASTER INVENTORY OF STORMWATER CAPTURE BMPS (ELECTRONIC ONLY)

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

APPENDIX B: CAPTURE ESTIMATE WORKBOOKS (ELECTRONIC ONLY)

APPENDIX C: PHASE II LID SIZING TOOL SWMM INPUTS AND OUTPUTS

SWMM Inputs and Sources

Inputs for the LID Sizing Tool's SWMM component include:

- Hourly rainfall and evaporation data from climate stations throughout California
- Saturated hydraulic conductivity for various hydrologic soil types
- Attributes for various BMP types (e.g., depth of ponding, soil amendments, storage, and porosities of soil amendments and gravel storage)
- Ratios of BMP footprints to impervious footprints

This appendix describes the inputs and their sources. Details regarding development and inputs for the entire Sizing Tool and SWMM are provided in the Sizing Tool's [Documentation Manual](#).

Rainfall and Evaporation Data

The SWMM program provides infiltration results based on precipitation and evaporation data from 92 climate stations located throughout California, as shown in Figure 9. These locations were chosen based on a variety of criteria, including: 1) statewide representation, 2) available climate data exceeding 30 years and 80 percent completeness, and 3) region-specific requests. The data is from the National Oceanic and Atmospheric Administration's National Center for Environmental Information and was downloaded through EPA's [Stormwater Calculator](#) (Version 2.0.0.1).

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

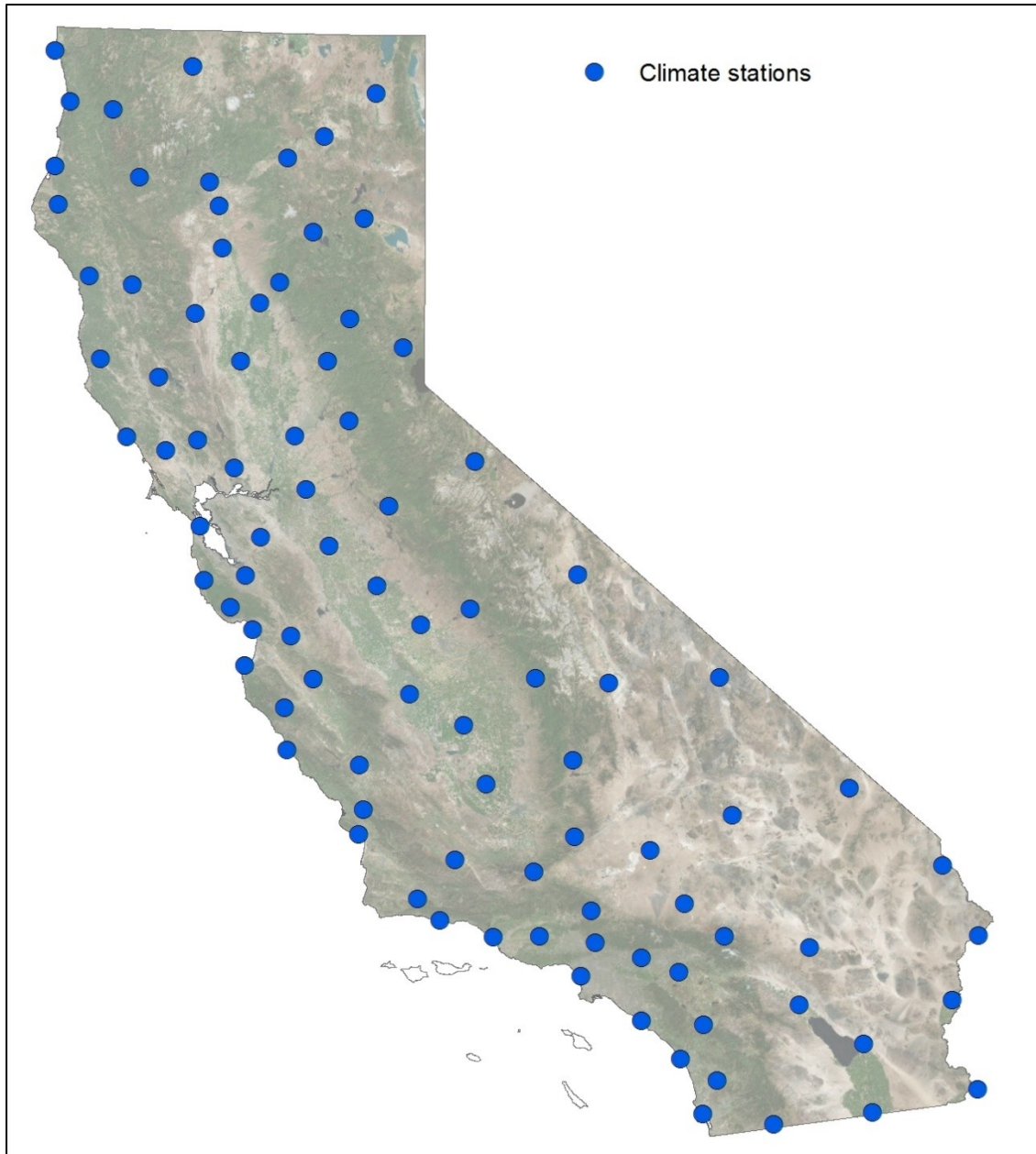


Figure 9. Climate data locations for the CA Phase II LID Sizing Tool

Subsurface Saturated Hydraulic Conductivity

The rate of infiltration into the BMP's subsurface is influenced by the type of soil underlying the BMP. Six different soil types were modeled. These soil types are based on the Hydrologic Soil Groups established by the Department of Agriculture, National Resource Conservation Service (NRCS) as follows: one representing Hydrologic Soil Group A, one representing Soil Group B, two representing Soil Group C, and two representing Soil Group D (USDA 2007). Table 10 presents the saturated hydraulic conductivity associated with each soil type modeled.

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Table 10. Infiltration rates based on hydrologic soil groups

Soil Group	Saturated Hydraulic Conductivity, in/h
A	5.0
B	1.0
C _{high}	0.3
C _{low}	0.1
D _{high}	0.04
D _{low}	0.01

BMP Types and Attributes

The 25 types and configurations of BMPs that were simulated are listed in Table 11. These were selected to represent the infiltrating BMPs commonly found in California. Figure 10 provides a general schematic of bioretention cells (called rain gardens in the main body of this report) and their various attributes. Details on all BMPs can be found at the California Phase II LID Sizing Tool website at <https://www.owp.csus.edu/LIDTool/>.

Table 11. BMP types and configurations

BMP Types	BMP Configuration
Amended Strip	5% slope, amended depth 18 in 5% slope, amended depth 12 in 5% slope, amended depth 6 in
Amended Swale	amended depth 18 in amended depth 12 in amended depth 6 in
Bioretention Cell—12 in Ponding	Soil depth 18 in, storage depth 12 in Soil depth 18 in, storage depth 24 in Soil depth 18 in, storage depth 36 in Soil depth 24 in, storage depth 12 in Soil depth 24 in, storage depth 24 in Soil depth 24 in, storage depth 36 in
Bioretention Cell—6 in Ponding	Soil depth 18 in, storage depth 12 in Soil depth 18 in, storage depth 24 in Soil depth 18 in, storage depth 36 in Soil depth 24 in, storage depth 12 in Soil depth 24 in, storage depth 24 in Soil depth 24 in, storage depth 36 in
Bioretention Cell—Alternative	Bioretention cell—alternative
Capture and Use Storage	Capture and use storage
Infiltration Gallery, Trench, and Basin	Infiltration gallery Infiltration trench Vegetated infiltration basin
Other	Overland flow, no amendment Porous pavement

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

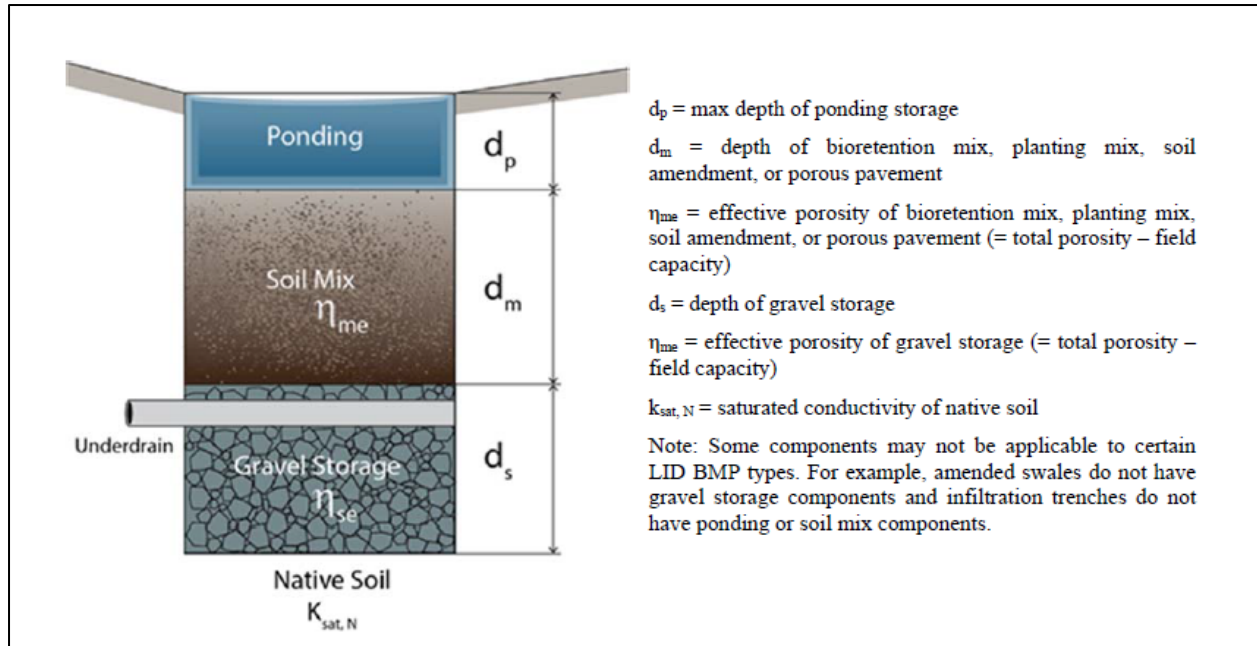


Figure 10. Schematic of a bioretention cell simulated in SWMM

Ratio of BMP to Impervious Area Footprints

The amount of stormwater available to be infiltrated varies with the size of the BMP footprint and the size of the impervious area draining to it. More stormwater will bypass BMPs that have a small ratio of BMP footprint to impervious area and thus the volume available for infiltration will be limited. Conversely, BMPs that have larger ratios of footprint to impervious drainage area will infiltrate more stormwater. Table 12 lists the eight ratios of BMP area to impervious area that were modeled in SWMM to represent ratios of BMP footprint to impervious area from one to 100 percent.

Table 12. BMP to impervious area ratios

BMP Area to Impervious Area
0.01
0.02
0.04
0.08
0.16
0.32
0.5
1.0

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

SWMM Output

To develop the LID Sizing Tool, SWMM was run with all the combinations of the previously described inputs, producing over 100,000 results that were stored in the Tool's database. Figure 11 is a screenshot of the bottom 45 rows of the 106,721 results stored in the database. The database was then exported to Microsoft Excel for use in this project.

1	COOP STN NAME	LID_Description	PrjSoilTyp	Ksat	PrjLID_AreaPct	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
106677	REDDING AP	Vegetated Infiltration Basin	A	5	0.08	0.00	2.87	0.00	0.00	0.002568	0	35.89966	0	0	0	0	0	0
106678	REDDING AP	Vegetated Infiltration Basin	A	5	0.16	0.00	3.11	0.00	0.00	0.000456	0	19.44062	0	0	0	0	0	0
106679	REDDING AP	Vegetated Infiltration Basin	A	5	0.32	0.00	3.59	0.00	0.00	4.14E-05	0	11.21093	0	0	0	0	0	0
106680	REDDING AP	Vegetated Infiltration Basin	A	5	0.5	0.00	4.12	0.00	0.00	0	0	8.248201	0	0	0	0	0	0
106681	REDDING AP	Vegetated Infiltration Basin	A	5	1	0.00	5.61	0.00	0.00	0	0	5.6147	0	0	0	0	0	0
106682	REDDING AP	Vegetated Infiltration Basin	B	1	0.01	0.01	1.54	0.00	1.14	0.930682	0	154.2127	0	0	0	0	0	0
106683	REDDING AP	Vegetated Infiltration Basin	B	1	0.02	0.01	2.25	0.00	0.44	0.688889	0	112.7189	0	0	0	0	0	0
106684	REDDING AP	Vegetated Infiltration Basin	B	1	0.04	0.02	2.69	0.00	0.05	0.4244	0	67.20033	0	0	0	0	0	0
106685	REDDING AP	Vegetated Infiltration Basin	B	1	0.08	0.01	2.86	0.00	0.00	0.160884	0	35.81003	0	0	0	0	0	0
106686	REDDING AP	Vegetated Infiltration Basin	B	1	0.16	0.01	3.11	0.00	0.00	0.038145	0	19.42778	0	0	0	0	0	0
106687	REDDING AP	Vegetated Infiltration Basin	B	1	0.32	0.00	3.59	0.00	0.00	0.006254	0	11.20915	0	0	0	0	0	0
106688	REDDING AP	Vegetated Infiltration Basin	B	1	0.5	0.00	4.12	0.00	0.00	0.001822	0	8.247746	0	0	0	0	0	0
106689	REDDING AP	Vegetated Infiltration Basin	B	1	1	0.00	5.61	0.00	0.00	0.000456	0	5.614617	0	0	0	0	0	0
106690	REDDING AP	Vegetated Infiltration Basin	C_High	0.3	0.01	0.01	0.61	0.00	2.09	1.237095	0	60.77978	0	0	0	0	0	0
106691	REDDING AP	Vegetated Infiltration Basin	C_High	0.3	0.02	0.02	1.07	0.00	1.63	1.083345	0	53.69068	0	0	0	0	0	0
106692	REDDING AP	Vegetated Infiltration Basin	C_High	0.3	0.04	0.03	1.75	0.00	0.99	0.866237	0	43.78555	0	0	0	0	0	0
106693	REDDING AP	Vegetated Infiltration Basin	C_High	0.3	0.08	0.05	2.51	0.00	0.33	0.60502	0	31.38504	0	0	0	0	0	0
106694	REDDING AP	Vegetated Infiltration Basin	C_High	0.3	0.16	0.05	3.05	0.00	0.03	0.340645	0	19.40463	0	0	0	0	0	0
106695	REDDING AP	Vegetated Infiltration Basin	C_High	0.3	0.32	0.04	3.57	0.00	0.00	0.138927	0	11.15423	0	0	0	0	0	0
106696	REDDING AP	Vegetated Infiltration Basin	C_High	0.3	0.5	0.03	4.11	0.00	0.00	0.064238	0	8.225174	0	0	0	0	0	0
106697	REDDING AP	Vegetated Infiltration Basin	C_High	0.3	1	0.02	5.61	0.00	0.00	0.021661	0	5.608901	0	0	0	0	0	0
106698	REDDING AP	Vegetated Infiltration Basin	C_Low	0.1	0.01	0.01	0.23	0.00	2.47	1.305713	0	22.57199	0	0	0	0	0	0
106699	REDDING AP	Vegetated Infiltration Basin	C_Low	0.1	0.02	0.02	0.43	0.00	2.28	1.23137	0	21.51035	0	0	0	0	0	0
106700	REDDING AP	Vegetated Infiltration Basin	C_Low	0.1	0.04	0.04	0.79	0.00	1.95	1.112213	0	19.73045	0	0	0	0	0	0
106701	REDDING AP	Vegetated Infiltration Basin	C_Low	0.1	0.08	0.08	1.37	0.00	1.46	0.940125	0	17.07989	0	0	0	0	0	0
106702	REDDING AP	Vegetated Infiltration Basin	C_Low	0.1	0.16	0.12	2.19	0.00	0.84	0.72252	0	13.68887	0	0	0	0	0	0
106703	REDDING AP	Vegetated Infiltration Basin	C_Low	0.1	0.32	0.16	3.19	0.00	0.29	0.488265	0	9.9656	0	0	0	0	0	0
106704	REDDING AP	Vegetated Infiltration Basin	C_Low	0.1	0.5	0.17	3.90	0.00	0.11	0.342602	0	7.809968	0	0	0	0	0	0
106705	REDDING AP	Vegetated Infiltration Basin	C_Low	0.1	1	0.18	5.51	0.00	0.00	0.178797	0	5.514222	0	0	0	0	0	0
106706	REDDING AP	Vegetated Infiltration Basin	D_High	0.04	0.01	0.01	0.10	0.00	2.60	1.211945	0	9.57247	0	0	0	0	0	0
106707	REDDING AP	Vegetated Infiltration Basin	D_High	0.04	0.02	0.02	0.19	0.00	2.52	1.192645	0	9.416452	0	0	0	0	0	0
106708	REDDING AP	Vegetated Infiltration Basin	D_High	0.04	0.04	0.05	0.36	0.00	2.38	1.137809	0	9.057407	0	0	0	0	0	0
106709	REDDING AP	Vegetated Infiltration Basin	D_High	0.04	0.08	0.08	0.68	0.00	2.14	1.04023	0	8.447293	0	0	0	0	0	0
106710	REDDING AP	Vegetated Infiltration Basin	D_High	0.04	0.16	0.14	1.21	0.00	1.79	0.903595	0	7.571737	0	0	0	0	0	0
106711	REDDING AP	Vegetated Infiltration Basin	D_High	0.04	0.32	0.24	2.07	0.00	1.34	0.736602	0	6.467973	0	0	0	0	0	0
106712	REDDING AP	Vegetated Infiltration Basin	D_High	0.04	0.5	0.31	2.87	0.00	1.02	0.621504	0	5.73017	0	0	0	0	0	0
106713	REDDING AP	Vegetated Infiltration Basin	D_High	0.04	1	0.46	4.65	0.00	0.63	0.460599	0	4.654653	0	0	0	0	0	0
106714	REDDING AP	Vegetated Infiltration Basin	D_Low	0.01	0.01	0.01	0.03	0.00	2.66	1.41025	0	3.149392	0	0	0	0	0	0
106715	REDDING AP	Vegetated Infiltration Basin	D_Low	0.01	0.02	0.03	0.06	0.00	2.64	1.39066	0	3.115348	0	0	0	0	0	0
106716	REDDING AP	Vegetated Infiltration Basin	D_Low	0.01	0.04	0.05	0.12	0.00	2.61	1.368294	0	3.074345	0	0	0	0	0	0
106717	REDDING AP	Vegetated Infiltration Basin	D_Low	0.01	0.08	0.11	0.24	0.00	2.56	1.319836	0	2.990268	0	0	0	0	0	0
106718	REDDING AP	Vegetated Infiltration Basin	D_Low	0.01	0.16	0.20	0.45	0.00	2.49	1.229382	0	2.843113	0	0	0	0	0	0
106719	REDDING AP	Vegetated Infiltration Basin	D_Low	0.01	0.32	0.36	0.85	0.00	2.42	1.118343	0	2.653384	0	0	0	0	0	0
106720	REDDING AP	Vegetated Infiltration Basin	D_Low	0.01	0.5	0.52	1.26	0.00	2.40	1.03642	0	2.522297	0	0	0	0	0	0
106721	REDDING AP	Vegetated Infiltration Basin	D_Low	0.01	1	0.91	2.32	0.00	2.49	0.914571	0	2.317863	0	0	0	0	0	0

Figure 11. Screenshot of bottom 45 rows of the exported SWMM database

This exported database was then used to create a table that can be used to estimate infiltration from BMPs across California. Figure 12 shows a typical infiltration estimation curve for a bioretention cell. This example bioretention cell, located in Sacramento, CA, has a soil with a saturated hydraulic conductivity of 0.3 inches per hour (in/h). The x-axis is the ratio of the BMP area to the impervious area, while the y-axis is the volume of water infiltrated per year (ac-ft/y). The Capture Model was run with the eight BMP to impervious area ratios shown in Table 12. The figure shows how the results between the modeled ratios can be interpolated linearly. Similarly, the results between the six infiltration rates can be interpolated. For example, the estimated annual average volume of infiltration captured by a bioretention cell that is sized to be four percent of the impervious area is 0.75 ac-ft. For estimating statewide stormwater capture relevant to this STORMS project, the table exported from the database can be imported to the Infiltration Estimate Workbook which contains functions to look up the relevant information and estimate the volume infiltrated by a BMP. These calculations can all be conducted using built-in Excel functions (no macros are necessary).

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

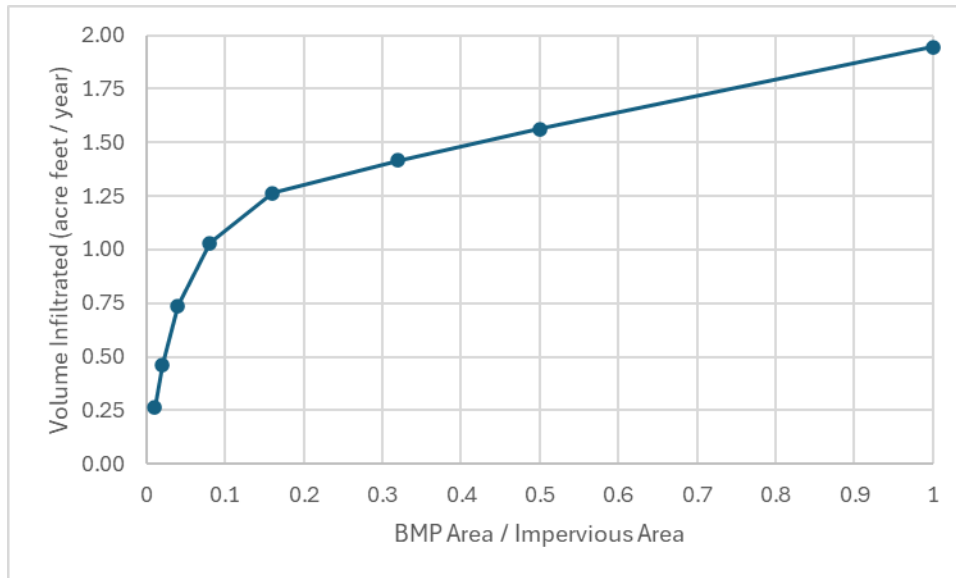


Figure 12. Infiltration volumes for various sizes of rain gardens in soils with an infiltration rate of 0.3 in/h for Sacramento, CA

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

APPENDIX D: RAIN BARREL REBATE PROGRAMS

County	Jurisdiction	Program Name
Alameda	Alameda County Water District	BAWSCA Rain Barrel Rebate Program
Alameda	City of Hayward	BAWSCA Rain Barrel Rebate Program
Fresno	City of Fresno, Department of Public Utilities	Rain Barrel Rebate
Humboldt	Humboldt Community Services District	Rain Catchment Rebate Program (aka Rainwater Harvesting Incentive)
Los Angeles	Los Angeles Department of Water and Power	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	Metropolitan Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	Pasadena Water and Power	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	Burbank Water and Power	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	Glendale Water and Power	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	Las Virgenes Municipal Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	City of Beverly Hills	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	Three Valleys Municipal Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	Long Beach Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Los Angeles	West Basin Municipal Water District	Rain Barrel Giveaway
Los Angeles	City of Santa Monica	Rain Harvest Rebates
Los Angeles	San Gabriel Valley Municipal Water District	Conservation Rebates (including rain barrels and cisterns)
Madera	City of Madera (Water Division)	Rainwater Harvesting (Rain Barrel) Rebate

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Marin	Marin Municipal Water District	Marin County Stormwater Pollution Prevention Partnership (MCSTOPPP)
Marin	North Marin Water District	Marin County Stormwater Pollution Prevention Partnership (MCSTOPPP)
Monterey	Marina Coast Water District	Rainwater Catchment Rebate Program
Monterey	Monterey Peninsula Water Management District	Rain Barrel Giveaway Program
Napa	City of St. Helena (City Utilities, Water Division)	Rainwater Harvesting Rebate
Orange	Municipal Water District of Orange County	Rain Barrels & Cisterns (Residential Rebates)
Orange	Anaheim Public Utilities	SoCal Water\$mart–Rain Barrels & Cisterns
Orange	City of Santa Ana	SoCal Water\$mart–Rain Barrels & Cisterns
Orange	Irvine Ranch Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Orange	Moulton Niguel Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Orange	Santa Margarita Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Orange	Yorba Linda Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Orange	East Orange County Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Orange	City of Westminster	SoCal Water\$mart–Rain Barrels & Cisterns
Orange	City of Huntington Beach	SoCal Water\$mart–Rain Barrels & Cisterns
Riverside	Western Municipal Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Riverside	Eastern Municipal Water District	SoCal Water\$mart–Rain Barrels & Cisterns
Riverside	Elsinore Valley Municipal Water District	SoCal Water\$mart–Rain Barrels & Cisterns

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Riverside	City of Corona, Utilities Department of Water and Power	SoCal WaterSmart–Rain Barrels & Cisterns
Riverside	Jurupa Community Services District	SoCal WaterSmart–Rain Barrels & Cisterns
Riverside	City of Riverside - Public Utilities	SoCal WaterSmart–Rain Barrels & Cisterns
Riverside	Lake Hemet Municipal Water District	SoCal WaterSmart–Rain Barrels & Cisterns
Riverside	Rancho California Water District	SoCal WaterSmart–Rain Barrels & Cisterns
Riverside	Rubidoux Community Services District	SoCal WaterSmart–Rain Barrels & Cisterns
Riverside	City of Hemet - Utilities	SoCal WaterSmart–Rain Barrels & Cisterns
Sacramento	City of Sacramento, Dept. of Utilities	Rain Barrel Rebate
San Bernardino	Inland Empire Utilities Agency	SoCal WaterSmart–Rain Barrels & Cisterns
San Bernardino	Cucamonga Valley Water District	SoCal WaterSmart–Rain Barrels & Cisterns
San Bernardino	Monte Vista Water District	SoCal WaterSmart–Rain Barrels & Cisterns
San Bernardino	City of Chino	SoCal WaterSmart–Rain Barrels & Cisterns
San Bernardino	Yucaipa Valley Water District	Rain Barrel Rebate
San Bernardino	Big Bear Lake Department of Water and Power	Rain Barrel Program
San Bernardino	Golden State Water Company - Apple Valley)	Apple Valley Conservation Rebates
San Diego	County of San Diego	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	City of San Diego	Rain Barrel & Cistern Rebate
San Diego	Otay Water District	SoCal WaterSmart–Rain Barrels & Cisterns

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

San Diego	Santa Fe Irrigation District	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	Sweetwater Authority	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	Helix Water District	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	Rincon del Diablo Municipal Water District	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	Padre Dam Municipal Water District	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	Vallecitos Water District	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	City of Oceanside	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	Olivenhain Municipal Water District	SoCal WaterSmart–Rain Barrels & Cisterns
San Diego	San Diego County Water Authority	SoCal WaterSmart–Rain Barrels & Cisterns
San Francisco	San Francisco Public Utilities Commission	Rain Barrel & Cistern Rebate
San Luis Obispo County	City of Pismo Beach	Water Conservation Incentive Programs, Rain Barrel Rebate
San Luis Obispo County	City of Morro Bay	Rain Barrel Rebate (Water Conservation Rebate Program)
San Mateo	San Mateo Countywide Water Pollution Prevention Program (Flows To Bay) administered by Bay Area Water Supply and Conservation Agency (BAWSCA)	BAWSCA Rain Barrel Rebate Program
San Mateo	City of San Mateo	BAWSCA Rain Barrel Rebate Program
San Mateo	Brisbane / Guadalupe Valley Municipal Irrigation District	BAWSCA Rain Barrel Rebate Program
San Mateo	Burlingame	BAWSCA Rain Barrel Rebate Program
San Mateo	Menlo Park Municipal Water	BAWSCA Rain Barrel Rebate Program

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

San Mateo	North Coast County Water District	BAWSCA Rain Barrel Rebate Program
San Mateo	Daly City	BAWSCA Rain Barrel Rebate Program
San Mateo	Mid-Peninsula Water District	BAWSCA Rain Barrel Rebate Program
San Mateo	Redwood City	BAWSCA Rain Barrel Rebate Program
Santa Barbara	City of Santa Barbara	Sustainable Storm Water Rebate
Santa Barbara	Carpinteria Valley Water District	CalWEP Smart Rebate - Rain Barrel
Santa Clara	Valley Water	Valley Water Rainwater Capture Rebate
Santa Clara	City of Santa Clara	Valley Water Rainwater Capture Rebate
Santa Clara	City of Palo Alto	Valley Water Rainwater Capture Rebate
Santa Clara	City of San José (Municipal Water System)	Valley Water Rainwater Capture Rebate
Santa Clara	City of Sunnyvale	BAWSCA Rain Barrel Rebate Program
Santa Clara	City of Mountain View	Valley Water Rainwater Capture Rebate
Santa Clara	City of Milpitas	Valley Water Rainwater Capture Rebate
Santa Cruz	Soquel Creek Water District	Rain Catchment System Rebate
Solano	Solano County Water Agency (SCWA)	SCWA Water-Conserving Products Rebates - Rain Barrels
Solano	City of Vallejo - Water Department	SCWA Water-Conserving Products Rebates - Rain Barrels
Solano	City of Vacaville	SCWA Water-Conserving Products Rebates - Rain Barrels
Solano	City of Dixon	SCWA Water-Conserving Products Rebates - Rain Barrels
Solano	City of Fairfield	SCWA Water-Conserving Products Rebates - Rain Barrels

Stormwater Capture Volumetric Assessment and Inventory

Project Summary Report

Sonoma	City of Santa Rosa (Santa Rosa Water)	Rainwater Harvesting Rebate
Ventura	City of Ventura (Ventura Water)	Rain Barrel Voucher (Discount Program)
Ventura	Calleguas Municipal Water District	SoCal WaterSmart–Rain Barrels & Cisterns
Ventura	City of Oxnard	SoCal WaterSmart–Rain Barrels & Cisterns
Ventura	City of Camarillo	SoCal WaterSmart–Rain Barrels & Cisterns
Ventura	Triunfo Water & Sanitation District	SoCal WaterSmart–Rain Barrels & Cisterns
Ventura	Camrosa Water District	SoCal WaterSmart–Rain Barrels & Cisterns
Yolo	City of Woodland	Rain Barrel Rebate