Urban Stormwater Runoff Capture and Management Resource Management Strategy

Draft Memorandum

CALIFORNIA WATER PLAN UPDATE 2023

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Acronyms and Abbreviations

6PPD	N-(1,3-dimethylbutyl)-N′-phenyl-p-phenylenediamine
BMP	best management practice
CalEPA	California Environmental Protection Agency
CASQA	California Stormwater Quality Association
CDFA	California Department of Food and Agriculture
CEC	contaminant of emerging concern
CNRA	California Natural Resources Agency
CSA	California State Auditor
CSA Report	*State and Regional Water Boards: They Must Do More to Ensure That Local Jurisdictions' Costs to Reduce Storm Water Pollution Are Necessary and Appropriate*
CWA	Clean Water Act
CWNS	Clean Watersheds Needs Survey
DWR	California Department of Water Resources
IRWM	integrated regional water management
JPA	joint powers authority
MS4	municipal separate storm sewer system
NPDES	national pollutant discharge elimination system
PFAS	Perfluoroalkyl and polyfluoroalkyl substances
RWL	receiving water limitations

regional water board	regional water quality control board
State Water Board	State Water Resources Control Board
STORMS	Strategy to Optimize Resource Management of Stormwater
SWRP	stormwater resource plans
TMDL	total maximum daily load
Water Supply Strategy	Water Supply Strategy: Adapting to a Hotter, Drier Future
Update 2023	California Water Plan Update 2023
EPA	U.S. Environmental Protection Agency
UWMP	urban water management plan
Water Code	California Water Code

1. Urban Stormwater Runoff Capture and Management in California

Urban stormwater runoff capture and management is a broad series of activities to manage stormwater runoff from precipitation events and dry-weather runoff during non-precipitation periods often caused when excess landscape irrigation water flows to the storm drain. Well-conceived urban stormwater capture and management actions provide multiple benefits for California communities and watersheds, including increased water supply, improved water quality, increased space for public recreation, increased tree canopy, and enhanced stream and riparian habitat area. The field of urban stormwater management has been rapidly changing over the past 10 years and must continue to do so to adapt to challenges from climate change as evidenced by recent historic droughts and recent historic precipitation and flooding events. Now is the time to increase urban stormwater capture and improve how urban stormwater is managed throughout the state. Addressing these needs to meet climate change and other challenges represents an opportunity to redefine how California utilizes and values urban stormwater as a water resource (State Water Resources Control Board 2016).

Valuing Urban Stormwater as a Water Supply Resource

Urban stormwater should be considered a valuable water supply resource and a critical element of local sustainability and resiliency. Capturing and using urban stormwater as a resource provides multiple benefits such as offsetting drought related impacts through additional groundwater recharge and aquifer storage, mitigating pollution of stormwater, creating green and open spaces, enhancing fish and wildlife habitat, supporting watershed processes, and improving water use efficiency while mitigating the adverse effects of flood flows (State Water Resources Control Board 2016).

Past or traditional management approaches did not value urban stormwater as a water supply resource. Urban areas were often designed to rapidly convey stormwater from the urban landscape into nearby streams and rivers that flow to estuaries, bays, and the ocean. As a result, natural flow regimes of many streams and rivers have been altered, reducing base flows for perennial streams during dry periods and reducing opportunities to recharge groundwater aquifers (State Water Resources Control Board 2016).

Efforts to change the past view that urban stormwater is a waste or hazard, and to treat it as a valuable resource, has begun to gain some momentum. Some examples of planning and implementation of urban stormwater capture at the local level include:

- The Safe, Clean Water Program in Los Angeles County provides local dedicated funding for multi-benefit stormwater and urban runoff capture projects to increase water supply, improve water quality, and provide community enhancements.
- The Fresno Metropolitan Flood Control District's planned drainage system of 155 stormwater basins infiltrates captured stormwater to augment groundwater supplies.
- The Orange Memorial Park Regional Stormwater Capture Project in the city of South San Francisco captures all dry-weather flow and first flush of urban stormwater from a nearby creek providing water supply, water quality, and flood reduction benefits.
- Stanford University in Santa Clara County is capturing stormwater and irrigation runoff as an alternate water source to supplement the non-potable irrigation system.

In addition, the California Stormwater Quality Association (CASQA) is working to engage and communicate the goals of sustainable stormwater management through its public messaging campaign, Rain Ready California: Protecting and Collecting Water for Our Future.

At the State level, in 2015, the State Water Resources Control Board (State Water Board) initiated a new program, Strategy to Optimize Resource Management of Stormwater (STORMS), to advance awareness around valuing stormwater as a resource. Through this program, the State Water Board has a goal to, "Change the perspective that urban stormwater is a waste or hazard, and to treat it as a valuable resource." This program defines urban runoff capture and use as, "The intentional collection of urban runoff to augment surface water supplies, to recharge groundwater, or to support ecosystems." (State Water Resources Control Board 2018a). The STORMS program also has a visual story map, *California's Untapped Stormwater Capture Potential*, that further details the importance of managing stormwater as a valuable resource.

The governor and Legislature have passed legislation and implemented initiatives that value urban stormwater as a water supply resource. Governor Newsom's water initiatives, the *Water Resilience Portfolio* and *Water Supply Strategy: Adapting to a*

Hotter, Drier Future (Water Supply Strategy), include several actions, incentives, and goals to increase the capture and use of urban stormwater. These are further discussed in Section 7, "Urban Stormwater Runoff Capture and Management in the Water Supply Strategy and Water Resilience Portfolio." The following statutes related to valuing urban stormwater runoff as a water supply resource, have been enacted:

- Stormwater Resource Planning Act (California Water Code [Water Code] Sections 10560–10565).
- Rainwater Capture Act of 2012 (Water Code Sections 10570–10574).
- Development of Statewide Targets for infiltration and direct use of urban stormwater runoff (Water Code Section 10608.50[b]).

Urban Stormwater Runoff Capture and Use Goals, Targets, Potential, and Baseline Amounts

The importance of capturing and using urban stormwater has been highlighted through various goals and targets that are shown in Table 1. A goal of the Water Supply Strategy is to use urban stormwater sources to increase the statewide water supply by 250,000 acre-feet per year. In addition to these goals and targets, the potential and baseline level of urban stormwater capture and use provide additional context. In 2022, the Pacific Institute estimated the urban stormwater capture potential in California to range from 580,000 acre-feet per year in a dry year, to 3.0 million acre-feet per year in a wet year for urban areas overlying public water supply aquifers (Cooley et al. 2022). Currently, a statewide baseline or existing level of urban stormwater capture and use does not exist. The State Water Board's STORMS program plans to evaluate and report on the baseline level of urban stormwater capture and use.

Table 1 Statewide Goals, Target, and Potential for Urban Stormwater Runoff Capture and Use

Organization and Year	Source	Objective	Annual Water Supply Increase from Urban Stormwater Capture and Use
Governor's Office, CNRA, DWR, Water Boards, CalEPA, CDFA 2022	*California's Water Supply Strategy – Adapting to a Hotter, Drier Future*	Goal	Statewide goal to increase annual supply capacity by at least 250,000 acre-feet by 2030 and 500,000 acre-feet by 2040 from urban stormwater capture and use.

Organization and Year	Source	Objective	Annual Water Supply Increase from Urban Stormwater Capture and Use
State Water Board 2013	State Water Board's Recycled Water Policy	Goal	Statewide goal to increase the annual use of stormwater over use in 2007 by at least 500,000 acre-feet by 2020 and by at least 1 million acre-feet by 2030.
DWR 2019	Stormwater Targets for Groundwater Recharge and Direct Use in Urban California	Target	Statewide target to increase annual supply by 105,000 acre-feet by 2020 and 250,000 acre-feet by 2035 from urban stormwater capture and use. (Details in DWR's Stormwater projects story map.)
Pacific Institute 2022	*The Untapped Potential of California's Urban Water Supply: Water Efficiency, Water Reuse, and Stormwater Capture*	Potential	Statewide potential of 580,000 acre-feet per year in a dry year to 3.0 million acre-feet per year in a wet year in urban areas overlying public supply aquifers.

Watershed Approach for Managing Urban Stormwater Runoff

A watershed approach for urban stormwater runoff management tries to emulate and preserve the natural hydrologic cycle that is altered by urbanization. The watershed approach consists of a series of best management practices (BMPs) designed to reduce the pollutant loading and reduce the volumes and velocities of urban runoff discharged to surface waters. Some urban runoff BMPs include facilities to capture, treat, and recharge groundwater. Public education campaigns are also helpful to inform the public about stormwater pollution prevention including the proper use and disposal of household chemicals. The watershed approach will not prevent, nor should it prevent, all urban stormwater from entering waterways. Elements of the traditional conveyance and storage strategy are still needed to protect downstream beneficial uses, protect water right holders, and protect the public from floods.

Traditional Approach for Managing Urban Stormwater Runoff

The traditional approach to runoff management views urban runoff as a flood management problem with water needing to be conveyed as quickly as possible from the urban landscape into waterways to protect public safety and property. Consequently, stormwater runoff in urban areas has generally been viewed as a waste or hazard and not as a water supply resource.

Urbanization alters streamflow pathways, water storage, pollutant levels, rates of evaporation, groundwater recharge, surface runoff, the timing and extent of flooding, the sediment yield of rivers, and the suitability and viability of aquatic habitats. The traditional approach for managing urban stormwater runoff has generally been successful at preventing flood damage, but it has several disadvantages. To convey water quickly, natural waterways are often straightened and lined with concrete, resulting in a loss of habitat and negative effects to natural stream physical and biological processes. Urbanization creates impervious surfaces that prevent infiltration of stormwater into groundwater aquifers. These impervious surfaces increase stormwater runoff volumes and velocities, resulting in streambank erosion and potential flooding problems downstream. Because the traditional approach emphasizes removing the water quickly from the urban landscape, the opportunity to capture and use stormwater runoff for multiple benefits is reduced.

Pollutants in Urban Stormwater Runoff

Urban stormwater runoff management has become more important and more controversial as municipal governments have been held increasingly responsible for pollutants from developed and construction areas within their jurisdictions being washed into the storm sewer system and discharged into waterways. Unlike pollution from industrial and sewage treatment plants, pollutants in stormwater runoff and urban dry-weather runoff come from many diffuse sources and typically are not treated prior to being discharged to surface waters. As rainfall or snowmelt moves over the urban landscape, it picks up and carries away human-made and natural pollutants, depositing them into rivers, lakes, wetlands, coastal waters, and potentially groundwater. It should be noted that in a few locations, dry-weather urban runoff, typically from irrigated landscaped areas, is diverted to the sanitary sewer system where it is treated at a local wastewater treatment plant.

Examples of pollutants and their sources in urban areas include:

- Microplastics from cigarette butts, textile fibers, single use plastic foodware, and tire wear particles (Moran et al. 2021).
- Tire wear particles, 6PPD, and 6PPD-quinone from motor vehicles (California Department of Toxic Substances Control 2023).
- Perfluoroalkyl and polyfluoroalkyl substances (PFAS) from fire training, fire response sites, and industrial sites (State Water Resources Control Board. 2020a).
- Herbicides and pesticides from landscaped areas (residential and commercial), (e.g., golf courses, city parks).
- Nutrients from the application of excess fertilizers on landscaped areas (e.g. home, commercial, parks).
- Oil, grease, and heavy metals from normal vehicle use (e.g., automobiles, trucks, and buses) that accumulate on streets, roads, highways, driveways, and parking lots (e.g., leaks and drips, brake pad dust, tire wear).
- Illegal dumping of material into the storm sewer system (e.g., used oil, antifreeze, pesticides, container rinse water).
- Bacteria from improperly maintained septic systems, encampments, pet waste, sanitary sewer overflows, and illegal cross-connections with sanitary sewer systems.
- Sediment from improperly managed construction activities.

Additional sources of pollution in urban areas include:

- Improperly managed industrial sites
- Building maintenance (e.g., pressure washing of lead-based paints, rinsing of walkways).
- Atmospheric deposition.
- Litter and green waste.
- Natural catastrophes.

Water Quality Regulations

Runoff in the urban environment, storm-generated and dry-weather flows, has been shown to transport pollutants to surface waters. As a result, the 1987 amendments to the federal Clean Water Act (CWA) require that discharges from municipal separate storm sewer systems (MS4s) serving a population of 100,000 or more must comply with requirements contained in National Pollutant Discharge Elimination System

(NPDES) permits. The U.S. Environmental Protection Agency (EPA) promulgated regulations for these discharges in 1990. These regulations were subsequently amended in 1999 requiring MS4s serving a population of less than 100,000 and located in an urbanized area to be subject to requirements contained in an NPDES permit. In California, the authority to regulate urban and stormwater runoff under the NPDES system has been delegated by the EPA to the State Water Board and the nine regional water quality control boards (regional water boards).

The State Water Board and regional water boards are required under the federal CWA Section 303(d) and federal regulations (Code of Federal Regulations Title 40, Section 130) to prepare a list of water bodies that do not meet water quality standards (those requiring total maximum daily loads (TMDLs) and set priorities for these water bodies. The Section 303(d) list was last revised in 2022. Federal regulations require the Section 303(d) list to be updated every two years. TMDLs represent the total pollutant load a water body can assimilate before the water body's beneficial uses are considered to be impaired and water quality standards are no longer met. Through the process of establishing the Section 303(d) list of impaired water bodies, it has often been found that pollutants in urban runoff contribute to this impairment.

NPDES permits issued to local agencies for discharges of stormwater require the implementation of specific measures to reduce the amount of pollutants in urban runoff. Permits for discharge to listed water bodies having a TMDL must be consistent with the waste load allocations in a TMDL. Under California law, TMDLs include implementation plans for meeting water quality standards. The implementation plans allow for time to implement control strategies to meet water quality standards.

Best Management Practices for Capturing Urban Stormwater

Urban stormwater can be captured and managed using a variety of built infrastructure known as structural stormwater BMPs and include infiltration basins and trenches, detention and retention basins, dry wells, bioretention (rain gardens), cisterns, permeable pavement, and green roofs. The Southern California Coastal Water Research Project's technical report, *Evaluating Potential Methods to Quantify Stormwater Capture* provides detailed descriptions of these BMPs and further groups them according to the scale of implementation. BMPs can be classified as individual or site-level BMPs, regional or neighborhood level BMPs, and urban runoff diversions.

Individual or site-level BMPs are designed to capture runoff at relatively smaller scales distributing the capture potential throughout the watershed. There can be dozens or potentially hundreds of individual BMPs within relatively small drainage areas. These BMPs can be constructed at individual residential units or small groups of dwellings, commercial or retail space, and parking lots or roadway segments of up to a few acres in size. Some individual or site-level BMPs include:

- Bioretention (rain gardens).
- Cisterns and rain barrels.
- Permeable porous pavement.
- Infiltration basins, trenches, and dry wells.

Regional or neighborhood scale BMPs are designed with a centralized approach to capture runoff from larger drainage areas which can include non-urban areas. These BMPs can be constructed within residential subdivisions or neighborhood parks where more than 10 acres drain into a single basin. Some regional or neighborhood scale BMPs include:

- Recharge basins and spreading grounds.
- Retention basins.
- Detention basins and flood control impoundments.

An urban runoff diversion is the direct connection of a storm drain system to a sanitary sewer system generally used to divert urban runoff during the dry weather months. Urban runoff diversions are usually constructed to protect sensitive water bodies such as high-use recreational beaches. The diverted runoff is piped to a wastewater treatment plant to be treated and can be recycled and reused (Fassman-Beck et al. 2020).

Local and Regional Programs and Planning Efforts

This section is a general overview of local municipal programs and regional collaboratives involved in urban stormwater runoff capture and management along with some examples of local and regional planning efforts.

Local Municipal Stormwater Programs

Large, medium, and small municipalities are required to comply with MS4 stormwater permits issued by the State Water Board or applicable regional water board. These municipalities are generally cities and counties that are regulated under a two-phase system. Phase I MS4 permittees consist of large municipalities with 250,000 or more

people and medium municipalities with 100,000 to 250,000 people. Phase II MS4 permittees consist of small municipalities with fewer than 100,000 people.

Regional Stormwater Collaboratives, Coalitions and Joint Powers Authorities

Regional stormwater collaboratives, coalitions, and joint powers authorities (JPAs) promote regional collaboration and consistency on stormwater and other water management activities. They also work to manage public resources more efficiently. The Bay Area Municipal Stormwater Collaborative is an example of a regional stormwater collaborative of nine local governments that was formed in response to the NPDES permitting program. JPAs such as Monterey One Water, Southern California Coastal Water Research Project, and Santa Ana Watershed Project Authority provide an institutional pathway for regional collaboration on stormwater planning that can evaluate and potentially coordinate the implementation of stormwater capture projects (State Water Resources Control Board. 2018a).

Local/Regional Urban Stormwater Capture Planning Efforts

Effective stormwater planning on a watershed basis involves collaboration of local and regional governments, utilities, and other interested groups to analyze and understand the local hydrology, stormwater conveyance systems, opportunity for new BMP sites, habitat considerations, and community needs within a watershed (State Water Resources Control Board 2015). The following are some examples of local and regional planning efforts or studies on urban stormwater capture.

Los Angeles Basin Study

This is a U.S. Bureau of Reclamation and Los Angeles County Flood Control District study on enhancing and modifying existing stormwater capture facilities and developing new stormwater capture facilities based on near-term and long-term climate science and hydrologic modeling projections.

Los Angeles Stormwater Capture Master Plan

This is Los Angeles Department of Water and Power's plan to implement stormwater and watershed management programs and projects in the City of Los Angeles that contribute to a more sustainable local water supply. The plan serves as a guiding document for policymakers to consider when making decisions that affect Los Angeles' water resources.

Regional-Scale Stormwater Management Planning Effort in San Mateo County
This is the City/County Association of Governments of San Mateo County's planning effort to advance regional stormwater capture projects. This effort builds on earlier work in the *San Mateo County Stormwater Resource Plan* and the *San Mateo Countywide Sustainable Streets Master Plan*. The association has completed a white paper on establishing a regional collaborative program and a regional project study memo to identify opportunities on building regional multi-benefit stormwater capture projects.

Stormwater Resource Plans
Stormwater resource plans (SWRPs) serve as a regional and local planning tool to identify, prioritize, develop, and implement projects that capture stormwater and dry-weather flows. These plans are required under Water Code Section 10563(c) for public agencies seeking State funding for stormwater or dry-weather runoff-capture projects. The Water Code does not require completion of a SWRP for those agencies not seeking State funding and does not require existing SWRPs to be updated.

Stormwater resource plans emphasize stormwater and dry-weather runoff-capture projects and prioritize multiple benefit projects within a watershed. Public agencies developing such plans are highly encouraged to coordinate planning efforts with other local agencies and partners in the watershed and surrounding communities, including non-governmental organizations, the regulated community, and water purveyors. Coordination among participants provides more opportunities for securing grants from various sources and provides more opportunities to leverage financial resources between the members (State Water Resources Control Board 2018b). The State Water Board prepared a draft *Storm Water Resource Plan Guidelines* in 2015 to assist public agencies developing a watershed-based SWRP consistent with the Water Code and has a list of completed SWRPs on their website. Here are a few examples:

- *American River Basin Storm Water Resource Plan*.
- *Santa Clara Basin Stormwater Resource Plan*.
- *Stanislaus Multi-Agency Regional Stormwater Resource Plan*.
- *Ventura Countywide Municipal Stormwater Resource Plan*.

State Agency Programs

The following is intended to be a brief overview of the major State agency programs involved in urban stormwater runoff capture and management. Additional

information on other agencies involved in urban stormwater is available in the State Water Board's 2018 report, *Enhancing Urban Runoff Capture and Use*.

State Water Board STORMS Planning Program

The State Water Board's STORMS program was initiated in 2015 with a mission to lead the evolution of stormwater management in California by advancing the perspective that stormwater is a valuable resource, supporting policies for collaborative watershed-level stormwater management and pollution prevention, removing obstacles to funding, developing resources, and integrating regulatory and non-regulatory interests.

DWR Alternative Water Supplies Planning Program

DWR's Alternative Water Supplies program is involved in non-traditional, alternative water supplies such as recycled water, desalination, stormwater, and greywater. In 2019, this program released a report, *Stormwater Targets for Groundwater Recharge and Direct Use in Urban California*.

State Water Board and Regional Water Board's Stormwater Regulatory Programs

The State Water Board and nine regional water boards all have programs that implement and enforce urban stormwater runoff regulations. In general, stormwater permits are required for industrial facilities, construction projects, municipalities, and for the management and maintenance of the State highway system.

State Water Board Stormwater Grant Program

The State Water Board's Storm Water Grant Program operates on a vision to change the perception of stormwater and dry-weather runoff as a contaminant source to that of a valuable resource that can be used to recharge groundwater aquifers, for domestic purposes, to support watershed processes, and to beautify communities creating habitat and open spaces.

DWR Integrated Regional Water Management Grant Programs

DWR's Integrated Regional Water Management grant programs is a collaborative effort to manage all aspects of water resources in a region. This program encourages implementation of integrated regional water resource management strategies by providing funding for projects that support integrated water management. This program provides funding for multi-benefit stormwater capture projects.

2. Benefits of Urban Stormwater Runoff Capture and Management

Well-conceived urban stormwater management actions provide multiple benefits and can improve local and statewide water supply reliability and support drought preparedness. Projects designed to capture and use urban stormwater as a resource provide multiple benefits such as offsetting drought-related impacts through groundwater recharge and aquifer storage, mitigating pollution of surface waters, creating green and open spaces, enhancing fish and wildlife habitat, supporting watershed processes, improving water use efficiency while mitigating the adverse effects of flood flows, and reducing energy use by lowering dependence on imported supplies. (State Water Resources Control Board 2016)

Local stormwater capture can lead to energy-saving schemes that (1) capture water before it becomes contaminated with the pollutants on streets and in sewers; (2) rely on energy efficient processes for removing contaminants; (3) treat water only to the extent necessary for intended use (fit-for-purpose water); and (4) obviate the need for diversion and large, centralized, energy-intensive treatment and distribution approaches. Stormwater capture and use can provide numerous co-benefits such as water quality improvement, green space, recreation and aesthetic value, wildlife habitat and corridors, carbon sequestration, pollination services, urban heat island cooling, increased property values, and improved public health and safety, as well as a much-needed supply of non-potable water in drought-prone areas (State Water Resources Control Board 2018a).

Designing stormwater infrastructure to directly support ecosystems broadens the approach to stormwater management. In this broader sense, retained stormwater can be put into soil where soil biota, macrophytes, and stream interflow systems improve water quality and ecosystems supported by baseflow or high groundwater. Ecosystem benefits include habitat improvement, increased food sources, carbon sequestration, pollutant uptake, and reduced heat-island effects from plant growth. Improved baseflow results in lower water temperatures, prolonged dry-weather flows, and increased amounts and types of soil biota to aid in carbon sequestration and pollutant uptake (State Water Resources Control Board 2018a).

Socioeconomic Benefits of Urban Stormwater Capture

There are multiple socioeconomic benefits that result from urban stormwater capture projects that are often not quantified which underestimates the true value of these projects. To begin to address this, CASQA published the 2024 report, *The Socioeconomic Value of Urban Stormwater Capture,* that estimates the monetary value of socioeconomic benefits from urban stormwater capture projects. In the study, five socioeconomic benefits were analyzed, including improved community health, water quality, green space, wetlands, and recreation. A monetary value was estimated for each of these benefits based on one or more benefit considerations that are shown in Table 2. For example, the monetary value for improved community health was analyzed in four areas: mental health, physical health, urban heat island, and air quality (California Stormwater Quality Association 2024). Some key finding from this study include:

- Urban stormwater capture projects not only benefit water supply and flood control, but also provide significant socioeconomic benefits to the local community.
- In the first year alone, the estimated monetary value of the socioeconomic benefits was shown to exceed the total cost of the project.
- The socioeconomic benefits of urban stormwater capture projects can be maximized by siting these projects in areas with the highest needs. For example, a project that creates urban green space in a high-need area will maximize benefits to that community.

Table 2 Socioeconomic Benefit Considerations Analyzed to Estimate Monetary Value

Benefit	Benefit Considerations Analyzed
Community Health	Mental health (e.g., ADHD, medical costs, life satisfaction). Physical health (e.g., avoided medical costs, physical activity, Alzheimer's disease). Urban heat island (e.g., avoided medical costs, avoided hospital emergency room costs, prevented loss of life). Air quality.
Water Quality	Improved quality or "good" quality maintained.
Green Space	Increase in property values within 100 meters.
Wetlands	Ecosystem services provided by urban wetlands.
Recreation	Value of recreation to communities within 0.5 mile.

Table 2 Source: California Stormwater Quality Association 2024

Benefits to Underserved Communities

Well-designed urban stormwater capture infrastructure can alleviate some problems stemming from historic and current inequities. For example, previously redlined neighborhoods and underserved communities generally have less flood control infrastructure, more flooding than other areas, less public green space, less access to nature, fewer trees, and more intense urban heat island effects. Stormwater capture projects can be sited, designed, and constructed in these communities to begin to address some of these effects. The Los Angeles Regional Water Board has a visual story map, *Race and Stormwater in LA County*, that further details historic and current inequities in Los Angeles County and provides some ideas for community involvement to incorporate green stormwater infrastructure in underserved neighborhoods.

A recent success story of combining large-scale stormwater capture with significant environmental, social, cultural, and recreational benefits is the completion of park improvements at the Earvin "Magic" Johnson Park in the Willowbrook neighborhood of South Los Angles. Historically, the site was an oil storage and processing facility, which was later turned into a park that used potable water to irrigate the landscape and to fill two artificial lakes. The new stormwater system improvements at the park capture urban runoff (dry and wet weather first-flush flows) from a 375-acre portion of the Compton Creek Watershed. In addition, the park has a new community center and social spaces, play areas, walking paths, picnic areas, outdoor classrooms, and a wedding area, all contributing to the health of the community by encouraging outdoor activity and improving the quality of life. At 126 acres, the park is the largest open space in South Los Angles providing stormwater capture benefits along with serving as an important recreational and social hub for the surrounding underserved community (California Stormwater Quality Association 2024).

3. Costs of Implementation

Many stormwater systems will need to be reconfigured to increase urban stormwater capture and to include a watershed approach that mimics natural hydrology. This will likely require the implementation of projects that are not highly compatible with existing infrastructure, resulting in large added expenses to retrofit the existing stormwater management systems. Cities and counties are generally responsible for carrying out most urban stormwater management activities, usually without a dedicated source of funding. Because urban stormwater's effect on public health and safety is less direct and tangible, urban stormwater management funding has trailed other water resources management sectors such as drinking water, water supply, flood control, and wastewater. The lack of a dedicated source of stormwater funding is a huge obstacle to implementing successful stormwater programs that will capture urban stormwater and comply with NPDES requirements (State Water Resources Control Board 2018b).

Estimate on Annual Expenditures

In 2020, the Sacramento State Environmental Finance Center (EFC) evaluated annual expenditures on stormwater management activities by cities, counties, and flood control districts. The EFC estimated that annual statewide stormwater management spending is at least $700 million (normalized to 2018 dollars). The EFC acknowledges this is a low estimate and that improved reporting would refine this amount. A summary of the results is shown in Table 3. The EFC also assessed the annual per capita expenditure on stormwater management for cities. It ranged from $3.50 to $54 per person per year (Environmental Finance Center at Sacramento State 2020).

Table 3 Average Stormwater Expenditures

Expenditure Level	City	County	Flood Control District
Average	$3.1 million	$18 million	$17 million
Maximum	$88 million	$51 million	$27 million
Minimum	$48,000	$400,000	$1.9 million
Number of Entities Sampled	171	9	4

Table 3 Source: Environmental Finance Center at Sacramento State 2020
Table 3 Note: Dollars normalized to 2018.

Standardizing Cost Reporting

The State Water Board is currently in the process of establishing a standardized cost policy to provide consistency on future stormwater management cost reporting. If implemented, this policy would require regional water boards to incorporate standardized cost reporting into MS4 permits, thereby requiring MS4 permittees to annually report stormwater program costs in a consistent manner statewide (State Water Resources Control Board 2023c).

Prior to this effort, the California State Auditor (CSA) published a report in 2018, *State and Regional Water Boards: They Must Do More to Ensure That Local Jurisdictions' Costs to Reduce Storm Water Pollution Are Necessary and Appropriate* (CSA Report). The CSA Report includes a review of existing cost-reporting requirements in various Phase I MS4 permits and highlights the need for standardized cost reporting guidance. The CSA concludes that the regional water boards used insufficient economic considerations to establish some TMDL implementation plans. It recommends that the State Water Board develop statewide guidance on methods for tracking the cost of stormwater program management.

Based on the CSA Report recommendations, the State Water Board Office of Research, Planning, and Performance published a 2020 guidance document, *Guidance for Obtaining Phase I Municipal Separate Storm Sewer System (MS4) Permit Compliance Costs*. The objective of this guidance was for regional water board staff and the public to obtain adequate, consistent, and comparable information on the stormwater management costs permittees incur.

Future Investment Needs

An assessment of the future statewide investment needs associated with achieving the goals of increasing urban stormwater capture and complying with water quality requirements must be completed to help inform investment decisions by elected officials and the public. There are some examples of stormwater management investment needs at the local and regional level. In the Los Angeles area, there is estimated need of $20 billion over 20 years (Los Angeles County 2023) In San Mateo County there is an estimated need of $700 million to $1 billion (San Mateo Countywide Water Pollution Prevention Program 2020). The City of San Diego has identified a stormwater management funding gap of $274 million annually, and estimates that over the next 20 years, $6.7 billion in investments are needed to ensure its stormwater system is safe, reliable, and in compliance with regulations (City of San Diego 2021).

In addition, the EPA conducts a periodic Clean Watersheds Needs Survey (CWNS) that includes a statewide estimate on the future financial needs to meet water quality requirements. The last CWNS was completed in 2012 and estimated that more than $3.9 billion over the next 20 years is needed to meet stormwater quality requirements in the California (U.S. Environmental Protection Agency 2016). The EPA did not conduct a 2016 or 2020 CWNS because of federal budgetary constraints. A 2022 CWNS is underway (State Water Resources Control Board 2023d). Because the goal of the CWNS is to assess investment needs to meet water quality objectives, the statewide investment needs to increase urban stormwater capture may need to be evaluated through an additional process.

4. Implementation Challenges, Barriers, and Possible Next Steps

There are many challenges and barriers to capturing and managing urban stormwater runoff. This section highlights some of these challenges and provides possible next steps to address them. This is not intended to be an exhaustive list, but rather, a highlight of some of the challenges, barriers, and possible next steps that have been identified in recent reports and past updates of this resource management strategy. The following reports were used to develop the content in this section and are a good resource for additional information:

- State Water Board's STORMS report from 2018, *Enhancing Urban Runoff Capture and Use*.
- State Water Board's STORMS report from 2018, *Project 4b: Eliminate Barriers to Funding Stormwater Programs and Identify Funding for Stormwater Capture and Use Projects*.
- California Stormwater Quality Association's report from 2020, *Vision for Sustainable Stormwater Management*.

Valuing Urban Stormwater as a Water Supply Resource

Past or traditional management approaches did not value urban stormwater as a water supply resource. Historically, storm sewer systems have been designed to carry stormwater away from the urban environment to reduce localized flooding during storm events. These systems have worked well in this regard but has led the public to view stormwater runoff as a waste or hazard. In addition, urban stormwater capture and use projects are often undervalued because there are no requirements to analyze and determine the value of the multiple benefits provided by urban stormwater capture projects when compared to other water supplies.

With increasing demands on a limited water supply and climate-induced changes in precipitation patterns, water that would otherwise quickly runoff to streams should be viewed as a water supply resource. Some possible next steps to valuing urban stormwater as a water supply resource include:

- Providing outreach and education to elected officials and the public to increase awareness and understanding on the importance of valuing urban stormwater runoff as a resource.

- Collaborating with municipalities, water agencies, and communities to support long-term planning and valuation of stormwater capture projects over 20-to-30-year periods.
- Determining the economic value of the multi-benefits provided by urban stormwater capture and management projects.

Establishing Watershed Collaboration to Capture and Manage Urban Stormwater

Water agencies and flood management agencies are not required to collaborate with cities and counties that oversee urban stormwater management projects even though these projects have water supply and flood management benefits. There are also no mechanisms in place to share costs among the beneficiaries that would provide a cost-savings. This often makes urban stormwater capture projects (funded solely by stormwater municipalities) cost prohibitive and may prevent effective siting of urban stormwater capture facilities. Lastly, there are no requirements to assess urban stormwater as a potential water supply source in integrated regional water management (IRWM) plans or in city and county general plans. For entities completing an urban water management plan (UWMP), it is only recommended that they assess urban stormwater as a potential water supply source.

Regional collaboration on urban stormwater capture and management has occurred in some areas. But additional support is needed on regional collaboration to increase implementation of urban stormwater capture projects. Some possible next steps to increase and improve regional collaboration include:

- Establishing collaborative watershed networks, (as recommended in *California Water Plan Update 2023*) that leverage the experience and knowledge of regions and include a goal or objective to promote urban stormwater capture as part of improving watershed resilience.
- Requiring that IRWM plans, city and county general plans, and UWMPs assess and integrate urban stormwater as a potential water supply resource.
- Providing technical assistance to small, underserved communities on engaging and partnering with local water agencies to support stormwater capture projects in their communities.

Integrating Land Use Planning Elements to Promote Capturing Urban Stormwater

Land use planning is not conducted on a watershed basis making it difficult to plan regional- or watershed-level urban stormwater capture projects. For many new development projects, integration of water supply, wastewater, recycled water, stormwater, and drainage is not required, so these water sectors are often independently considered in new development projects. There are also no requirements to assess urban stormwater as a potential water supply source in city and county general plans.

Some possible next steps to integrate land use planning elements to promote capturing urban stormwater include:

- Requiring that city and county general plans assess and integrate urban stormwater as a potential water supply resource.
- Promoting innovative urban stormwater capture and use technologies that integrate the different water sectors.

Supporting Sustainable Funding

Cities and counties overseeing urban stormwater runoff management programs have limited ability to establish dedicated stormwater fees needed to implement robust urban stormwater runoff management programs. Municipal stormwater systems are public facilities, but they differ from other public utilities such as water, sewer, and trash in one key aspect: these other utilities existed prior to the passage of Proposition 218 (in 1996) and are financially supported by service fees. By comparison, most stormwater programs rely on a public agency's general fund which presents a major challenge when competing for that funding with police, fire, libraries, social services, and other services (California Stormwater Quality Association 2020).

An EPA survey of California municipal stormwater programs in 2017 found that only 16 percent of stormwater programs are currently funded through dedicated stormwater fees. Most municipal stormwater programs are funded through non-dedicated and alternative funding sources as shown in Table 4.

Table 4 Stormwater Program Non-Dedicated and Alternative Funding Sources

Type of Non-Dedicated and Alternative Funding Sources	Percent of Municipal Stormwater Programs using these funding sources
General Funds	41%
Local Fees	23%
Stormwater Fees	16%
Grants	15%
Other	6%

Table 4 Source: Gebhardt, J. 2017.

To have successful urban stormwater capture and management programs, municipalities overseeing these programs need dedicated, sustainable funding. Some possible next steps to support sustainable funding include:

- Establishing a formal working group to report on possible solutions to develop a dedicated source of funding for urban stormwater capture and management programs statewide.
- Determine the capital improvements, operations, and maintenance funding needs for municipal stormwater programs.

Developing Technical Guidance, Tools, and Standards

Technical guidance, tools, and standards along with training and education programs are necessary to effectively advance urban stormwater capture and management. Some technical guidance and tools have been developed, but more are needed. A few examples of recently completed or in progress technical guidance, tools, and standards includes CASQA's report, *The Socioeconomic Value of Urban Stormwater Capture,* that quantifies five socioeconomic benefits with a monetary value. The State Water Board is also working on regulations for on-site treatment and reuse of non-potable water. These newer resources help promote urban stormwater capture and management, but additional technical guidance and tools are needed. Some examples include:

- Technical guidance and training on the design and applicability of individual and regional BMPs that capture urban stormwater.
- Technical guidance and training on surface water storage and treatment standards to avoid future water quality and odor issues.
- Technical guidance and training on local design standards that account for soil types, infiltration rates, instream flows, rainfall, climate, and possible need for equalization storage basins.

- Technical guidance and training on hydrologic and watershed analysis.
- Technical guidance and training on the appropriate scale and use of triple bottom line analyses to evaluate the social, economic, and environmental benefits of urban stormwater runoff projects in integrated watershed planning efforts.
- Analysis tools for retrofit options on existing infrastructure, including evaluation of potential water rights restrictions, particularly for flood control facilities.
- Expansion of DWR's Water Management Planning Tool (through coordination between the State Water Board and DWR) to incorporate stormwater infrastructure and analyze stormwater as a water supply source.

Identifying and Protecting Groundwater Recharge Areas

Local land use plans often do not recognize and protect groundwater recharge and discharge areas. Areas with soil and geologic conditions that allow groundwater recharge should be protected where appropriate. If development does occur in these areas, the amount of impervious cover should be minimized, and infiltration of stormwater should be encouraged on a regional scale as well as at the "lot" level. Additional information on this topic is available in the California Water Plan's *Recharge Area Identification, Utilization, and Protection Resource Management Strategy*.

Overcoming Regulatory Barriers

Some existing regulations and policies may impede or fail to prioritize urban stormwater as a valuable resource. These include:

- The current regulatory framework for stormwater permitting that primarily focuses on attaining water quality goals.
- The inconsistent permitting of pretreatment and infiltration BMPs that are protective of groundwater resources.
- Existing stormwater conveyance systems that may be considered "waters of the United States."
- Unclear water rights considerations for urban stormwater capture.

The current statewide regulatory framework for stormwater permitting was established three decades ago and primarily focuses on implementation to attain water quality goals. At best, some permits allow stormwater capture to be viewed as a tool to attain water quality goals. Because the goal(s) of the permits drive investment of resources and infrastructure, stormwater permits may need to be re-evaluated to

focus on maximizing stormwater capture as a primary goal to ensure implementation of the most effective infrastructure solutions.

There is inconsistent permitting of pretreatment and infiltration BMPs that are protective of groundwater resources. For example, in Northern California there is a perceived regulatory barrier to install drywells to capture and infiltrate stormwater, while in Southern California construction of drywells is common.

There are regulatory barriers with existing stormwater conveyance systems that may be considered "waters of the United States" and are subject to receiving water limitations (RWLs). This can create legal uncertainty and inhibit long-term planning by local agencies. For example, stormwater managers planning to utilize existing conveyance systems to move urban stormwater runoff to a regional stormwater capture facility may have to comply with RWLs that require treatment at multiple locations rather than at a more cost-effective centralized treatment location.

Water rights in California are required if water is diverted from a lake, river, stream, or creek for a beneficial use. For stormwater, there is a general lack of clarity around when, and to what extent, water rights are needed for urban stormwater capture projects.

Protecting Water Quality

Protecting water quality is necessary to advance urban stormwater capture and management. There are many pollutants and associated sources that contribute to water quality degradation of urban stormwater as noted in the "Pollutants in Urban Stormwater Runoff" subsection of this RMS. BMPs are often used and needed to help remove pollutants in stormwater. But, in addition to utilizing BMPs, more should be done to prevent pollutants from entering stormwater. Minimizing pollution at the source can be a more effective and sustainable approach. In CASQA's *Vision for Sustainable Stormwater Management*, it recommends that the State establish a statewide true source control policy for sustainable stormwater management.

Addressing Vector and Odor Issues

Standing water in stormwater recharge basins and storage facilities attracts mosquitoes and other insects whose egg, larval, and pupal stages mature underwater. Mosquitoes can be vectors for serious or deadly diseases such as West Nile virus. To reduce mosquito populations, some existing groundwater recharge programs use large numbers of mosquitofish which feed on the mosquito larvae.

Odors can be generated by growth and decay of algae, organic matter, and other water-borne vegetation. Vectors and odors should be addressed in any urban stormwater project that involves standing water.

5. Costs if Not Implemented

If there is inaction on implementing urban stormwater runoff capture and management, some of the negative impacts may include:

- Lack of drought and flood preparedness needed to adapt to climate change vulnerabilities.
- Missed opportunity to improve surface water quality and increase regional water supply sustainability.
- Impacts on aquatic ecosystems and the environment, especially from pollutants that are not fully treated or accounted for.
- Increased costs from pumping imported water over long distances as opposed to capturing stormwater locally.
- Overwhelming of existing stormwater infrastructure from more intense precipitation events anticipated with climate change.
- Increased costs from energy-intensive water treatment needed to meet RWLs when not infiltrating stormwater.

Climate Change

Climate change models predict that California will become drier overall in the coming decades. Droughts are becoming more severe, and precipitation events are becoming progressively less frequent but more intense. During increasingly severe drought periods, water demand increases because of higher temperatures and drier soils. In addition to straining water supply, this heightened water use increases urban dry weather runoff. Drought conditions may also exacerbate stormwater quality issues by concentrating pollutants. An increase in high-precipitation storm events during wet years will strain urban stormwater infrastructure and increase flood risk in affected areas. Increases in localized flooding will contribute to water quality issues as pollutants are carried into local waterways. In the face of these challenges, water managers should consider implementing urban stormwater management strategies designed to adapt to the changing climate and mitigate further negative impacts.

Climate Change Adaptation

Climate change is projected to diminish California's water supply by as much as 10 percent by 2040 (California Natural Resources Agency et al. 2022). As the state moves into a hotter, drier future, urban stormwater runoff is increasingly being viewed as a possible component of diverse, sustainable water portfolio (California

Urban Water Agencies 2023). Urban planning and development strategies designed to capture stormwater for beneficial use as a water supply may also provide flood protection, water quality, and urban recreation benefits. Strategies for capturing and infiltrating stormwater include:

- Runoff collection in reservoirs as raw surface water supply or followed by treatment for non-potable uses.
- Groundwater recharge basins.
- Diversion into wetlands, bioswales, or rain gardens.
- Groundwater recharge through pervious surfaces.
- On-site collection in rain barrels or cisterns.
- Providing public education and outreach to homeowners on methods to capture and infiltrate stormwater.

In addition to supplementing water supply during dry years, urban planning and development that incorporates these stormwater strategies may help municipalities adapt to the high-precipitation storm events that are predicted to occur more frequently in the coming decades. Although there are likely opportunities to implement all the aforementioned strategies throughout the state, the feasibility of any given strategy in a particular area will depend on local conditions and cost limitations.

Climate Change Mitigation

Stormwater capture, when combined with the use of regionally appropriate landscaping, can reduce the amount of water needed for landscape irrigation. This may lower demand for energy-intensive water supplies, thus reducing the greenhouse gas emissions produced from an urban water supply.

Capturing urban stormwater runoff benefits the state and individual water users by reducing long-distance water conveyance needs, providing local water supplies that are generally a drought-resistant resource.

6. Watershed Resilience and Urban Stormwater Runoff Capture and Management

California Water Plan Update 2023 (Update 2023) focuses on three intersecting and interdependent themes – addressing climate urgency, strengthening watershed resilience, and achieving equity. Strengthening watershed resilience throughout the state will support the multiple benefits that watersheds provide such as water supply, flood management, ecosystem, hydropower, recreation, and other benefits. State agencies administering regional- or watershed-scale programs are encouraged to incorporate the watershed resilience principles in Update 2023 to facilitate more consistent and equitable approaches to climate vulnerability and adaptation planning and project implementation. The Update 2023 watershed resilience principles are:

1. Promote multi-sectoral, multi-benefit resilience strategies.
2. Integrate and prioritize equity and inclusiveness.
3. Focus on watersheds and interdependencies of natural resource and engineered systems.
4. Build and strengthen watershed networks.
5. Apply best available science and promote best practices, approaches, and tools for climate resilience planning.
6. Build a robust understanding of climate risks and embrace uncertainty.
7. Promote outcomes-based management.
8. Move the needle.

Update 2023 recommends an expanded role for regional- and watershed-scale initiatives, especially those that incentivize the establishment of networks of local agencies, Tribal governments, community leaders, and non-profit organizations. These watershed networks are intended to represent a broader cross-section of local voices and perspectives, contributing to water plans and projects that are more naturally integrated across water management sectors (e.g. water supply, stormwater, sanitation, recycling, groundwater). As watershed networks are established, they should include local municipal stormwater programs as partners in strengthening watershed resilience.

7. Urban Stormwater Runoff Capture and Management in the Water Supply Strategy and Water Resilience Portfolio

Increasing urban stormwater runoff capture and use continues to be a priority as highlighted in two State initiatives, the *Water Supply Strategy: Adapting to a Hotter, Drier Future* (Water Supply Strategy) and the *Water Resilience Portfolio*. Both initiatives recognize the need for action to prepare and adapt to a future with reduced snowpack and more droughts.

The Water Supply Strategy, released in 2022, highlights the importance of capturing urban stormwater above and below ground to diversify water supplies and better prepare for drought. This strategy set a statewide goal to increase annual supply capacity by at least 250,000 acre-feet by 2030, and 500,000 acre-feet by 2040, through implementation of new local stormwater capture projects. This strategy includes the following implementation steps:

- Through permitting and funding, the State will incentivize local agencies to develop stormwater capture projects and help offset the cost of completing these projects, including through stormwater crediting systems to encourage public-private partnerships.
- The State Water Board will hire a contractor to provide an estimate of current stormwater capture and use statewide and then, every five years, re-evaluate progress made toward the 2030 and 2040 goals.

The *Water Resilience Portfolio*, released in 2020, calls for water supply diversification to cope with a future of reduced snowpack and more droughts. It includes details on how State agencies can support cities and counties to make stormwater capture a growing share of their supply. The *Water Resilience Portfolio* includes the following four actions related to urban stormwater capture:

- To address inconsistent approaches in how municipalities estimate the cost of stormwater programs, develop a framework to identify cost of compliance with stormwater permit requirements. (Action 5.1 – State Water Board to implement this action)

- Pilot stormwater capture and use projects through the Drinking Water State Revolving Fund to identify impediments to address and to provide a framework for additional future projects. (Action 5.2 – State Water Board to implement this action)
- Develop best management practices and standards for the design and construction of recharge wells used to capture urban stormwater. (Action 5.3 – DWR to implement this action)
- Provide statewide authority for wastewater facilities to accept stormwater and incentivize stormwater permittees to divert their captured stormwater at times when wastewater facilities have the capacity to accept such diversions. (Action 5.4 – State Water Board to implement this action)

8. Recommendations

The following recommendations support urban stormwater runoff capture and management in California with an emphasis on improving the pace to construct projects that capture urban stormwater runoff:

1. The State should consider establishing an advisory group that meets regularly to discuss how best to advance policy, planning, and implementation of urban stormwater runoff capture and management throughout the state. The advisory group should include, at a minimum, representatives from municipal stormwater programs, water agencies and districts, flood management agencies, groundwater sustainability agencies, environmental groups, non-governmental organizations, disadvantaged communities, and Tribes. If established, the advisory group should assist with implementation of the following recommendations.
2. The State Legislature should enact a new general State policy (in the Water Code) to prepare for future droughts and adapt to climate change by encouraging construction of new groundwater storage projects in urban and rural areas. This new general State policy should also encourage implementation of true source control measures (minimizing pollutants at the source) to protect water quality. These groundwater storage projects would store urban stormwater, non-urban stormwater, and flood water (resulting from floods or in anticipation of floods) underground to benefit future drinking water, agricultural, and environmental water needs.
3. City and county municipal stormwater programs should be included in future watershed networks that are recommended in *California Water Plan Update 2023*. In addition, watershed networks should include a goal or objective to capture urban stormwater runoff and should leverage existing local and regional planning efforts (e.g., IRWM plans, general land use plans, and stormwater resource plans) to advance urban stormwater capture and improve watershed resilience.
4. The State Water Board should develop a statewide policy on infiltration of urban stormwater to assist with permitting of these facilities.
5. The State should provide technical assistance to encourage multi-benefit stormwater capture projects in small and urban communities, especially for underserved neighborhoods. The advisory group would help identify and prioritize the technical assistance needs.

6. The State should provide outreach and education to elected officials and the public to increase awareness and understanding on the importance of valuing urban stormwater runoff as a water supply resource.
7. The State should collaborate with municipalities, water agencies, communities, and others to support long-term planning and valuation of stormwater capture projects over a 20-to-30-year period that includes socioeconomic and environmental benefits.
8. The State should require that future updates to an UWMP or an IRWM plan include an assessment of urban stormwater capture amounts as a potential water supply resource.
9. The State should survey municipal stormwater programs to determine the funding needed for future infrastructure improvement projects and annual funding needed for operation and maintenance activities.
10. The State should develop technical guidance, tools, standards, and training on all aspects of advancing urban stormwater capture and management. The advisory group would help prioritize the initial list of technical guidance and tools needed in the subsection, "Developing Technical Guidance, Tools, and Standards," in this RMS.
11. The Governor's Office of Planning and Research, when updating the General Plan Guidelines, should include a requirement that all relevant parts of city and county general plans (i.e., any part that addresses stormwater drainage infrastructure or has a potential nexus to stormwater management) assess and integrate urban stormwater capture as a potential water supply resource.
12. The State Water Board and regional water boards, when developing or renewing stormwater permits, should evaluate short-term and long-term water supply and water quality desired outcomes.

9. References

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10. Useful Web Links

American River Basin Storm Water Resource Plan
https://www.owp.csus.edu/images/upcoming/ARBSWRP/ARB_SWRP_Final_5-25-18.pdf

California Coastkeeper Alliance – Drought to Flood: What to do about California's New Normal? Part 2: Stormwater Capture
https://cacoastkeeper.org/drought-to-flood-what-to-do-about-californias-new-normal-part-2-stormwater-capture/

California Stormwater Quality Association's Vision for Sustainable Stormwater Management
https://www.casqa.org/wp-content/uploads/2022/10/final_-_vision_for_sustainable_stormwater_management_-_10-07-2020.pdf

California Water Plan Update 2023
https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/Update2023/Final/California-Water-Plan-Update-2023.pdf

California Water Resilience Portfolio
https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Water-Resilience/Final_California-Water-Resilience-Portfolio-2020_ADA3_v2_ay11-opt.pdf

California Water Supply Strategy – Adapting to a Hotter, Drier Future
https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Water-Resilience/CA-Water-Supply-Strategy.pdf

Drinking Water State Revolving Fund
https://www.waterboards.ca.gov/drinking_water/services/funding/SRF.html

DWR Alternative Water Supplies
https://water.ca.gov/Programs/Water-Use-And-Efficiency/Recycling-Desalination-Stormwater-and-Graywater

DWR Integrated Regional Water Management
https://water.ca.gov/Programs/Integrated-Regional-Water-Management

Enhancing Urban Runoff Capture and Use
https://www.waterboards.ca.gov/water_issues/programs/stormwater/storms/docs/STORMS-capture-use.pdf

Environmental Finance Center at Sacramento State – Stormwater Funding and Financing
https://www.efc.csus.edu/stormwater-funding-and-financing/

Evaluating Potential Methods to Quantify Stormwater Capture
https://ftp.sccwrp.org/pub/download/DOCUMENTS/TechnicalReports/1116_StormwaterCapture.pdf

Fresno Metropolitan Flood Control District
https://www.fresnofloodcontrol.org/

Guidance for Obtaining Phase I Municipal Separate Storm Sewer System (MS4) Permit Compliance Costs
https://www.waterboards.ca.gov/water_issues/programs/stormwater/storms/docs/ms4costrptguide.pdf

Los Angeles Basin Study
https://www.usbr.gov/lc/socal/basinstudies/LABasin.html

Los Angeles Regional Water Board's *Race and Stormwater in LA County* story map
https://storymaps.arcgis.com/stories/1b75f0cde0a348fd803a587950b3955c

Los Angeles Stormwater Capture Master Plan
https://www.ladwp.com/who-we-are/water-system/sources-supply/stormwater-capture-master-plan

Monterey One Water
https://www.montereyonewater.org/

Orange Memorial Park Regional Stormwater Capture Project
https://www.ssf.net/departments/public-works/engineering-division/capital-improvement-program/orange-memorial-park-regional-storm-water-capture-project

Project 4b: Eliminate Barriers to Funding Stormwater Programs and Identify Funding for Stormwater Capture and Use Projects
https://www.waterboards.ca.gov/water_issues/programs/stormwater/storms/obj4_proj4b.html

Rain Ready California: Protecting and Collecting Water for Our Future
https://www.casqa.org/programs-initiatives/engagement-education

Regional-Scale Stormwater Management Planning Effort in San Mateo County
https://www.flowstobay.org/regional-collaborative/

Safe, Clean Water Program (Los Angeles County)
https://safecleanwaterla.org/

San Mateo County Stormwater Resource Plan
https://ccag.ca.gov/plansreportslibrary-2/san-mateo-county-stormwater-resource-plan/

San Mateo Countywide Sustainable Streets Master Plan
https://ccag.ca.gov/countywide-sustainable-streets-master-plan/

Santa Ana Watershed Project Authority
https://sawpa.gov/

Santa Clara Basin Stormwater Resource Plan
https://scvurppp.org/swrp/docs-maps/

Southern California Coastal Water Research Project
https://www.sccwrp.org/

Southern California Coastal Water Research Project – Stormwater BMPs
https://www.sccwrp.org/about/research-areas/stormwater-bmps/

Stanford University Stormwater Capture
https://suwater.stanford.edu/water-supplies/stormwater-capture

Stanislaus Multi-Agency Regional Storm Water Resource Plan
https://www.stancounty.com/publicworks/swrp/#overview

State and Regional Water Boards: They Must Do More to Ensure That Local Jurisdictions' Costs to Reduce Storm Water Pollution Are Necessary and Appropriate
https://www.auditor.ca.gov/pdfs/reports/2017-118.pdf

State Water Board's Recycled Water Policy
https://www.waterboards.ca.gov/board_decisions/adopted_orders/resolutions/2013/rs2013_0003_a.pdf

State Water Board Regulations for Onsite Treatment and Resuse of Nonpotable Water (Under Development)
https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/onsite_nonpotable_reuse_regulations.html

State Water Board STORMS California's Untapped Stormwater Capture Potential
https://gispublic.waterboards.ca.gov/portal/apps/storymaps/stories/3073c5b98ecb4f76969e50b3e9065a79

State Water Board STORMS Program
https://www.waterboards.ca.gov/water_issues/programs/stormwater/storms/

State Water Board Stormwater Grant Program
https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swgp/

State Water Board Stormwater Program
https://www.waterboards.ca.gov/water_issues/programs/stormwater/

Storm Water Resource Plan Guidelines (draft)
https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swgp/docs/draft_guidelines_120315.pdf

Stormwater Resource Plans
https://www.waterboards.ca.gov/water_issues/programs/grants_loans/swrp/

The Socioeconomic Value of Urban Stormwater Capture
https://www.casqa.org/wp-content/uploads/2024/02/FINAL-The-Socioeconomic-Value-of-Urban-Stormwater-Capture-02-03-2024.pdf

The Untapped Potential of California's Urban Water Supply: Water Efficiency, Water Reuse, and Stormwater Capture
https://pacinst.org/wp-content/uploads/2022/04/PI_California_Untapped_Urban_Water_Potential_2022-1.pdf

Ventura Countywide Municipal Stormwater Resource Plan
https://vcstormwater.org/publications/plans/stormwater-resource-plan

Water Resilience Portfolio
https://resources.ca.gov/Initiatives/Building-Water-Resilience/portfolio

Waters of the United States
https://www.epa.gov/wotus

Water Supply Strategy: Adapting to a Hotter, Drier Future
https://resources.ca.gov/-/media/CNRA-Website/Files/Initiatives/Water-Resilience/CA-Water-Supply-Strategy.pdf

Related Resource Management Strategies

The following resource management strategies have a significant connection to the Urban Stormwater Capture and Management Resource Management Strategy:

- Urban Water Use Efficiency.
- Conjunctive Management and Groundwater Storage.
- Municipal Recycled Water.
- Pollution Prevention.
- Land Use Planning and Management.
- Recharge Area Identification, Utilization, and Protection.
- Watershed Management.


DEPARTMENT OF WATER RESOURCES
STATE OF CALIFORNIA