Estimating Benefits and Costs of Stormwater Management

Part II: Evaluating Municipal Spending in California

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ENVIRONMENTAL FINANCE CENTER
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The views expressed in this document are those of the EFC at Sacramento State. Reviewers provide no endorsement of the work.

About the EFC at Sacramento State

The EPA Region 9 Environmental Finance Center is operated by the Office of Water Programs (OWP) at California State University, Sacramento (Sacramento State). The EFC at Sacramento State assists state and local governments, tribal communities, and non-profits in EPA Region 9 with financial planning, asset management, and data analysis. The goal of the EFC is to support these entities in building the capacity to sustainably fund environmental and public health programs for residents.

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Summary and Key Findings

Communities in California fund stormwater management programs to reduce flooding and improve water quality. Few studies have attempted to quantify current spending related to stormwater programs. Past surveys indicated a range of $18–46 per person in spending for water quality improvements, while data extrapolation from several case study areas yielded estimates of over $1 billion in funding needs to meet stormwater management permit requirements (Currier et al. 2005, Hanak et al. 2014).

To improve current estimates of stormwater spending in California, the United States Environmental Protection Agency's (EPA's) Region 9 Environmental Finance Center at California State University, Sacramento (EFC at Sacramento State) compiled existing, publicly-available data on reported stormwater expenditures (actual spending in a previous year) and budgets (apportioned funding or projected spending in a future year) based on multiple sources, including annual reports published as part of municipal separate storm sewer system (MS4) permit compliance requirements. The analysis identified reports for over 160 entities spanning cities, counties, flood control districts, a port authority, and an airport. The most representative cost data for each MS4 permittee was chosen for further analysis. Values representing different years were normalized to 2018 dollars to improve comparisons across California.

The analysis yielded several key findings:

- Available reports indicate that current stormwater spending is at least $700 million based on available sources (normalized to 2018 dollars). This is an underestimate due to regional gaps in publicly-available data across California and, likely, the types of costs that are included (and excluded). Improved reporting would refine the estimate.
- From available data, counties and flood control districts provide significant contributions to stormwater spending, but cities reported more in aggregate. More complete reporting could shift the relative contributions of each entity.
- Identified spending in southern California communities was higher than spending reported by others. This is likely influenced by regional requirements for cost reporting in public sources (resulting in more data from southern California) as well as regulations for watershed planning, Total Maximum Daily Load (TMDL) compliance, and reporting.
- Correlations in spending across municipal characteristics of population or area were inconsistent.

- From available data, MS4 spending in most communities has not increased over time, even as water quality regulations grow more stringent. Spending increased in only a few of the communities evaluated, especially in recent years.
- While spending activities span many categories, the largest percentage (about 35 percent) is dedicated to pollution prevention. Some of these costs may include operations and maintenance (O&M) activities that were not explicitly labeled as such, resulting in elevated representation of pollution prevention efforts and underestimation of O&M costs.
- A lack of standardized reporting across and even within regions inhibits better estimates and confidence in the observed trends. The Los Angeles region had recent reporting with the most standardized and comparable dollar values. Communities in other parts of the south coast also had significant available data, though it was less standardized. In the Central Valley, larger communities had available data in annual reports, but it was also less standardized. Finally, areas of the North Coast, San Francisco Bay Area, and Central Coast tended not to have publicly-available reported values.
- For spending by counties and flood control districts, reported values in many reports often do not differentiate between spending with a regional focus or spending for local needs. This limits opportunities to compare normalized spending (per capita and unit area) by cities versus counties. Better comparisons could be made if, to the extent possible, counties and flood control districts note activities targeted for particular communities such as unincorporated areas as compared to activities they undertake on behalf of all regional cities.
- Further and more accurate understanding of budgets and expenditures for stormwater management in California would require greater consistency in the types of activities reported (i.e., standardizing categories and the types of activities that apply to each category), as well as more communities reporting data. While this may burden some communities, it may also provide benefits if such data can be used to support funding and financing initiatives. To simplify the reporting process, costs could be aligned with specific sections of MS4 permits. An example of cost categories that could align with reorganized permit sections and activities that could be reported within each category is presented in Table 13.

- Reported data does not consistently differentiate between flood control and water quality activities. Past studies of stormwater spending have focused on costs of complying with MS4 permits rather than including both the water quality and flood control functions that stormwater systems provide. If spending on such activities were more explicitly detailed, stormwater managers would better understand how to plan joint projects with other local departments, such as local flood control managers.

About this report

This report is Part II of a project on evaluating benefits and costs for stormwater management by the United States Environmental Protection Agency's (EPA's) Region 9 Environmental Finance Center at California State University, Sacramento (EFC at Sacramento State). Since 2016, the EFC has been developing tools and resources to support stormwater management and finance in urban areas. Part I of the project published a report that describes best practices, illustrates examples, and identifies data sources for evaluating benefits and costs in municipal stormwater management (OWP EFC 2019).

This report builds on Part I by compiling and analyzing stormwater cost data from municipalities across California. To our knowledge, studies have not thoroughly examined how stormwater expenditures (actual spending in a previous year) and budgets (apportioned funding or projected spending in a future year) vary across permittees, including comparisons between stormwater funding and other sectors of local government. Additionally, there is little information on how spending on stormwater changes over time or compares to inflation. Collecting more and better data on stormwater program funding and operations helps fill current knowledge gaps regarding the state of stormwater spending and future needs.

To address these questions, EFC staff compiled a database of expenditures and budgets reported by municipalities in annual program documents required for compliance with National Pollutant Discharge Elimination System (NPDES) permits for municipal separate storm sewer systems (MS4s). We extracted, standardized, and analyzed data from hundreds of sources for communities across California. We evaluated trends by geography, municipality size and type, and category of costs.

While there are a growing number of resources available to assist communities in estimating costs for stormwater management, many resources focus on project

construction and maintenance. Often, existing data is drawn from larger municipalities where construction and labor costs are higher. Existing data is often inadequate to understand local and regional differences in costs, leaving smaller communities with limited information to get programs up and running. Together, the EFC's two reports offer new resources for communities in EPA Region 9 and across the country.

The reports from Part I and Part II are linked, but written to be stand-alone products. Some common material exists in the Background section of both reports to provide sufficient context regarding stormwater management strategies and categories of expenditures.

Results from this report are intended to help inform planning and regulatory processes, but are not intended for use in project or program budgeting.

Introduction

Municipal stormwater infrastructure was built to control flooding by conveying runoff away from urban streets quickly. In some urban areas, especially in drier climates, drainage infrastructure also collects runoff even when it does not rain, largely from over-irrigation. In the past, stormwater management was typically a secondary concern as compared to water supply and wastewater management. In the United States today, stormwater management efforts are growing as municipalities recognize the need for institutionalized stormwater programs. The reasons are many: for some, regulatory requirements drive investments dealing with combined sewer overflows, pollution, flooding, and erosion in local streams and rivers. For others, urban water planners hope to benefit from integrating management across water sectors. Local governments increasingly invest in efforts that support both aims.

Stormwater management is one need among many in municipalities. Schools, road maintenance, personnel, and many other expenses all compete for limited local funds. In addition, stormwater management emerged later than many municipal needs. Stormwater management duties have expanded beyond flood control to incorporate larger cross-cutting goals ranging from protecting and restoring local watersheds to creating new green spaces in otherwise concrete-dominated urban areas. Other goals hope to recharge local groundwater basins that provide water supply. The change in approach is significant for cities, counties, and water utilities.

In many municipalities, planning procedures and funding structures are not prepared for this new era of stormwater management. Many municipalities have no dedicated funding streams for stormwater programs, instead relying on general funds that get allocated among the many services that municipalities provide. Others have established utilities with dedicated funding streams. However, for all types, limited information exists on the full range of costs in urban stormwater, which can include everything from new projects with green infrastructure (GI) and stormwater control measures (SCMs; also called best management practices or BMPs) to regular activities required by stormwater permits. Greater clarity is essential for building effective capacity for managing stormwater in cities.

Background

Municipal stormwater management programs must pay for labor, activities, and infrastructure costs. Programs undertake monitoring and operations and maintenance (routine and emergency), while also planning for capital investments of new infrastructure. To date, research on costs for stormwater management has especially focused on unit costs of projects such as new low-impact development features or runoff conveyance infrastructure such as storm sewers, culverts, or drainage ditches. A growing list of resources exists to help regulated entities evaluate project-oriented costs when planning new investments, many of which were surveyed in the report for Part I of this project (OWP EFC 2019).

Better data is needed to understand the range of spending to meet stormwater permit compliance requirements as well as stormwater-related capital investments (i.e., both green and gray infrastructure). In particular, empirical studies can examine several important questions:

1) What are the best available sources of data for municipal stormwater budgets and expenditures?
2) What is the breakdown of municipal stormwater spending between programmatic activities, operations and maintenance of existing infrastructure, and investments in new infrastructure?
3) What percentage of spending is directly related to complying with TMDL requirements?
4) How does spending differ across communities of varying size, climate, and geographic location?
5) What categorization schemes do communities currently use when reporting costs? Can such schemes be standardized to improve confidence in reported values?

This report attempted to answer these questions in California using best available data.

There are several possible approaches to accrue data to address these questions. For instance, agencies or researchers can administer a survey that collects data from a representative sample of municipalities and then standardize that data based on factors of inflation, population, area, wealth, and others. Surveys provide an opportunity to develop targeted questions that directly address the topics of interest, but response rates can be low and respondents may have problems in making

available data meet requested formats. Alternatively, agencies or researchers could identify and collect data from available sources. This eliminates the time-consuming process of administering a survey and issues with response rates, but presents challenges associated with understanding the representativeness of available data. Further, results and insights are limited to the available data. This method can be appropriate when the parties of interest (potential survey respondents) already provide similar information in another venue or format.

Few studies have systematically gathered data on the costs of activities related to permit compliance or new infrastructure across communities of varying sizes and locations. In 2005, the Office of Water Programs (OWP) at Sacramento State, the University of Southern California, University of California Los Angeles (UCLA), the California State Water Resources Control Board (State Water Board), and the Regional Water Quality Control Boards (Regional Water Boards) surveyed six municipalities to estimate costs for compliance with permit requirements. The study standardized the survey results and found that communities spent between $18–$46 per household for compliance (Currier et al. 2005).

The 2005 survey resulted from discussions and disputes regarding implementation of NPDES permit compliance requirements under the Clean Water Act. Starting in 1987, amendments to the Clean Water Act provided authority for state and federal regulatory agencies to publish water quality requirements for discharges associated with stormwater. Regulations were first enacted for large communities (Phase I) and then smaller communities and other systems (Phase II). Permittees were required to demonstrate progress toward improved water quality in local watersheds, which required time and monetary investments.

In another study, in 2014, the Public Policy Institute of California estimated stormwater funding needs in the range of $1–$1.5 billion across the state (Hanak et al. 2014). The value was derived based on extrapolating detailed data for a few case study communities. Current funding was approximated to be about half of the need, totaling no more than $500–$800 million annually across communities. The report identified difficulties in raising funds for stormwater management due to voter-approval requirements associated with Proposition 218 (Hanak et al. 2014). The method used to extrapolate spending demonstrated the lack of centralized data sources. Unlike other municipal water management sectors, the absence of

dedicated stormwater utilities, which would report spending through annual audited reports, makes it difficult to evaluate current expenditures.

Recently, the cost burden that municipalities incur to meet water quality requirements identified in permits to discharge stormwater from point and non-point sources has been the basis of lawsuits and controversy. This continues today. For instance, in California, in 2018, the State Auditor, by legislative order, evaluated future expected costs of stormwater permit compliance by municipalities. The auditing agency reviewed procedures that the State Water Board and Regional Water Boards took to estimate the economic costs of stormwater permit compliance actions on the part of municipalities. The Auditor's report recommended the State Water Board develop guidance for the Regional Water Boards to document estimates of the costs that local jurisdictions will incur in order to comply with pollution control plans (California State Auditor 2018). The State Water Board developed two guidance documents in 2019, one focusing on the costs of MS4 permit compliance (State Water Board 2019a) and one focusing on the costs of TMDL compliance (State Water Board 2019b).

Organizing Stormwater Management

Urban stormwater programs can be authorized in several ways. Many communities perform stormwater activities as part of general municipal duties. In these cases, a municipality would support stormwater management from the same accounts that fund other municipal activities, such as trash collection, park management, or many others. Using general funds provides flexibility, but results in stormwater management programs conflicting with other municipal spending needs.

Some jurisdictions form dedicated stormwater utilities. These are enterprises set up within a city that have a dedicated funding stream, such as a parcel charge or tax, and are responsible for undertaking a specific set of duties.

The collection of stormwater-related activities that a city, county, or other jurisdiction undertakes comprises a stormwater program. These can include operations, maintenance, compliance, water quality testing, and others. A utility could undertake most or all of a city's stormwater management duties under a program.

Finally, stormwater projects are physical infrastructure that is built and maintained for the purposes of improving water quality or managing flooding. Projects must be managed by experts.

Stormwater Management Strategies

Most stormwater systems have traditional components that emphasize drainage (capture and conveyance), while more recently MS4s have implemented strategies (both structural and non-structural) to prevent and address water quality issues. The nomenclature is not standard across communities or regions. Some sources categorize components as gray or green, with gray devices used for capture and conveyance and green devices used to capture, retain, and infiltrate. The terms best management practices (BMPs) and stormwater control measures (SCMs) are often used to refer to all types of stormwater infrastructure, devices, and practices (including non-structural actions and strategies) used to reduce the downstream quality and quantity impacts of stormwater (NRC 2008).

Common drainage infrastructure can include gravity and force mains (large pipes), smaller lateral line pipes, catch basins and inlets, detention basins, culverts, manholes, valves, and pumps. Each of these will have descriptive characteristics, such as date of installation (age), material, size, flow capacity, and depth.

GI and LID devices are designed to mimic natural hydrology, retaining water in the landscape and reducing downstream discharges through infiltration, capture and use, and evapotranspiration. Other structural BMPs/SCMs are designed not to retain a majority of runoff but to provide treatment of runoff and perhaps flow rate reduction. A wide variety of GI and LID devices and other structural SCMs/BMPs exist (Table 1 and Table 2). Such structures can come in many designs and sizes, from small on-site devices in front yards to large regional projects capturing runoff from small watersheds. For example, bioretention planters can have various media and gravel depths and may or may not have underdrains; the differences in these features results in different facility costs.

Table 3 lists many of the types of non-structural BMPs/SCMs that are used to prevent and reduce water quality degradation. Finally, as part of integrated water management, several communities participate in restoration activities to promote watershed health (Table 4).

Table 1. Types of green infrastructure and LID devices

Device Type (and Styles/Synonyms)
Bioretention planter ([infiltrating] stormwater planter, bioretention facility)
Biostrip (vegetated filter strip)
Bioswale (swale, vegetated filter swale, vegetated swale)
Green roof
Green street
Infiltration basin, gallery, or trench
Permeable pavement (porous pavement, porous permeable asphalt/concrete/pavers)
Rain garden (compost amended soil, soil quality improvement and maintenance)
Disconnected impervious surfaces (disconnected pavement, disconnected downspouts/roof drains, rooftop and impervious area disconnection)
Tree planting and preservation (interceptor trees)
Alternative driveways
Wet pond
Constructed wetland
Rain barrel or cistern for rainwater capture and use

Table 2. Types of other structural BMPs/SCMs

Device Type (and Styles/Synonyms)
Detention basin
Lined (non-infiltrating) planter ([flow-through] stormwater planter, tree box filter)
Media filter (sand filter, in-vault media filter)
Vortex separator (hydrodynamic separator)
Catch basin inserts with/without filtration media (drain inlet inserts with/without filtration media)
Treatment train
Diversion (to sanitary sewer)

Table 3. Non-structural BMPs/SCMs

Practice/Measure Type (and Styles/Synonyms)
Operations and maintenance of structural BMPs/SCMs
Water quality monitoring
Construction site runoff control
Illicit discharge detection and elimination
Pollution prevention and good housekeeping for municipal operations (e.g., street sweeping; secondary containment; operations and maintenance of GI, LID devices, and structural BMPs/SCMs)
Outreach and education
Public involvement and participation programs
Program management (e.g., administration, reporting, effectiveness evaluations, fees)

Table 4. Habitat restoration practices

Examples
Stream bed and bank stabilization
Riparian buffer enhancement and protection
In-stream enhancement
Floodplain reconnection

Methods

For this analysis, we focused on communities in the state of California as a case study to evaluate expenditures (actual spending in a previous year) and budgets (apportioned funding or projected spending in a future year) for stormwater management. We also focused on publicly-available data This section describes procedures the EFC used to identify and standardize financial data, categorize expenditures and budgets, and compare results across regions and governance type.

Data Sources

We evaluated publicly-available sources and extracted financial data to assemble a database of municipal expenditures and budgets related to stormwater management for municipalities in California. We investigated several potential sources of data, including:

1) Annual audited financial reports from cities, counties, and special water districts
2) Annual program reports from city and county permittees on stormwater management activities
3) Regional watershed planning documents such as Enhanced Watershed Management Plans (EWMPs) or Water Quality Improvement Plans (WQIPs)
4) Municipal separate storm sewer (MS4) permits

Each of these sources had benefits and drawbacks. For instance, annual audited financial statements, while robust and peer-reviewed, often have limited information on stormwater spending. A report would not provide budget and expenditure numbers if the municipality did not have an identifiable "enterprise" fund associated with a dedicated stormwater utility. As another example, regional watershed planning documents can have detailed estimates of costs for new infrastructure and programs to meet regional water quality requirements, but many are based on future projected costs ("bid" costs) and not actual expenditures from past years.

Annual stormwater program reports, however, offer a potentially robust source of data for MS4s across the state. Through these annual reports, MS4s in California typically describe activities, results of watershed monitoring, and infrastructure operations and investment, along with estimates of relevant expenditures and budgets, sometimes for multiple years. Although expenditures and budgets may be provided in annual audited financial reports to state regulators, the annual program reports often provide more detail.

Challenges in Data Collection and Analysis

Using these annual program reports posed several challenges. First, no central repository of such reports exists for entities in California. In some cases, reports are available through a centralized reporting database populated by the State and Regional Water Boards, the Stormwater Multiple Application and Report Tracking System (SMARTS). In other cases, reports are published on websites of municipalities or regional water quality authorities. Finding and collecting them required significant time. Second, when the reports do provide expense or budget information, reporting categories are not standardized. Comparing expenditures and budgets across communities and regions is difficult, and cost categories had to be matched to a typology for analysis. Third, reports often provide limited detail on the methods used to calculate costs. For instance, when the report provides budgets or expenses over multiple years, it was uncertain whether costs were normalized for inflation. Finally, while the reports are detailed, they are not audited, therefore reported expenditure and budget values are subject to inconsistencies. Values are often revised between years. Time and resource constraints prohibited direct follow-up with municipalities for clarifications when inconsistencies arose.

The nested structure of stormwater programs provides another significant challenge. In a given region, an agency or entity, often the county or a joint powers authority, is typically designated as the principal permittee, with subsidiary jurisdictions being co-permittees. Each permittee is responsible for stormwater management within its jurisdiction, while also contributing to regional programs that may undertake larger projects or broader programs. Ensuring that expenditures are only reported once is a task that required significant time and effort.

Data Availability

For the analysis, we surveyed reports and identified data for 162 entities. These included cities (147), counties (nine), special districts (four watershed protection districts), an airport, and a port authority. Figure 1 maps entities with data included in the analysis. Appendix C includes a table of all entities and their respective type, county, region, and years of reported data. Due to instances where a county and a city share a name, all data for counties are identified with the word "County" in their jurisdiction. For example, all data with jurisdiction listed as "San Diego" is for the City of

San Diego, and all data with jurisdiction listed as "San Diego County" is for the County of San Diego. County location data for each city is included in a separate column.

Not all entities reported separate documents. In some instances, summary regional documents were available with sections and data for each permittee in an area. The majority of the available data represents cities and counties. Flood control district boundaries often overlap and align with county boundaries, but when a region contains two legally distinct agencies (such as a county and flood control district), annual stormwater reports provide separate budgetary and/or expenditure values for each of the named permittees.

The total number of entities reporting budgets and expenditures was 178 and 186, respectively (Table 5). The entities spanned fifteen of California's fifty-eight counties. The areas of the state with the greater number of reporting entities generally coincide with Regional Water Board jurisdictions that require cost reporting in sources that are public, not necessarily a lack of stormwater expenses and programs in the other areas.

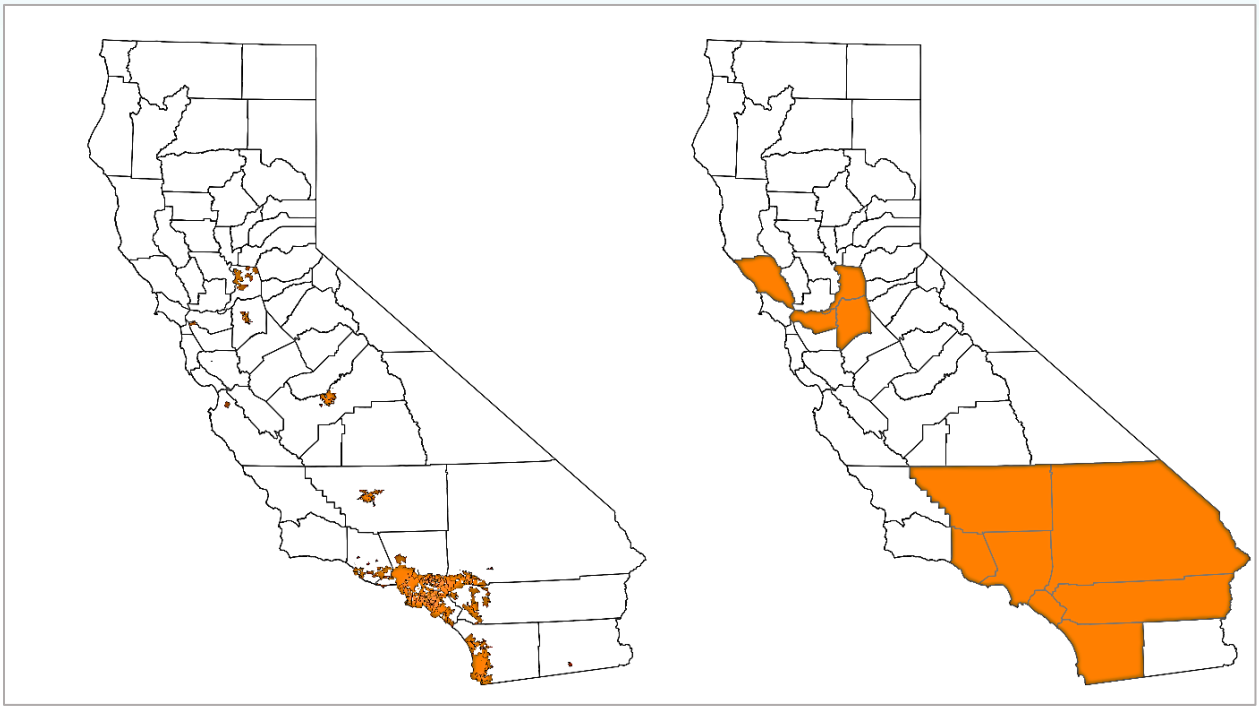


Figure 1. Map of cities, flood control districts, airports, and port authorities (left) and counties (right) included in the analysis

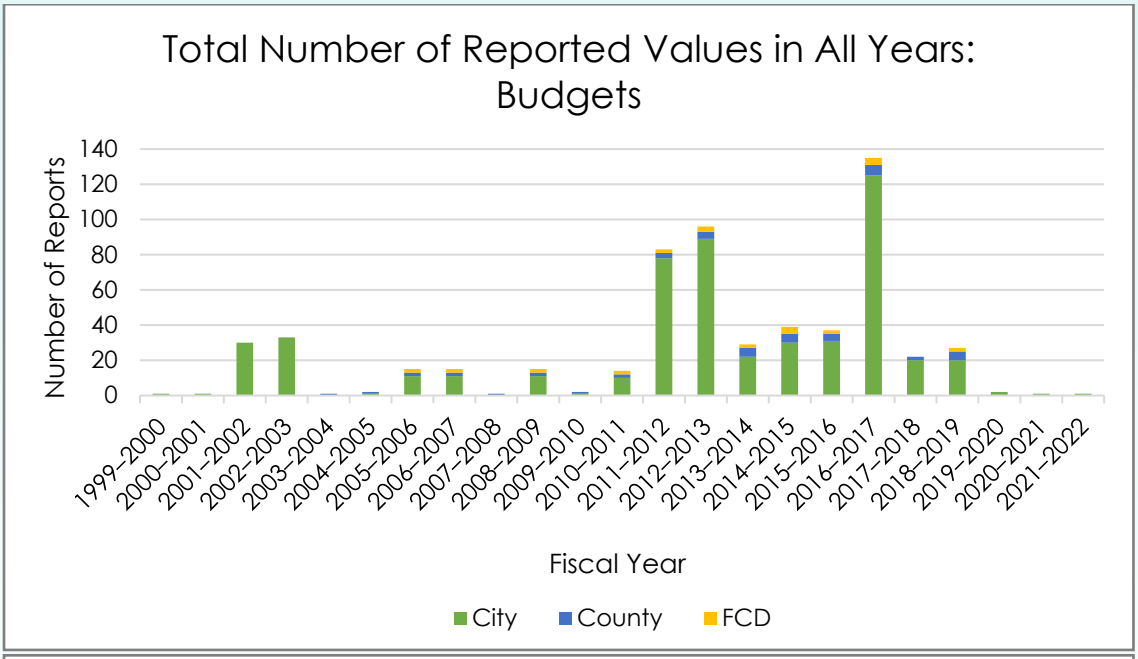
Table 5. Number of entities with identified publicly-available reporting for stormwater-related budgets and expenditures in regions of the California State Water Resources Control Board

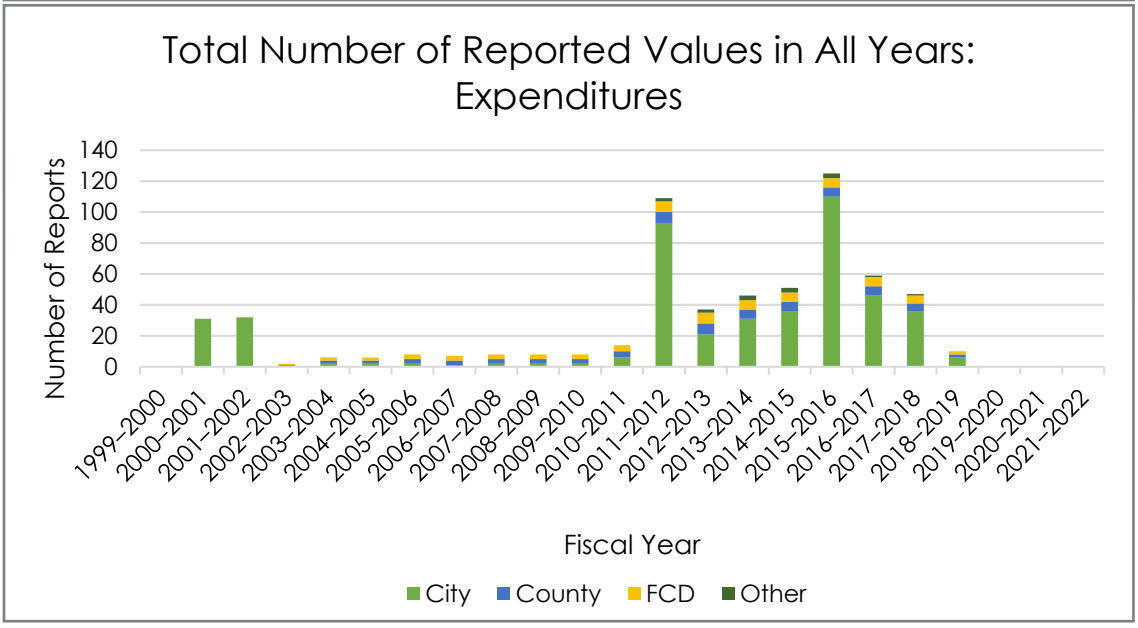
Regions	Number of Entities Reporting Budgets	Number of Entities Reporting Expenditures
1: North Coast	0	1
2: San Francisco Bay Area	2	1
3: Central Coast	1	1
4: Los Angeles	90	78
5: Central Valley	11	13
6: Lahontan	0	0
7: Colorado River Basin	1	1
8: Santa Ana	58	58
9: San Diego	15	33
Total	**178**	**186**

Some reports provided both budgets and expenditures, while others only reported one value such as previous year expenditures. Additionally, reports included inconsistent timeframes. Budgets were available for 1999 through 2021 (future years are projections). Expenditures were available for 2000 through 2018. Figure 2 shows the total number of budgets and expenditures reported across years. Overall, we identified 602 total annual budget values and 550 total annual expense values. Some reports had data covering over a decade, while others included only one year of values. On average, an entity had five years of available data (mean = 4.51, SD = 2.73). In total, the database of annual budgets and expenditures included 1,152 distinct records.

Based on collected data, the 2015–16 fiscal year had the most available reports. In Figure 3, this coincides with expenditures that occurred in 2015 and budgets expected for 2016. This is in part due to the Los Angeles region's standardized reporting system, with significant available data for this year. In addition, the 2011–12 fiscal year was prominent, particularly due to many reports from the Los Angeles metropolitan region. It is unknown why the numbers of reports peaked and declined and peaked and declined again from fiscal year 2011–12 and beyond; it perhaps may be due to interim, anticipated, or phased regulatory reporting requirements. Only a few entities, such as Berkeley, reported estimated budgets through future years. As described

below (Standardizing Data), the summary statewide numbers used a single representative year for each jurisdiction, normalized to 2018 dollars.





"Other" represents one airport and one port authority, neither of which reported budgets.

Figure 2. Total number of reported values available for budgets and expenditures across all years

Standardizing Data

Standardizing by Cost Type

Some geographic regions, such as Los Angeles, Ventura, and San Diego counties, had standardized reporting categories for recent years, where all permittees within the region used the same reporting format. However, the categories used for reporting varied between these regions, and cost types reported by other entities widened the diversity. EFC staff therefore developed a cost typology to standardize costs by type. Specific methods for categorizing costs are presented below in Section III.E (Categorizing Costs).

Standardizing Over Time

To evaluate expenses, we used a single year's budget and/or expenditure value, depending on data availability, of recent data from each reporting jurisdiction. For most instances, this was the most recent year of reported budget or expenditures. In some instances, however, a large spike or dip occurred (during the most recent year compared to other years reported), perhaps due to budget reclassifications or one-time grant or bond revenues. In such cases, we instead used another recent year with spending that more closely represented trends over time. We normalized values to 2018 dollars using the Consumer Price Index inflation indicators (USBLS 2019).

Figure 3 shows the breakdown of years selected as representative budgets and expenditures that were normalized to 2018 dollars. Appendix C lists the representative year for each reporting entity.

Several entities reported only budgets. Of those, some reported detailed budgeting. When detailed budgets were provided but actual expenditures were not, we assumed expenditures were equal to the reported budget. These entities included Camarillo, Citrus Heights, Contra Costa, Fillmore, Moorpark, Ojai, Oxnard, Port Hueneme, VCWPD, Santa Paula, Simi Valley, Thousand Oaks, San Buenaventura (Ventura), and Ventura County. The expenditures presented in Figure 3 only reflect the actual data that was available, and not data from these MS4s whose budgets were assumed for expenditures. Our analysis excluded spending from permittees for which expenditures and detailed budgets were not provided.

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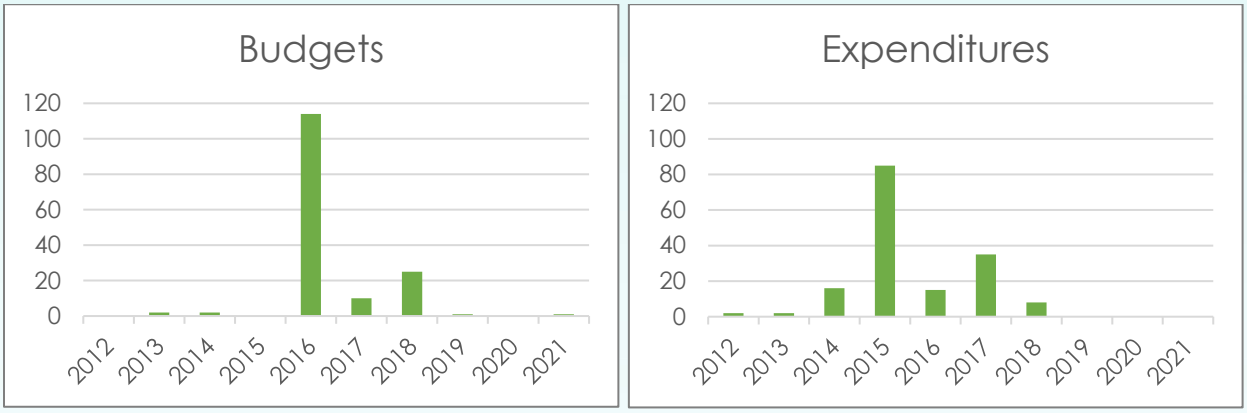


Statistics are based on evaluating the most recent single fiscal year in the jurisdiction's annual reports, or another year representative of multi-year spending trends.

Figure 3. Number of entities that reported budgets (left) and expenditures (right).

Standardizing by Jurisdiction

In analyzing budget and expenditure differences between MS4s, we standardized reported budgets and expenditures based on geographic area and population for each jurisdiction. We used GIS to estimate geographic area and collected data from US Census data to estimate populations (US Census 2014). We then estimated spending per capita (dollars per person) and spending per unit area (dollars per acre) for each entity to normalize and compare values. As we intended this report to be a first cut at evaluating stormwater costs, the unit area analysis was based on jurisdictional area and not contributing watershed area. Future assessments may consider evaluations that include costs based on contributing watershed area.

Categorizing Costs

To analyze and compare spending across different stormwater management activities, we developed a typology of cost categories. The categorization procedure started with categories from existing documentation we developed for stormwater

asset management, which identified stormwater expenditure categories, and then we refined and augmented the categories based on reported cost types in annual reports.

Stormwater management costs can be incurred for both designing and building capital projects, as well as for program activities such as inspections, planning, monitoring, maintenance, and reporting. Project and program costs can be incurred by individual local entities, by several entities within a region, or by a regional entity.

Many new resources are available to assist in estimating costs of green (water quality) and gray (drainage) infrastructure projects. Most available sources provide unit costs to inform estimates of new projects or operations and maintenance. For instance, the USEPA's National Stormwater Calculator tool includes regression models that estimate the cost of new stormwater infrastructure based on capacity, location, and other factors that directly influence costs. Most cost estimation procedures rely on a "bottom-up" approach, which first identifies materials and labor for a project, quantifies the number of items needed, then applies an explicit assumed unit cost for each. The sum of unit costs across all the labor and materials yields an estimate of total costs.

Though such tools are helpful in evaluating project costs, when estimating or evaluating program costs, significant gaps exist for the many types of activities undertaken by municipal stormwater managers (e.g. construction site inspections, outreach and education programs, illicit discharge programs). Limited information is available to comprehensively understand municipal stormwater spending that includes both infrastructure investments and programs.

Grouping costs helps in summing estimates for funds needed to support municipal stormwater programs and projects. The EFC's Stormwater Asset Management Toolkit grouped municipal stormwater program expenses into three general categories: operations and maintenance (O&M) of existing assets, permit compliance, and future buildouts. Costs associated with O&M of the existing assets include labor, materials, and equipment related to inspections, repairs, and replacements of both drainage (gray) and water quality (green) assets. The frequency and extent of O&M activities and amount of infrastructure drive the cost estimates. Activities are outlined via a level of service (LOS) that the municipal utility provides for residents. LOS plans describe how often inspections, repair, and replacement occur, and details the labor and material

needs for each. A higher LOS implies more proactive maintenance actions. Unit costs for materials and labor are applied to the LOS to estimate overall annual O&M costs. O&M for new or future assets may be included in budgetary forecasts.

Permit compliance refers to costs MS4s face to comply with National Pollutant Discharge Elimination System (NPDES) permit requirements outlined by state or federal regulators. These include specific activities such as construction site runoff control, illicit discharge detection, pollution prevention, public education, and water quality monitoring, as well as associated materials and equipment. Permit compliance activities should also include labor costs for program administration and staff.

Future buildout costs involve investments MS4s make in additional infrastructure to meet water quality standards established by the Clean Water Act. The extent (or existence) of plans for future infrastructure varies widely across communities. In some parts of western North America, municipalities are planning for significant investments in new centralized and distributed stormwater devices for water quality, drainage, and water supply goals. Within EPA Region 9, for instance, some southern California communities have outlined infrastructure investment plans for future urban stormwater systems that meet NPDES requirements, including TMDLs of discharges to receiving waters. Some are planning stormwater capture projects for direct use or groundwater recharge. In addition to addressing water quality and water supply needs, new infrastructure may reduce flood risk or mitigate runoff from new development.

Each category can have direct costs for infrastructure, compliance activities, or labor, and indirect costs for rent, equipment, personnel benefits, and other expenses that are attributable to a department or utility. Organizations recover indirect costs in many ways. In a municipality, such expenses could be paid through general funds if all employee expenses are centrally managed. In other cases, the stormwater program may be responsible for individual employee and office costs. Managers should consider both direct and indirect costs when developing asset management and funding plans.

In the EFC's Stormwater Asset Management Toolkit, we drew on past documentation to populate cost categories. The 2005 NPDES Costs Survey (OWP EFC 2005) categorized costs according to six minimum control measures identified in the Phase II NPDES permit at the time. These include:

1) Public education and outreach
2) Public involvement and participation
3) Illicit discharge detection and elimination
4) Construction site stormwater runoff control
5) Post-construction stormwater management in new development
6) Pollution prevention and good housekeeping for municipal operations

In addition to these, many municipalities undertake water quality monitoring and have costs for overall stormwater program management that coordinates these activities.

In surveying reports and collecting data, we identified additional categories of reported spending by municipalities, which did not fit into any of these existing areas. These included: industrial and commercial management programs and watershed/TMDL collaboration. There were some reported activities that fit into multiple categories or were not able to be classified. These were placed into a separate category, "Multiple categories or unable to decipher."

Assembling all of these, the full typology of municipal stormwater costs included categories for capital costs, core minimum control measures, additional activities identified through reports, and regional activities such as watershed/TMDL collaboration. Where possible, we categorized infrastructure investments as capital costs to separate that spending from programmatic activities. Table **6** summarizes the typology. Appendix B provides a complete list of the terms reported by various entities, and how we categorized them. Note that the cost categories presented in Table 6 do not exactly coincide with the organization of California's 2013 Phase II MS4 permit (State Water Board 2013). In particular:

The Phase II permit has education and outreach requirements, with requirements to provide resources to the public and separate requirements to providing training to municipal staff. For our typology, public education was selected as a primary category, while staff training activities were placed under the overall project management category.

We combined public activities including education, outreach, involvement, participation, and engagement into a single category, "public education and involvement," to cover occurrences where public outreach and public involvement

costs were combined, or where it was unclear whether the costs related to outreach or involvement (e.g., "public engagement").

The Phase II permit requires involvement in the regional integrated water management plan or other watershed-level planning effort (if applicable) under public involvement and participation. We included regional/watershed planning in the watershed/TMDL collaboration planning.

The Phase II permit includes maintenance of stormwater drainage facilities in the pollution prevention and good housekeeping of municipal facilities section, while we created a stand-alone category (operations and maintenance) for such activities.

As with any exercise in data aggregation, assumptions can introduce uncertainty. Classifying activities is subjective. For instance, integrated pest management could fall under several categories, such as pollution prevention and good housekeeping, or education and outreach. We strove for consistency through a multi-step classification and verification procedure that first categorized spending activities that were clearly identifiable, then used an iterative approach to revamp or add categories as the list of reported spending activities was assessed.

As a final note, evaluating costs of stormwater management would improve if cost categories are standardized, and such standardization may continue to evolve as MS4 permittees adopt guidance issued by regulatory agencies. In California, in response to the recommendations made by the State Auditor in 2018, the State Water Board released guidance in 2019 for the Regional Water Boards on how to: 1) obtain adequate, consistent, and comparable information on stormwater management costs incurred by MS4 permittees so the Water Boards can make informed decisions related to the costs of MS4 permit compliance; and 2) increase consistency and transparency for estimating TMDL implementation costs. Categories of relevant permit and TMDL compliance costs are included in the guidance (State Water Board, 2019a, 2019b). The categories include program management, minimum control measures, project spending (green and gray), monitoring, watershed management planning, alternative compliance plan development, reporting costs, and others. Guidance such as this may inform future reporting by municipalities (i.e., these categories could be used for reporting costs), but across the United States, accepted categorizations such as costs for minimum control measures and capital investments will likely be included in any typology.

Table 6. Typology of stormwater cost categories used in this analysis

Expense Category	Typical Activities
Capital costs	• Invest in new green and gray infrastructure or other structural BMPs/SCMs
Public education and involvement	• Develop programs, brochures, billboards, videos, web pages • Encourage volunteerism, public commentary, input on policy, and activism in the community • Public engagement and other public-related activities including education, outreach, involvement, and participation
Illicit discharge detection and elimination	• Investigate calls reporting potential illicit discharge • Issue enforcement actions
Construction site stormwater runoff control	• Develop and update best management practices handbooks and resources • Issue grading permits • Review stormwater pollution prevention plans • Issue enforcement actions • Send winterization letters • Develop and maintain database to track inspections and enforcement actions
Pollution prevention and good housekeeping for municipal operations	• Street sweeping • Pesticide and fertilizer management • Ditch cleaning • Used oil recycling • Secondary containment implementation with spill response kits and procedures • Facility mapping
Operations and maintenance	• BMP inspections • Facility drain maintenance • GI maintenance • Municipal facility inspections
Post-construction stormwater management for new and re-development	• Develop and update handbooks and resources • Review plans and issue permits • Issue enforcement actions • Develop and maintain database to track new infrastructure
Water quality monitoring	• Prepare quality assurance plans and sampling plans • Collect samples • Conduct sample laboratory analysis • Perform data analysis and reporting
Industrial and commercial management	• Conduct inspections • Develop and update handbooks and resources • Issue enforcement actions • Manage permitting and oversight • Conduct reporting

Watershed/TMDL collaboration	• Manage regional programs for TMDL compliance and/or watershed planning for multiple benefits
Overall stormwater program management	• Assess program effectiveness • Conduct annual reporting • Execute permit compliance administration • Achieve budget planning
Unable to decipher	• Reported description of spending is insufficient to place into a single category • Reported spending may fall into multiple categories

Results

The results below describe ranges of total annual budgets and expenditures by jurisdictional type, geographic region, and cost category. Costs by population and jurisdictional area are also presented, along with changes in spending over time for case study areas. All budgets, expenditures, and other costs reported in the results section were normalized to 2018 dollars as described in Section III (Methods) unless noted otherwise. Nominal, actual-year dollar amounts for all budget and expenditure data is included in Appendix D.

Due to the various ways that MS4s report budgets and expenditures, no single year provides a good estimate of identifiable stormwater spending across California. Some entities provide significant detail in categorizing types of expenses, while others provide only summary numbers. Similarly, some entities report multiple years of budgets or spending, while others provide only a recent year. The data standardization procedures and underlying assumptions to categorize spending activities and identify representative years of data affect the ultimate outcomes (see discussions in Section III, Methods).

The tables and figures presented in this section may use different expenditure data sets depending on the type of analysis, and thus may report slightly different summary statistics. For example, entities may have reported categorized expenditures that do not add up to the total reported expenditures. For region-based analyses, total reported budget and expenditure data for each region was used. For category-based analyses, categorical data was used. Overall, total discrepancies between data sets are limited to less than 5%. Data sources for each table and figure can be found in Appendix D.

Budgets and Expenditures by Jurisdiction Type

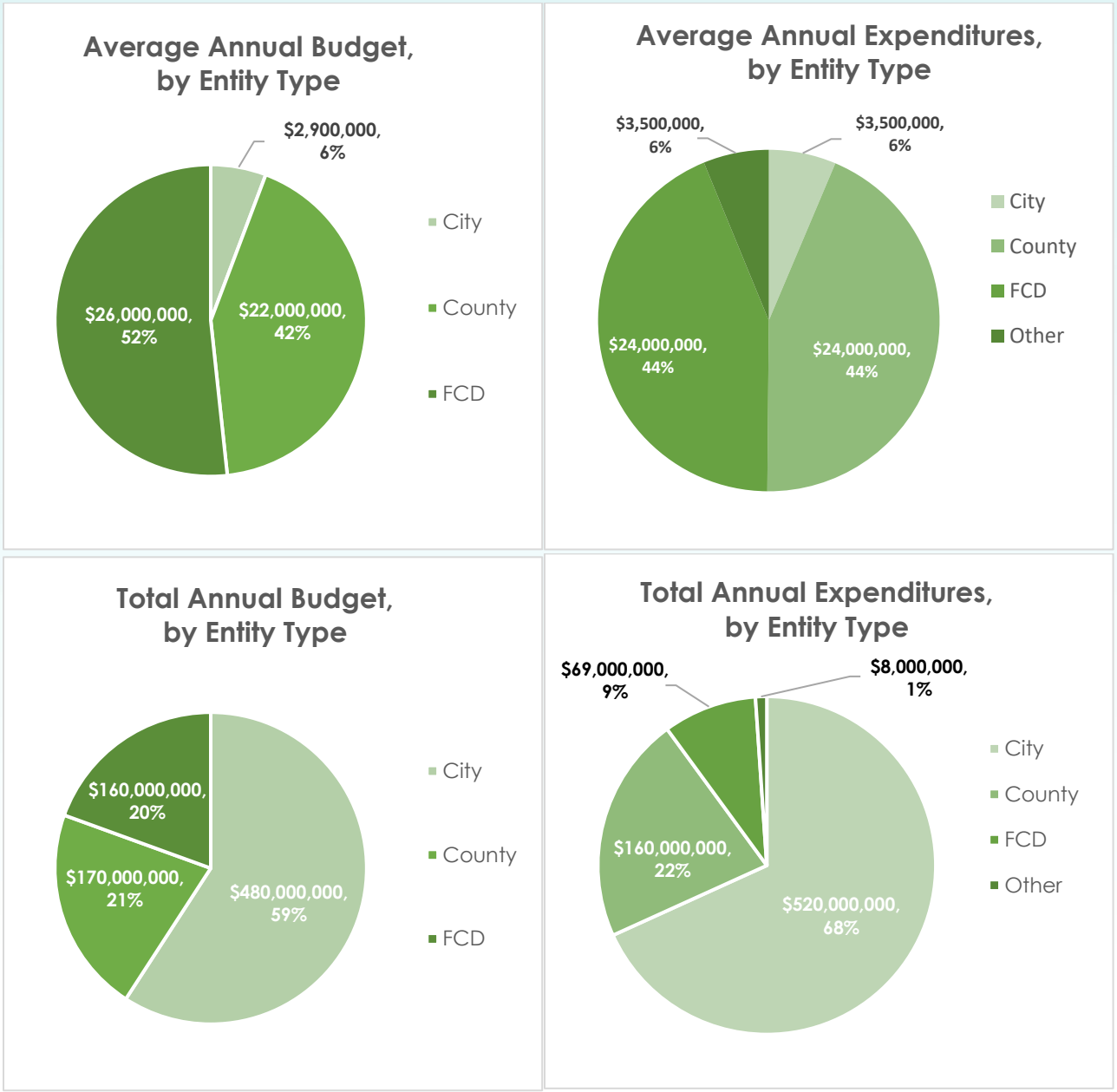
Table 7 presents summary statistics for MS4 budgets and spending. Statistics for flood control districts (FCDs), port authorities, and airports were not calculated due to insufficient sample sizes. County budgets were generally greater than city budgets. In a given year, 2018-normalized annual city budgets ranged from $39,000 to $110 million (mean = $2.9 million, median = $1.0 million), while annual county budgets ranged from about $1.3 million to over $93 million (mean = $22 million, median = $9.2 million). 2018-normalized annual expenditures for cities ranged from $48,000 to $88 million (mean = $3.1 million, median = $890,000), while county expenditures ranged from $400,000 to $51 million (mean = $18 million, median = $13 million).

Table 7. Summary statistics for reported annual budgets and expenditures

Statistic	City Budgets	County Budgets	City Expenditures	County Expenditures
Mean	$2.9M	$22M	$3.1M	$18M
Median	$1.0M	$9.2M	$0.89M	$13M
Standard Deviation	$9.5M	$31M	$9.5M	$18M
Maximum	$110M	$93M	$88M	$51M
Minimum	$0.039M	$1.3M	$0.048M	$0.40M
25% Quartile	$0.40M	$4.0M	$0.42M	$5.5M
75% Quartile	$2.6M	$24M	$2.5M	$28M
Number of Records	164	8	171	9

Values reported here are only for cities and counties, not flood control districts or others, due to the low sample size for these latter entities. Statistics are for data from the most representative year for each jurisdiction, normalized to 2018 dollars.

Figure 4 compares the real values (i.e., normalized to 2018 dollars) across entity types. On average, a county or flood control district spent significantly more on stormwater programs than a single city. However, summing costs within entity types, total spending by cities was greater than counties or flood control districts. Thus, the reported data indicates that while counties and flood control districts have larger budgets and centralize some regional aspects of stormwater programs, cities are the most significant contributor to overall spending. Due to the limited number of MS4s reporting data publicly relative to the total number of MS4s within California, this observation may not hold true statewide (although it is expected when considering the number of regulated cities to counties and other MS4 types).



All budgets and spending normalized to 2018 dollars.

Figure 4. Average and total annual budgets and expenditures, by entity type.

Comparing reported budgets and expenditures across the entities, flood control districts tended to budget more than they reported to spend, while cities and counties spent approximately what they budgeted (Figure 4, Table 8 and Table 9). The reasons for this were not clear from the available reports. Across all permittees, there was significant variation in both expenditures and budgeting.

Table 8. Total and average stormwater budgets

Statistic	City Budgets	County Budgets	Flood Control District Budgets	Others Budgets
Total (Sum)	$480M	$170M	$160M	--
Mean	$2.9M	$22M	$26M	--
Minimum	$0.039M	$1.3M	$2.0M	--
Maximum	$110M	$93M	$88M	--
Sample size	164	8	6	0

Values are reported by entity type, in real dollars (normalized to 2018). The summary statistics are based on the most representative year for each entity, providing a method to estimate statewide budgets.

Table 9. Total and average stormwater expenditures

Statistic	City Expenditures	County Expenditures	Flood Control District Expenditures	Others Expenditures
Total (Sum)	$520M	$170M	$69M	$8.3M
Mean	$3.1M	$18M	$17M	$4.1M
Minimum	$0.048M	$0.40M	$1.9M	$3.0M
Maximum	$88M	$51M	$27M	$5.2M
Sample size	171	9	4	2

Values are reported by entity type, in real dollars (normalized to 2018). The summary statistics are based on the most representative year for each entity, providing a method to estimate statewide budgets.

Total and average statistics for budgets and expenditures reveal important insights across entity types. County and flood control districts budgeted more per agency than cities, with counties and flood control districts budgeting on average $22 and $26 million each, and cities budgeting on average $2.9 million (Table 8). There is a similar

trend for actual expenditures, with average county and flood control district expenditures of $18 million and $17 million, respectively, and average city expenditures of $3.1 million (Table 9).

Finally, both city and county spending were right-skewed (Figure 5); median values were quite low compared to the mean and maximum. The range of spending by cities was greater than that of counties, though for cities, several very large entities increased the mean significantly in comparison to the median. Only reported expenditures are provided, as they represent actual spending, rather than projected spending that is represented by budgets.

Statistics are for data from the most representative year for each jurisdiction, normalized to 2018 dollars.

Figure 5. Distribution of reported expenditures across cities and counties. Mean values are indicated by an X, while median values are represented by lines.

Budgets and Expenditures by Region

Evaluating spending by geographic regions revealed noticeable trends in spending and data availability. The analysis aggregated data for MS4s in a region according to Regional Water Quality Control Board boundaries. Table 10 shows the total and average annual spending across regions.

Table 10. Total and average identified budgets and expenditures (normalized to 2018 dollars) grouped by Regional Water Quality Control Boards in California

Region	Statistic	Budget	Expenditures
Region 1 North Coast	Sum	--	$0.84M
	Average	--	--
	Sample size	--	1
Region 2 San Francisco Bay	Sum	$9.8M	$6.6M
	Average	$4.9M (± $0.79M)	--
	Sample size	2	1
Region 3 Central Coast	Sum	$1.1M	$4.6M
	Average	--	--
	Sample size	1	1
Region 4 Los Angeles	Sum	$420M	$300M
	Average	$4.6M (± $15M)	$3.8M (± $12M)
	Sample size	90	78
Region 5 Central Valley	Sum	$130M	$140M
	Average	$12M (± $15M)	$11M (± $12M)
	Sample size	11	13
Region 6 Lahontan	Sum	--	--
	Average	--	--
	Sample size	--	--
Region 7 Colorado River Basin	Sum	$0.16M	$0.15M
	Average	--	--
	Sample size	1	1
Region 8 Santa Ana	Sum	$220M	$130M
	Average	$3.9M (± $12M)	$2.3M (± $4.6M)
	Sample size	58	58
Region 9 San Diego	Sum	$30M	$180M
	Average	$2.0M (± $1.6M)	$5.4M (± $14M)
	Sample size	15	33
All Regions	**Total Spending**	**$810M**	**$770M**

Average annual expenditures ranged from $150,000 to $11 million based on as few as one or as many as seventy-eight reporting entities in a region (Table 10). Region 4 (Los Angeles) and Region 8 (Santa Ana) had the highest reported spending and budgets. This is because the preponderance of publicly-available reports collected were from entities located in those regions. Available data in other regions was more sporadic. Region 1 (North Coast), Region 2 (San Francisco Bay), Region 3 (Central Coast), Region 6 (Lahontan), and Region 7 (Colorado River Basin) each had only one or two entities, if any, reporting expenditures and/or budget, even though many communities do have robust stormwater programs in these areas. Given the diversity of reporting entities across regions, summary estimates or total and average annual spending are recognized to be an underestimate. In total, annual expenditures reported by entities is $770 million (2018 dollars).

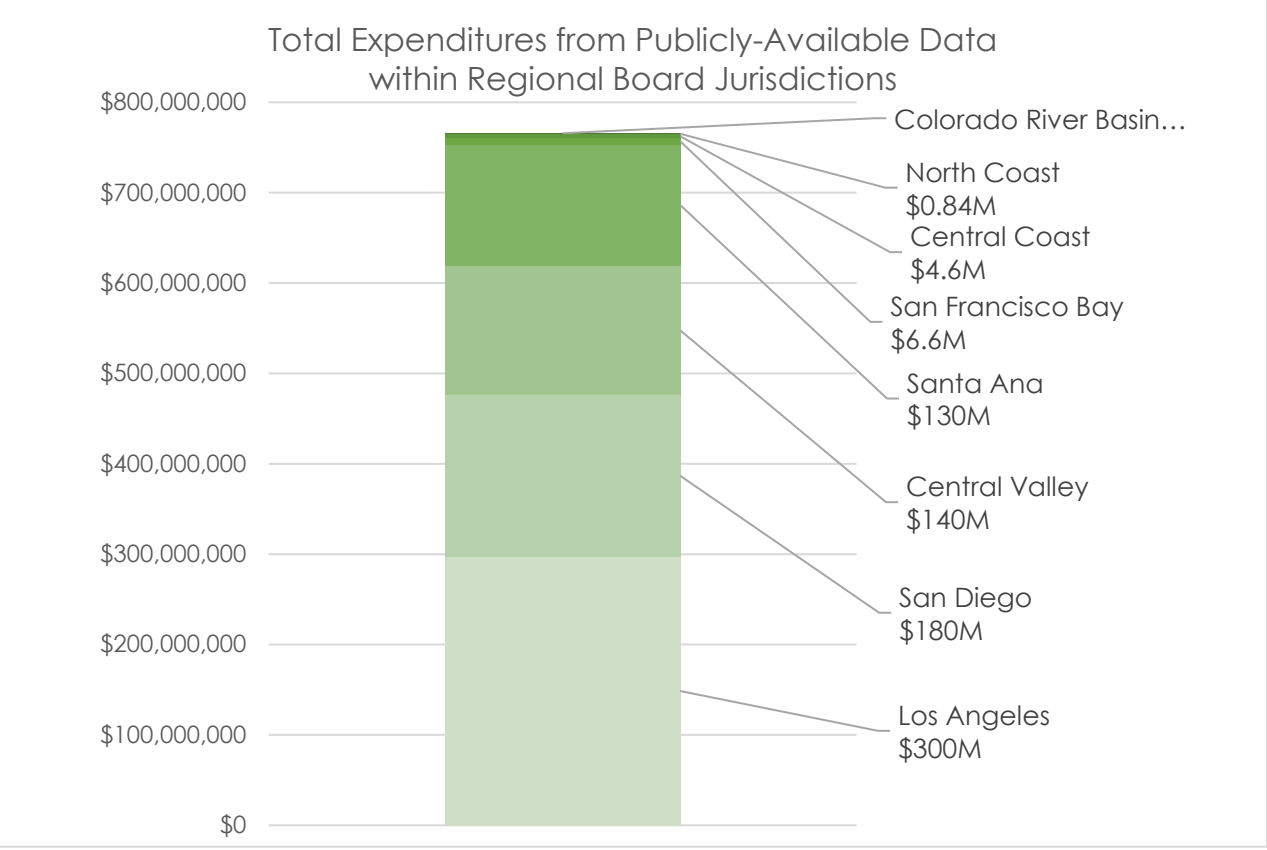


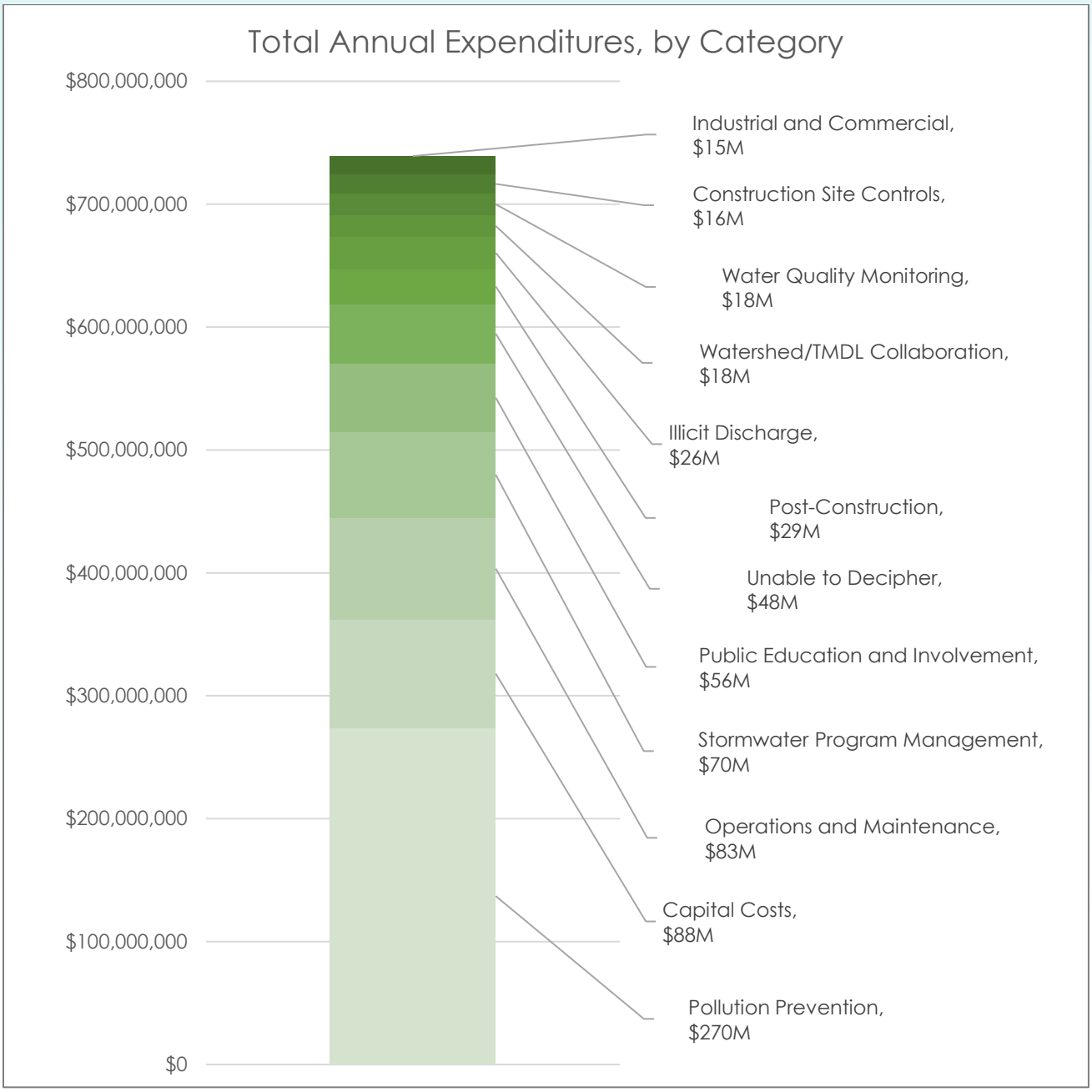
Figure 6. Estimated expenditures (normalized to 2018 dollars) by Regional Board

Spending by Category

While some pre-2012 categorized data is available in Appendix D, only data from 2012 and later was considered for category statistics. Table 11 presents the average annual expenditures based on the available data and identified cost categories. The average annual expenditures across categories ranged from $120,000 to $990,000. The greatest percentage of total annual stormwater expenditures in California went toward pollution prevention and good housekeeping activities such as street sweeping and other municipal activities (approximately 35 percent). Conversely, industrial and commercial activities and post-construction stormwater management were allocated the smallest portions of spending. Table 11 also provides the breakdown of total annual expenditures across categories (i.e. the sum of each MS4 costs for the most representative year, in 2018 dollars). Figure 7 depicts this breakdown, with total annual expenditures of nearly $740 million for all reporting MS4s.

Table 11. Average and total annual expenditures by category, normalized to 2018 dollars

Category	Average Annual Expenditures (standard deviation)	Total Annual Expenditures	Sample Size
Capital costs	$0.77M (± $4.1M)	$88M	114
Public education and involvement	$0.30M (± $2.9M)	$56M	186
Illicit discharge	$0.22M (± $0.96M)	$26M	118
Construction site controls	$0.24M (± $0.53M)	$16M	66
Pollution prevention	$0.74M (± $3.0M)	$270M	371
Operations and maintenance	$0.99M (± $2.9M)	$83M	84
Post-construction	$0.13M (± $0.42M)	$29M	213
Water quality monitoring	$0.17M (± $0.50M)	$18M	106
Industrial and commercial	$0.12M (± $0.37M)	$15M	123
Watershed/TMDL collaboration	$0.26M (± $0.57M)	$18M	69
Stormwater program management	$0.28M (± $1.2M)	$70M	250
Unable to decipher	$0.26M (± $0.95M)	$48M	186



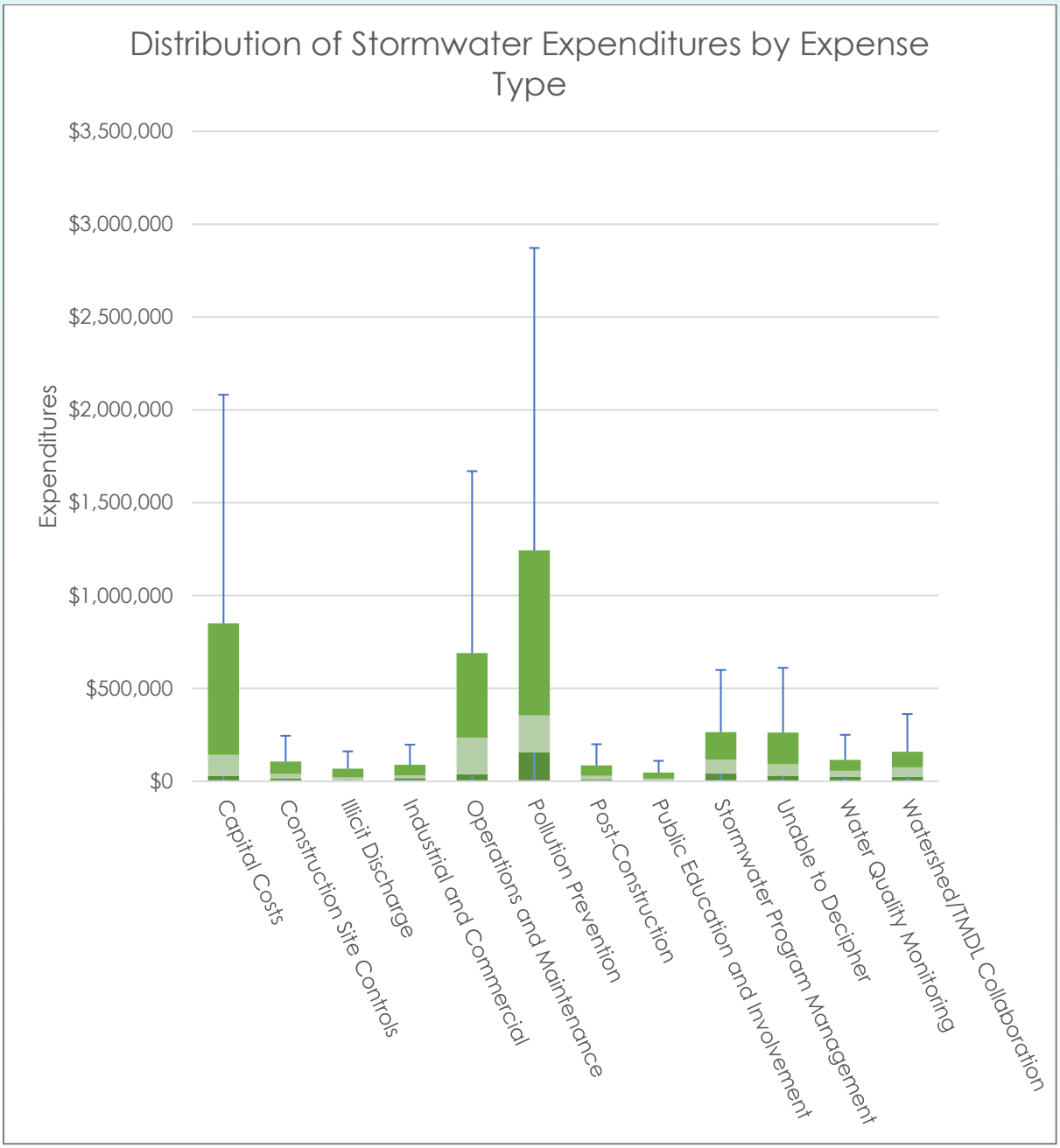
Values shown are real dollars (i.e., normalized to 2018 dollars) for the most representative year of each entity.

Figure 7. Identified total annual stormwater expenditures, by category.

Figure 8 presents the distribution of spending for each cost category. For each category, the distribution was skewed right, indicating the presence of several outliers with high reported spending (the medians are low compared to the mean and maximum). Again, this is likely explained by reported values from larger communities in Orange County, Los Angeles, and San Diego. The capital costs, operations and maintenance, and pollution prevention categories had the widest variation in spending.

We standardized expenditure data for population (per capita) and area (per square mile) for cities within each region. The analysis was only performed for cities because it was not possible to identify the areas or populations where county or flood control districts were the sole providers of services. In such areas, larger entities may manage all program aspects in unincorporated (non-city) areas, or run stormwater program aspects that span jurisdictions. The area estimates were based on total area associated with a city jurisdiction, not the contributing watershed area managed by the stormwater system, which could be a more refined estimate for unit area values. Future cost assessments should consider gathering contributing areas and analyzing expenditures based on such units.

Table 12 and Figure 9 present the data. Annual per capita expenditures ranged from $3.50–$54 per person, while expenditures per square mile ranged from $14,000 to $630,000 (Table 12). There is significant variation in expenditures for both per capita and per square mile values across the state (Figure 9). More densely populated coastal areas spent more, both per capita and per square mile.



Values are normalized to 2018 dollars. Median values are represented by horizontal lines. Outliers not shown.

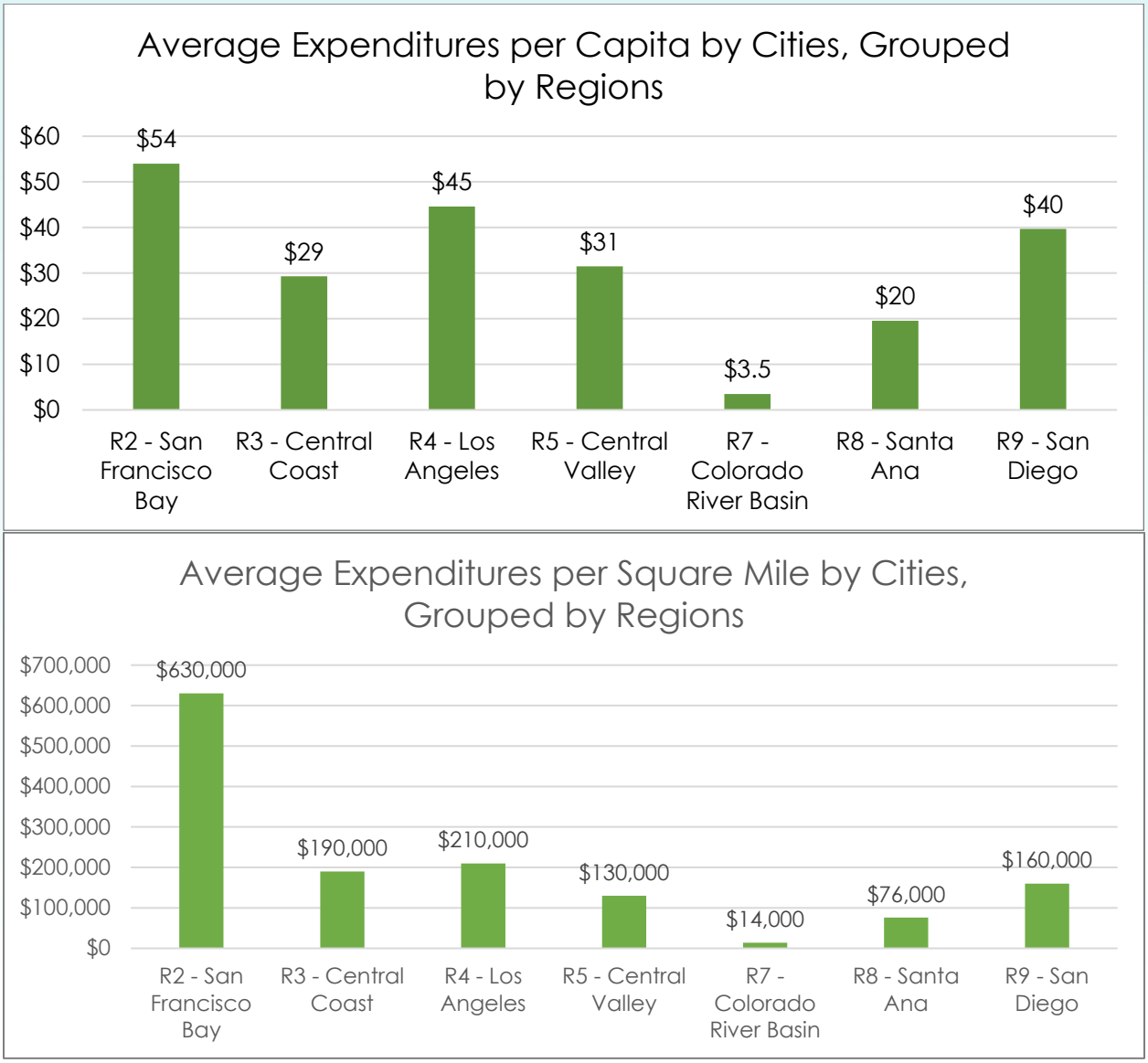
Figure 8. Box and whisker plot showing distribution of reported annual expenditures for all entities by category of stormwater expenditures by population and area.

Table 12. Average and standard deviation values of per capita and unit area expenditures across cities within regional boards

Region	Per Capita Expenditures	Unit Area Expenditures, per Square Mile	Number of Cities Reporting
Region 1: North Coast	**	**	0
Region 2: San Francisco Bay	$54	$630K	1
Region 3: Central Coast	$29	$190K	1
Region 4: Los Angeles	$45 (± $66)	$210K (± $270K)	74*
Region 5: Central Valley	$31 (± $24)	$130K (± $120K)	7
Region 6: Lahontan	**	**	0
Region 7: Colorado River Basin	$3.50	$14K	1
Region 8: Santa Ana	$20 (± $44)	$76K (± $92K)	38
Region 9: San Diego	$40 (± $44)	$160K (± $230K)	9
TOTAL			131

Values are in normalized 2018 dollars.
**Region 4 (Los Angeles) excludes the city of Industry as an outlier.*
***No contributing data points available.*

Figure 10 plots values of total expenditures against total area, categorized by region. Figure 11 plots total expenditures against population. For both figures, expenditures by cities with populations over 600,000 people were considered outliers and therefore omitted. As indicated by the low determinant of correlation values (R^2 values ranged 0.06 to 0.60 for expenditures versus area and 0.07 to 0.59 for expenditures versus population), weak correlations exist between expenditures and area or expenditures and population. This is not surprising given the inconsistencies in the type and number of reported costs. A more detailed socio-economic analysis that includes statistical evaluations and further controlling factors may better uncover any trends that do exist.



Only cities are included in the analysis, as county expenditures may cover programs that serve city populations or unincorporated areas.

Figure 9. Average stormwater expenditures by cities within various regions. Values are normalized by population (top) and area (bottom).

Each category of stormwater utility expenses can have direct costs (infrastructure or compliance activities) and indirect costs for labor and management, rent, equipment,

and benefits that are attributable to a department/utility. Organizations recover indirect costs in many ways. In a municipality, such expenses could be paid through general funds if all employee expenses are centrally managed. In other cases, the stormwater program may be responsible for individual employee and office costs. Managers should consider both direct and indirect costs when developing asset management and funding plans. Chapter 3 provides further information on cost categories and guidance for incorporating indirect costs into project and program estimates.

Categorizing permit compliance and O&M activities

While costs for permit compliance and O&M are considered separately in the categorization just discussed, in some cases, municipalities combine costs. Most municipal stormwater programs must conduct routine maintenance and comply with NPDES permits. Such O&M activities assist with preventive and corrective maintenance and can include anything from opening manholes to investigating pipe conditions to walking drainage canals and evaluating structural integrity. Other example activities include visual inspections, cleaning and debris clearing, and data management. Whether a municipality counts these as permit compliance or existing system O&M depends on several factors. For example, cities may choose to incorporate O&M costs as permit compliance because they must do O&M as a requirement for compliance. Alternatively, cities may have an existing funding source to maintain drainage systems and prefer to categorize maintenance under the existing system O&M category. Categorizing costs ultimately depends on the method that makes sense for the responsible entity. For NPDES compliance, required activities can be categorized according to common components of NPDES permits, often referred to as minimum control measures, as shown in Table 3.

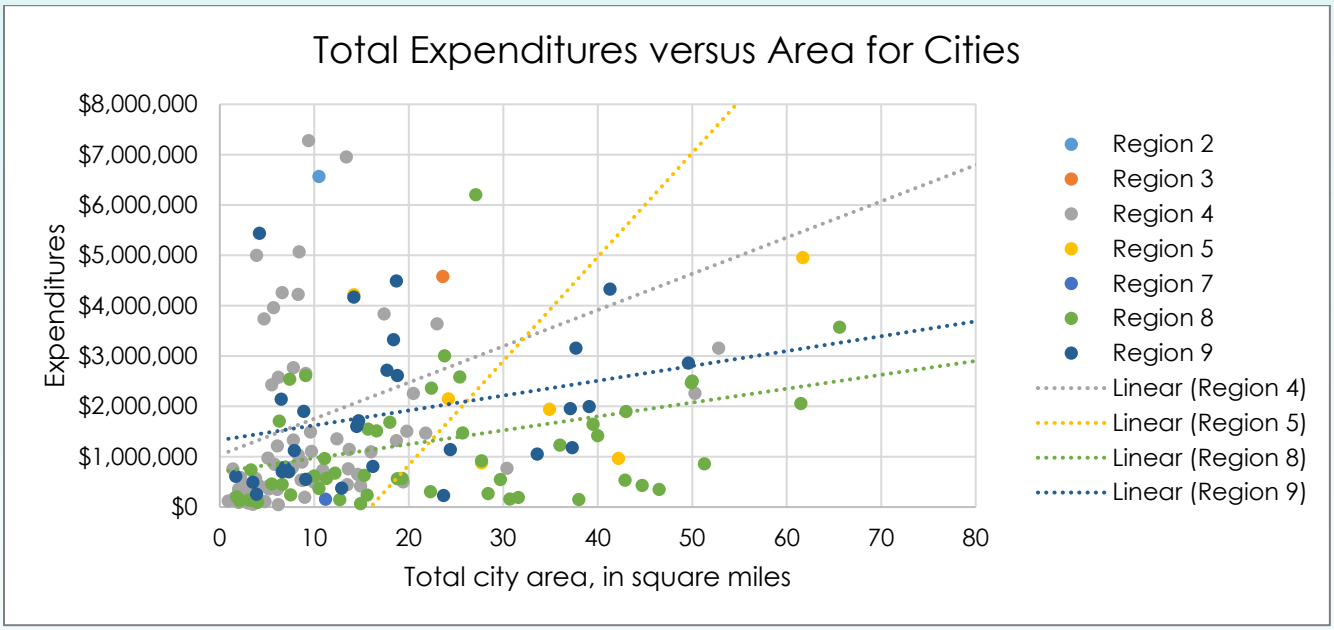


Figure 10. Total expenditures versus total area in a city, by regions. All cities were included in the trend lines, but some cities may not be visible due to chart scaling. Values are normalized to 2018 dollars.

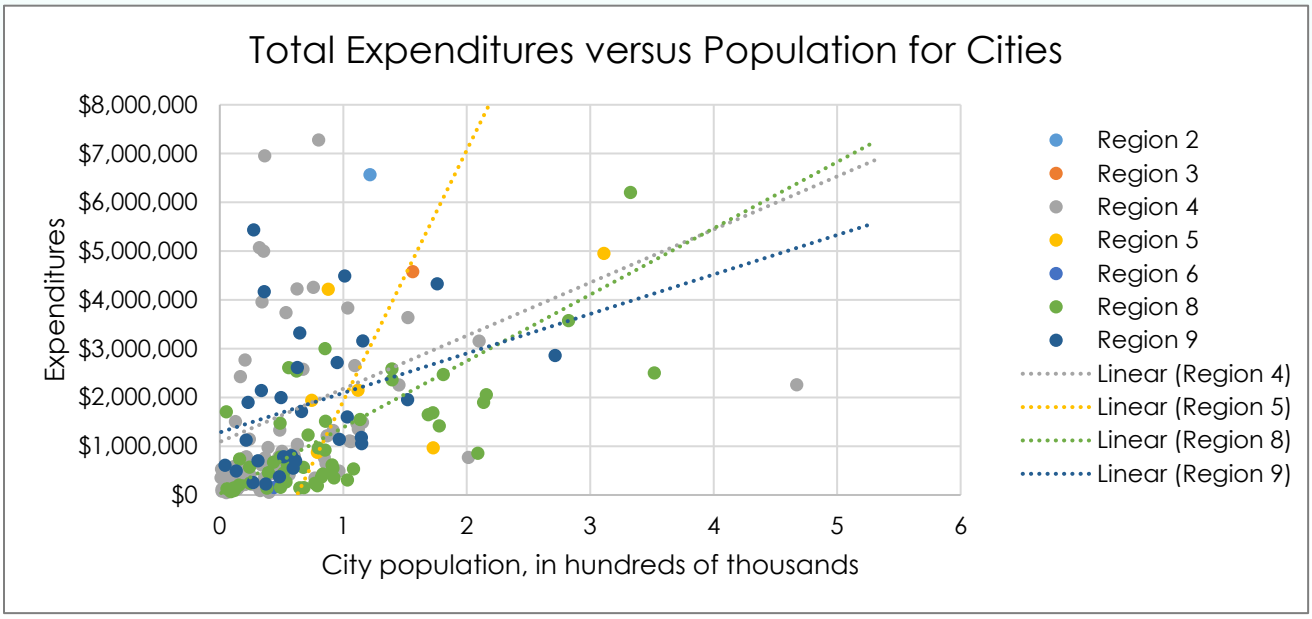


Figure 11. Total expenditures versus population in a city, by regions. All cities were included in the trend lines, but some cities may not be visible due to chart scaling. Values are normalized to 2018 dollars.

Stormwater Expenditures Over Time in Selected Communities

While most entities only report expenditures or budgets for a few recent years, several have more years of data on spending. These included places such as Bakersfield and Kern County, Sacramento City and County, and El Cajon. To examine trends over time for available communities, we plotted real values (i.e., normalized to 2018 dollars) of expenditures, for these selected areas. The results are presented in Figures 12 and 13.

Results are mixed across areas, but in general, many MS4s showed flat or declining levels of normalized expenditures (i.e., in 2018 dollars). A few MS4s (Bakersfield, Folsom, and El Cajon) showed jumps in spending, which are likely explained by changes in increased regulations and levels of service, including the availability and use of grant funding.

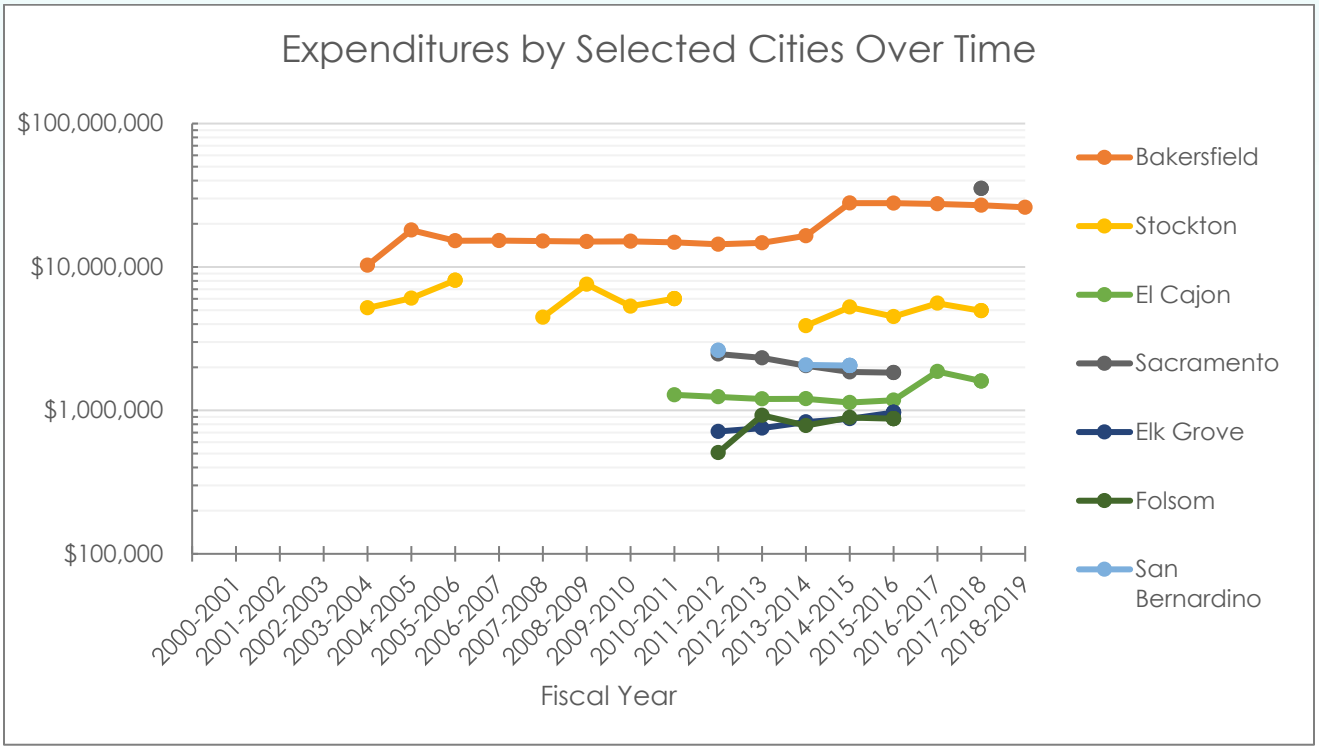


Figure 12. Expenditures over time (normalized to 2018 dollars) in selected cities in California

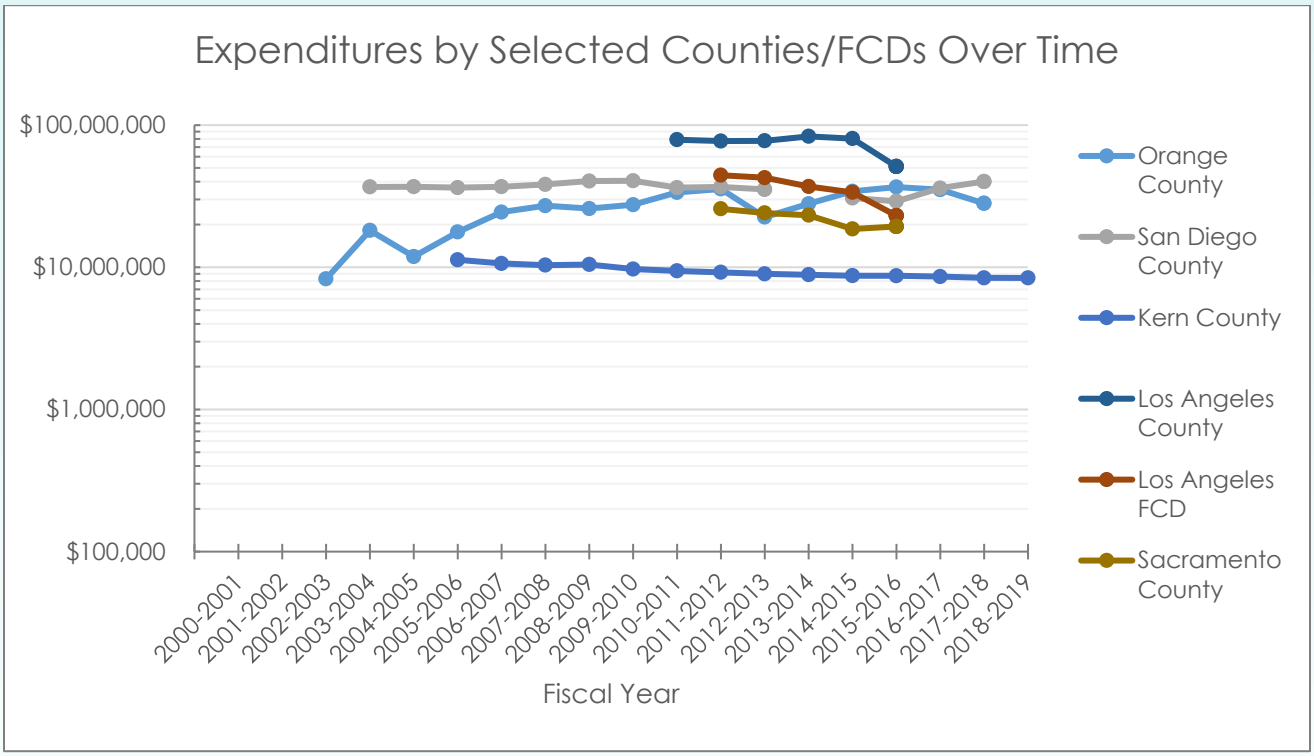


Figure 13. Expenditures over time (normalized to 2018 dollars) in selected counties and a flood control district in California

Conclusions

Results from the analysis provide several valuable insights:

- Annual stormwater spending in California is at least $700 million based on available sources (normalized to 2018 dollars). This is an underestimate due to limited publicly-reported data from California communities and, likely, the types of costs that are included (and excluded). Improved reporting could refine the estimate.
- From available data, counties and flood control districts provide significant contributions to stormwater spending, but cities reported more in aggregate. More complete reporting could shift the relative contributions of each entity.
- Spending reported by southern California communities were higher than spending reported by others. This is likely influenced by regional requirements for cost reporting in public sources (resulting in more data from southern California) as well as increased regulations for watershed planning, Total Maximum Daily Load (TMDL) compliance, and reporting.
- Summary trends across municipal characteristics were limited, with poor correlations between municipal expenditures and population or area of a jurisdiction.
- From available data, most MS4 spending has not increased over time, which is surprising considering the increased regulations and presumably increased levels of service over time. Spending increased in only a few of the communities evaluated, especially in recent years.
- While spending activities span many categories, the largest percentage (about 35 percent) goes to pollution prevention. Some of these costs may include operations and maintenance (O&M) activities that were not explicitly labeled as such, resulting in elevated representation of pollution prevention efforts and underestimation of O&M costs.
- A lack of standardized reporting across and even within Regional Water Quality Board regions inhibits better estimates and confidence in the results and trends observed. The Los Angeles region had recent reporting with the most standardized and comparable dollar values. Communities in other parts of the south coast also had significant available data, though it was less standardized. In the Central Valley, larger communities had available data in annual reports, but it was also less standardized. Finally, areas of the North Coast, San Francisco Bay Area, and Central Coast tended not to have publicly available report values.

- For spending by counties and flood control districts, reported values in many reports often do not differentiate between spending with a regional focus or spending for local needs. This limits opportunities to compare normalized spending values (per capita and unit area) by cities versus counties. Better comparisons could be made if, to the extent possible, counties and flood control districts note activities targeted for particular communities such as unincorporated areas as compared to activities they undertake on behalf of all regional cities.
- Further and more accurate understanding of budgets and expenditures for stormwater management in California would require greater consistency in types of activities reported (i.e., standardizing categories and the types of activities that apply to each category), as well as more communities reporting data. While this may burden some communities, it may also provide benefits if such data can be used to support funding and financing initiatives. To simplify the reporting process, costs could be aligned with specific sections of MS4 permits. An example of cost categories that could align with reorganized permit sections and activities that could be reported within each category is presented in Table 13.
- Reported data does not consistently differentiate between flood control and water quality activities. Past studies of stormwater spending have focused on costs of complying with MS4 permits rather than including both the water quality and flood control functions that stormwater systems provide. If spending on such activities were more explicitly detailed, stormwater managers would better understand how to plan joint projects with other local departments, such as local flood control managers.

Table 13. Example of establishing cost categories that align with permit requirements and typical expenses for each category

Cost Category/Permit Section	Typical Expenses
Capital costs (no applicable permit section)	• Designing and replacing gray or green infrastructure • Designing and constructing new infrastructure for TMDL compliance • Designing and constructing new infrastructure for multi-benefit, One Water, and/or Stormwater Resource Plan projects
Public education, outreach, participation, and involvement program	• Participating in a county or regional program or developing a community-specific public education and outreach program • Implementing the public education and outreach program • Developing and implementing a public involvement and participation program • Developing and conducting training for municipal staff responsible for public education, outreach, participation, and involvement programs • Reporting information specifically required for public education, outreach, participation, and involvement programs
Illicit discharge detection and elimination program	• Developing an illicit discharge detection and elimination program • Mapping and inspecting municipal outfalls • Developing inventories and conducting inspections of potential sources of illicit discharges, including those at commercial, industrial, and other facilities • Reporting information specifically required in the illicit discharge detection and elimination program • Developing and conducting training for municipal staff responsible for illicit discharge detection and elimination
Construction site runoff control program	• Developing and maintaining an inventory of projects subject to the local construction site storm water runoff control ordinance within its jurisdiction • Developing and implementing procedures to review and approve relevant construction plan documents • Developing and implementing inspection procedures for verifying compliance with MS4 construction site stormwater control ordinances • Developing and implementing enforcement procedures to ensure compliance with MS4 construction site stormwater control ordinances • Developing and conducting training for municipal staff responsible for construction site runoff control programs • Developing and distributing education materials for construction site operators • Reporting information specifically required for the construction site runoff control program

Pollution prevention/good housekeeping program for municipal operations	• Developing and maintaining an inventory and map of MS4-owned or operated facilities within their jurisdiction that are a threat to water quality • Conducting inspections and assessments of pollutant discharge potential at relevant facilities • Identifying pollutant hotspots within relevant facilities • Developing and implementing Stormwater Pollution Prevention Plans (SWPPPs) for hotspots • Conducting inspections, visual monitoring, and remedial actions of and for MS4-owned and operated facilities • Developing and implementing procedures to assess and prioritize MS4 storm drain system maintenance • Coordinating with the flood conveyance management entities • Maintaining high priority storm drain systems and components • Assessing and inspecting O&M activities for potential to discharge pollutants • Implementing BMPs to address O&M activities that have the potential to discharge pollutants • Incorporating water quality and habitat enhancement features in new flood management facilities • Developing and implementing a landscape design and maintenance program to reduce the amount of water, pesticides, herbicides, and fertilizers used • Developing and implementing training for municipal staff responsible for pollution prevention/good housekeeping • Reporting information specifically required for the pollution prevention/good housekeeping program
Post-construction runoff control program	• Developing and implementing a program to regulate new and re-development design, including requirements for site design, source control, LID design standards, and hydromodification • Developing and/or modifying enforceable mechanisms to effectively implement the relevant requirements • Developing and implementing an O&M verification program for stormwater treatment and baseline hydromodification management structural control measures • Establishing and implementing, in coordination with the appropriate mosquito and vector control agencies, a protocol for notification of installed treatment systems and hydromodification management controls • Developing and implementing a process for obtaining conditions of approval or other legally enforceable agreements/mechanisms for all projects that require the granting of site access • Developing and implementing O&M plans for regional projects and controls that are MS4-owned and/or operated • Developing and maintaining a database or equivalent tabular format of all projects with treatment systems • Reviewing planning and permitting processes and addressing issues as necessary

	• Developing and implementing post-construction stormwater management requirements based on assessment and maintenance of watershed processes • Developing and implementing an alternative compliance post-construction stormwater management program • Developing and implementing training for municipal staff responsible for the post-construction runoff control program • Reporting information specifically required for the post-construction runoff control program
Water quality monitoring program	• Developing and implementing plans for monitoring discharges to ASBS, TMDL, or 303(d) impaired water bodies, as required by state regulations • Developing and implementing plans for conducting receiving water and special study monitoring • Developing and implementing training for municipal staff responsible for the water quality monitoring program • Reporting information specifically required for the water quality monitoring program
TMDL compliance and watershed planning and coordination	• Developing and implementing plans to comply with TMDL requirements • Developing and implementing training for municipal staff responsible for TMDL compliance and watershed planning/coordination • Reporting information specifically required for the TMDL compliance and watershed planning
Program management	• Reviewing, revising, creating, and adopting ordinances and mechanisms to obtain legal authority to control pollutant discharges into and from the MS4 and permit requirements • Certifying the MS4 has such legal authority • Developing and implementing enforcement response plans • Developing and implementing a program effectiveness assessment and improvement plan • Conducting miscellaneous activities required for permit compliance, not covered by the above categories • Developing and implementing training for municipal staff responsible for stormwater management activities not covered in other categories above • Developing and conducting training for MS4 staff responsible for program management • Developing and submitting annual reports

References

Ajami, Newsha and Juliet Christian-Smith. 2013. *Beyond Water Pricing: An Overview of Water Financing Options in California.* Oakland, CA: Pacific Institute. November. https://pacinst.org/wp-content/uploads/2013/11/beyond-water-financing-pacinst-full.pdf.

California Regional Water Quality Control Board, Los Angeles Region. 2012. *Waste Discharge Requirements for Municipal Separate Storm Sewer System (MS4) Discharges Within the Coastal Watersheds of Los Angeles County, Except Those Discharges Originating from the City of Long Beach MS4.* Order Number R4-2012-0175 as amended by State Water Board Order WQ 2015-0075 and Los Angeles Water Board Order R4-2012-0175-A01. NPDES Permit Number CAS004001. https://www.waterboards.ca.gov/losangeles/water_issues/programs/stormwater/municipal/la_ms4/2015/OrderR4-2012-0175-FinalOrderasamendedbyOrderWQ2015-0075.pdf.

California State Auditor. 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.* Report Number 2017-118. https://www.auditor.ca.gov/pdfs/reports/2017-118.pdf.

California State Water Resources Control Board (State Water Board). 2013. *National Pollutant Discharge Elimination Systems (NPDES) General Permit for Waste Discharge Requirements (WDRs) for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (MS4s), Water Quality (WQ) Order 2013-0001-DWQ NPDES NO. CAS000004 as Amended by Order WQ 2015-0133-EXEC, Order WQ 2016-0069-EXEC, WQ Order 2017-XXXX-DWQ, Order WQ 2018-0001-EXEC, and Order WQ 2018-0007-EXEC.*

California State Water Resources Control Board (State Water Board). 2018. *Staff Report. Project 4b: Eliminate Barriers to Funding Stormwater Programs and Identify Funding for Stormwater Capture and Use Projects*. May 31. https://www.waterboards.ca.gov/water_issues/programs/stormwater/storms/

California State Water Resources Control Board (State Water Board). 2019a. *Guidance for Obtaining Phase I Municipal Separate Storm Sewer System Permit (MS4) Compliance Costs.* December.

California State Water Resources Control Board (State Water Board). 2019b. *Guidance for Total Maximum Daily Load (TMDL) Municipal Storm Water Compliance Cost Estimation.* April.

California Water Service. "Low-Income Rate Assistance (LIRA)." Accessed August 2018. https://www.calwater.com/community/lira/.

Campbell, C. Warren, Randel L. Dymond, and Amanda Dritschel. 2016. *Western Kentucky University Stormwater Utility Survey.* Bowling Green, KY: Western Kentucky University. https://www.wku.edu/seas/documents/swusurvey-2016.pdf.

City of Grand Rapids, MI, Environmental Protection Services Department. 2016. *Stormwater Asset Management and Capital Improvement Plan*. https://www.grandrapidsmi.gov/Government/Boards-and-Commissions/Stormwater-Oversight-Commission/Stormwater-Oversight-Commission-Documents.

Currier, Brian K., Joseph M. Jones, Glenn Moeller, and Bruce Fujimoto. 2005. *NPDES Stormwater Cost Survey: Final Report.* Office of Water Programs, California State University, Sacramento. Prepared for the California State Water Resources Control Board. https://www.owp.csus.edu/research/papers/papers/NPDES_Stormwater_costsurvey.pdf.

Hanak, Ellen, Brian Gray, Jay Lund, David Mitchell, Caitrin Chappelle, Andrew Fahlund, Katrina Jessoe, Josué Medellín-Azuara, Dean Misczynski, James Nachbaur, and Robyn Suddeth. 2014. "Paying for Water in California." San Francisco: Public Policy Institute of California. https://www.ppic.org/content/pubs/report/R_314EHR.pdf.

Jacques, Justin. 2018. "US Cities Mitigate Risk and Runoff with Environmental Impact Bonds." *Stormwater Management*. 12–13.

Office of Water Programs Environmental Finance Center at California State University, Sacramento (OWP EFC). 2019. *Estimating Costs and Benefits of Stormwater Management, Part I: Methods and Challenges*. July. https://www.efc.csus.edu/reports/efc-cost-project-part-1.pdf

National Academy of Public Administration. 2017. *Developing a New Framework for Community Affordability of Clean Water Services*. October. https://www.napawash.org/uploads/Academy_Studies/NAPA_EPA_FINAL_REPORT_110117.pdf.

National Research Council (NRC). 2008. *Urban Stormwater Management in the United States.*

Quesnel, Kim and Newsha Ajami. 2015. "Funding Water in Times of Financial Uncertainty: The Case for a Public Goods Charge in California." Woods Institute for the Environment. Palo Alto, CA: Stanford University. https://waterinthewest.stanford.edu/sites/default/files/Ajami-PGC-WhitePaper-FINAL02172015.pdf.

Quesnel, Kim and Newsha Ajami. 2018. "Advancing Water Innovation Through Public Benefit Funds: Examining California's Approach for Electricity." *Journal of the American Water Works Association*. 110 (2): E18–E32. https://awwa.onlinelibrary.wiley.com/doi/abs/10.5942/jawwa.2018.110.0009.

San Francisco Public Utilities Commission (SFPUC). 2017. *Wastewater Enterprise: Green Bonds Annual Report.* Public Utilities Commission of the City and County of San Francisco. https://sfwater.org/modules/showdocument.aspx?documentid=12129.

Tarr, Joel A. 1984. "The Evolution of the Urban Infrastructure in the Nineteenth and Twentieth Centuries." In *Perspectives on Urban Infrastructure,* National Research Council (NRC), 4–66. Washington, DC: The National Academies Press. https://www.nap.edu/read/561/chapter/3.

Tarr, Joel A., James McCurley III, Francis C. McMichael and Terry Yosie. 1984. "Water and Wastes: A Retrospective Assessment of Wastewater Technology in the U.S., 1800–1932." *Technology and Culture*. 25 (2): 226–263. https://www.jstor.org/stable/pdf/3104713.pdf.

Teodoro, M. 2018. "Measuring Household-Level Water and Sewer Utility Affordability." Proceedings of the Water Environment Federation, 2018 (1): 1024–1026. https://doi.org/10.2175/193864718823773337.

United States Bureau of Labor and Statistics (USBLS). 2019. Consumer Price Index. https://www.bls.gov/cpi/overview.htm

United States Census (US Census). 2014. *American Community Survey*. US Census Bureau, Washington, D.C.: Government Printing Office.

United States Conference of Mayors. 2014. *Public Water Cost per Household: Assessing Financial Impacts of EPA Affordability Criteria in California Cities.* https://www.cacities.org/getattachment/Member-Engagement/Regional-Divisions/Los-Angeles-County/Water-Cost-Per-Household-Report-California-Cities.pdf.aspx.

United States Environmental Protection Agency. 2016. *Funding Stormwater Management with the Clean Water State Revolving Fund.* https://www.epa.gov/sites/production/files/2016-11/documents/funding_stormwater_management_with_the_clean_water_state_revolving_fund.pdf.

United States Environmental Protection Agency. 2012. Memorandum, "Integrated Municipal Stormwater and Wastewater Planning Approach Framework." https://www.epa.gov/sites/production/files/2015-10/documents/integrated_planning_framework.pdf.

United States Environmental Protection Agency New England. 2009. *Funding Stormwater Programs*. https://www3.epa.gov/region1/npdes/stormwater/assets/pdfs/FundingStormwater.pdf

United States Environmental Protection Agency. 2003. *Asset Management: A Handbook for Small Water Systems – STEP Guide Series*. https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100U7T2.txt.

United States Environmental Protection Agency. 1997. *Combined Sewer Overflows Guidance for Financial Capability Assessment and Schedule Development (Final)*. https://www3.epa.gov/npdes/pubs/csofc.pdf.

Van der Tak, Laurens. 2015. "User-Fee-Funded Stormwater Programs, the 2013 WEF Manual, and Lessons Learned from Recent Stormwater Utilities." CH2M HILL. Lecture, Radisson Hotel and Suites, Chelmsford, MA, March 25.

Appendices

Appendix A: Supplemental graphs of reported spending

Appendix B: Reported spending activities and associated categories

Appendix C: List of entities included in the analysis

Appendix D: Data tables with reported costs of activities as well as data-driven charts and tables

Appendix A: Supplemental graphs of reported spending

Appendix A provides supplemental graphs for per capita and unit area spending. Plotting the values for all cities and calculating regression equations indicates positive relationships for both (Figure A1, R^2 = 0.77 for per capita spending versus population, R^2 = 0.84 for unit area spending versus total area). After removing several large outliers, however, the relationships show much poorer fit (Figure A2, R^2 of 0.13 and 0.03).

Figure A1 shows total spending by population and area within a city. These figures include outliers of especially large cities from Southern California. Including outliers tends to increase the coefficient of determination (R^2) value, but provides limited resolution to understand correlations for the majority of cities with small populations at the lower left portion of the graphs. Figure A2 shows the same results if high-population (>600,000) outliers are not considered.

Figure A1: Total expenditures versus population (top) and total expenditures versus area (bottom). Expenditures include all cities

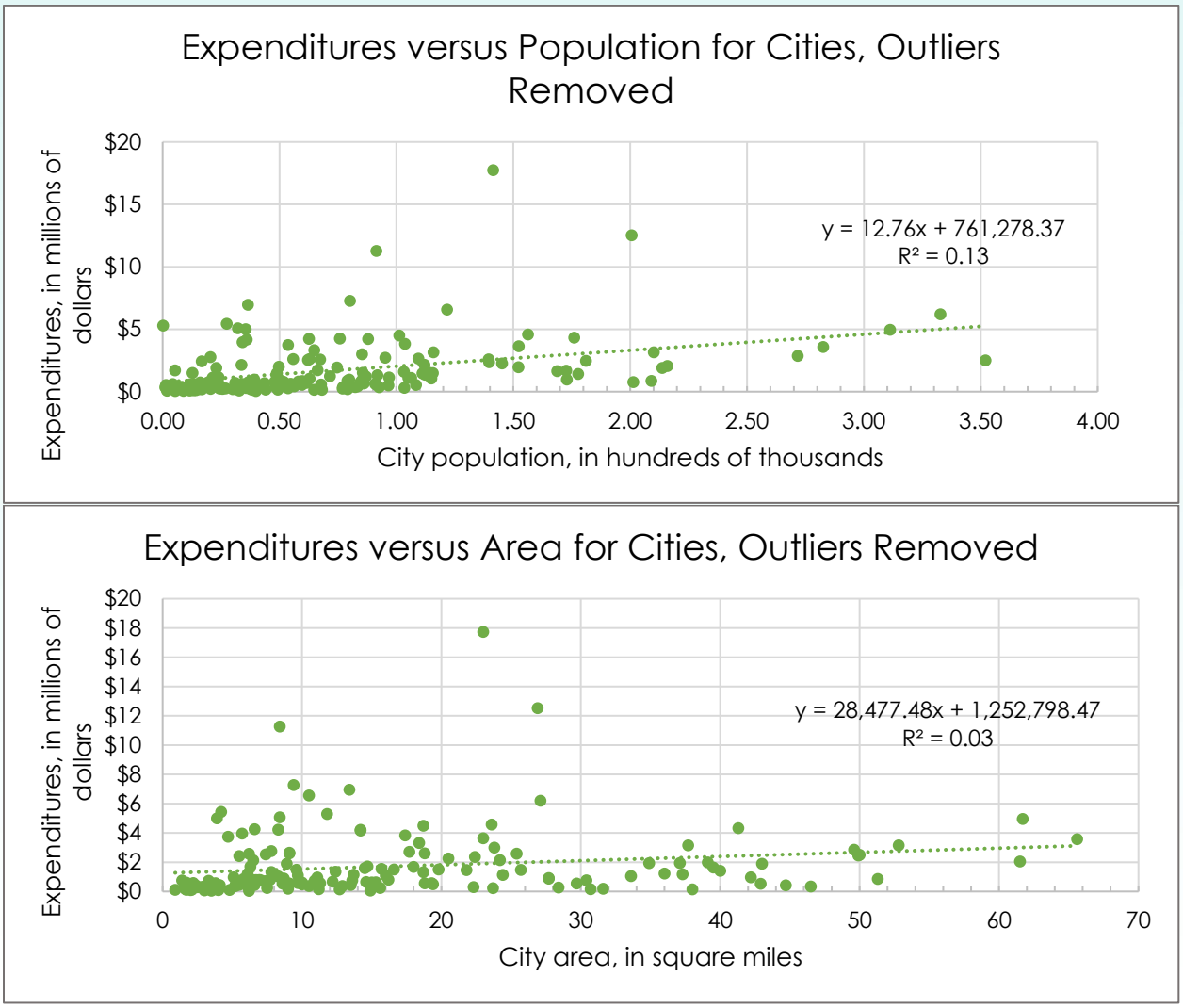


Figure A2: Total expenditures versus population (top) and total expenditures versus area (bottom). Expenditures do not include outliers (cities with populations >600,000)

Appendix B: Reported spending activities and associated categories

Appendix B provides the list of reported spending activities and categorization schemes that attributed spending activities with identifiable categories of spending, as described in Methods.

The list is included as a spreadsheet attachment: Appendix_B-Activity_List.xlsx.

Appendix C: List of entities included the analysis

Appendix C lists the entities included in the analysis, spanning cities, counties, flood control districts, and a limited number of other types of special districts such as port authorities.

Name	Type	County	Regional Water Board	Years Reported: Budgets	Representative Year: Budgets	Years Reported: Expenditures	Representative Year: Expenditures
Salinas	City	Monterey	Central Coast	2017-2018	2017	2017-2018	2017
Bakersfield	City	Kern	Central Valley	N/A*	N/A*	2003-2019	2018
Citrus Heights	City	Sacramento	Central Valley	2012-2015	2014	2015-2016	2015
Clovis	City	Fresno	Central Valley	2016-2017	2016	2013-2016	2015
Elk Grove	City	Sacramento	Central Valley	2012-2017	2016	2011-2016	2015
Folsom	City	Sacramento	Central Valley	2012-2017	2016	2011-2016	2015
Fresno	City	Fresno	Central Valley	2016-2017	2016	2013-2016	2015
Rancho Cordova	City	Sacramento	Central Valley	2011-2015, 2017-2018	2014	2010-2017	2014
Sacramento	City	Sacramento	Central Valley	2012-2018	2016	2011-2018	2015
Stockton	City	San Joaquin	Central Valley	1999-2003,2004-2007, 2008-2012, 2014-2019	2018	2003-2006, 2007-2011, 2013-2018	2017
Kern County	County	Kern	Central Valley	N/A*	N/A*	2005-2019	2018
Sacramento County	County	Sacramento	Central Valley	2012-2017	2016	2011-2016	2015
San Joaquin County	County	San Joaquin	Central Valley	2013-2014, 2017-2019	2018	2011-2013, 2016-2018	2017
Fresno FCD	FCD	Fresno	Central Valley	2016-2017	2016	2013-2016	2015
El Centro	City	Imperial	Colorado River Basin	2016-2017	2016	2013-2016	2015
Agoura Hills	City	Los Angeles	Los Angeles	2016-2017	2016	2011-2012, 2015-2016	2015
Alhambra	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Arcadia	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015

Artesia	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Azusa	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Baldwin Park	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Bell	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Bellflower	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Beverly Hills	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Bradbury	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Burbank	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Calabasas	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Camarillo	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
Carson	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Cerritos	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Claremont	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Compton	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Covina	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Culver City	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Diamond Bar	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Downey	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Duarte	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
El Monte	City	Los Angeles	Los Angeles	2011-2012, 2016-2017	2016	2011-2012, 2015-2016	2015
El Segundo	City	Los Angeles	Los Angeles	2011-2012, 2016-2017	2016	2010-2012, 2015-2016	2015
Fillmore	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013,	2018	N/A*	N/A*

				2014-2015, 2018-2019			
Gardena	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Glendale	City	Los Angeles	Los Angeles	2016-2017	2016	2011-2012, 2015-2016	2015
Glendora	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Hawaiian Gardens	City	Los Angeles	Los Angeles	2016-2017	2016	2011-2012, 2015-2016	2015
Hawthorne	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Hermosa Beach	City	Los Angeles	Los Angeles	2011-2013, 2015-2017	2016	2011-2012, 2014-2016	2015
Hidden Hills	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Industry	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Inglewood	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Irwindale	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
La Canada Flintridge	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
La Habra Heights	City	Los Angeles	Los Angeles	2012-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
La Mirada	City	Los Angeles	Los Angeles	2016-2017	2016	2011-2012, 2015-2016	2015
La Puente	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
La Verne	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Lakewood	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Lawndale	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Lomita	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Long Beach	City	Los Angeles	Los Angeles	2016-2017	2016	2015-2016	2015
Los Angeles	City	Los Angeles	Los Angeles	2011-2012, 2016-2017	2016	2011-2012, 2015-2016	2015
Malibu	City	Los Angeles	Los Angeles	2011-2012, 2016-2017	2016	2011-2012, 2015-2016	2015
Manhattan Beach	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Monrovia	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015

Montebello	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Monterey Park	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Moorpark	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-19	2018	N/A*	N/A*
Norwalk	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Ojai	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
Oxnard	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
Palos Verdes Estates	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Paramount	City	Los Angeles	Los Angeles	2016-2017	2016	2015-2016	2015
Pasadena	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Pico Rivera	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Pomona	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2010-2012, 2015-2016	2015
Port Hueneme	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
Rancho Palos Verdes	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Redondo Beach	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Rolling Hills	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Rolling Hills Estates	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Rosemead	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015

San Buena-ventura (Ventura)	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015	2014	2018-2019	2018
San Dimas	City	Los Angeles	Los Angeles	2011-2012, 2016-2017	2016	2011-2012, 2015-2016	2015
San Fernando	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
San Gabriel	City	Los Angeles	Los Angeles	2011-2012, 2016-2017	2016	2011-2012, 2015-2016	2015
San Marino	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Santa Clarita	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Santa Monica	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Santa Paula	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
Sierra Madre	City	Los Angeles	Los Angeles	2012-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Signal Hill	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Simi Valley	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
South El Monte	City	Los Angeles	Los Angeles	2011-2012, 2016-207	2016	2011-2012, 2015-2016	2015
South Pasadena	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Temple City	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Thousand Oaks	City	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
Torrance	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Walnut	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
West Covina	City	Los Angeles	Los Angeles	2011-2013, 2016-2017	2016	2011-2012, 2015-2016	2015
Westlake Village	City	Los Angeles	Los Angeles	2011-2012, 2016-2017	2016	2011-2012, 2015-2016	2015

Whittier	City	Los Angeles	Los Angeles	2016-2017	2016	2011-2012, 2015-2016	2015
Los Angeles County	County	Los Angeles	Los Angeles	2011-2012, 2013-2017	2016	2010-2016	2015
Ventura County	County	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
Los Angeles FCD	FCD	Los Angeles	Los Angeles	2013-2017	2016	2011-2016	2015
Principal Permittee (VCWPD)	FCD	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015	2018	N/A*	N/A*
Ventura County Watershed Protection District	FCD	Ventura	Los Angeles	2005-2007, 2008-2009, 2010-2013, 2014-2015, 2018-2019	2018	N/A*	N/A*
Sonoma County	County	Sonoma	North Coast	N/A*	N/A*	2013-2014	2013
Aliso Viejo	City	Orange	San Diego	2002-2003, 2015-2018	2017	2001-2002, 2014-2018	2016
Carlsbad	City	San Diego	San Diego	N/A*	N/A*	2016-2018	2017
Chula Vista	City	San Diego	San Diego	N/A*	N/A*	2015-2018	2017
Coronado	City	San Diego	San Diego	N/A*	N/A*	2015-2018	2017
Dana Point	City	Orange	San Diego	2001-2003, 2016-2019	2018	2000-2002, 2013-2018	2017
Del Mar	City	San Diego	San Diego	2015-2018	2017	2015-2018	2017
El Cajon	City	San Diego	San Diego	2016-2019	2018	2010-2018	2017
Encinitas	City	San Diego	San Diego	N/A*	N/A*	2016-2018	2017
Escondido	City	San Diego	San Diego	N/A*	N/A*	2016-2018	2017
Imperial Beach	City	San Diego	San Diego	2016-2018	2017	2016-2018	2017
La Mesa	City	San Diego	San Diego	2015-2018	2017	2015-2018	2017
Laguna Beach	City	Orange	San Diego	2001-2003, 2016-2019	2018	2000-2002, 2013-2018	2017
Laguna Hills	City	Orange	San Diego	2002-2003, 2015-2019	2018	2000-2002, 2013-2018	2017
Laguna Niguel	City	Orange	San Diego	2001-2003, 2015-2019	2018	2000-2002, 2013-2018	2017
Lemon Grove	City	San Diego	San Diego	N/A*	N/A*	2015-2018	2017
Mission Viejo	City	Orange	San Diego	2001-2003, 2015-2019	2018	2000-2002, 2013-2018	2017

Murrieta	City	Riverside	San Diego	N/A*	N/A*	2015-2019	2018
National City	City	San Diego	San Diego	N/A*	N/A*	2015-2018	2017
Oceanside	City	San Diego	San Diego	N/A*	N/A*	2015-2018	2017
Poway	City	San Diego	San Diego	2015-2018	2017	2015-2018	2017
Rancho Santa Margarita	City	Orange	San Diego	2001-2003, 2015-2019	2018	2000-2002, 2014-2018	2017
San Clemente	City	Orange	San Diego	2001-2003, 2016-2020	2019	2000-2002, 2014-2019	2018
San Diego	City	San Diego	San Diego	N/A*	N/A*	2015-2018	2017
San Juan Capistrano	City	Orange	San Diego	2001-2003, 2015-2019	2018	2000-2002, 2013-2018	2017
San Marcos	City	San Diego	San Diego	2013-2018	2017	2013-2014	2013
Santee	City	San Diego	San Diego	N/A*	N/A*	2016-2019	2017
Solana Beach	City	San Diego	San Diego	N/A*	N/A*	2015-2018	2017
Temecula	City	Riverside	San Diego	N/A*	N/A*	2015-2019	2018
Vista	City	San Diego	San Diego	N/A*	N/A*	2015-2016, 2017-2018	2017
Wildomar	City	Riverside	San Diego	N/A*	N/A*	2015-2019	2018
San Diego County	County	San Diego	San Diego	N/A*	N/A*	2003-2018	2017
San Diego County Regional Airport Authority	Other	San Diego	San Diego	N/A*	N/A*	2016-2018	2017
San Diego Unified Port District	Other	San Diego	San Diego	N/A*	N/A*	2015-2018	2017
Berkeley	City	Alameda	San Francisco Bay	2018-2022	2021	2016-2018	2017
Contra Costa County	County	Contra Costa	San Francisco Bay	2018-2019	2018	N/A*	N/A*
Anaheim	City	Orange	Santa Ana	2001-2003	2002	2000-2002	2001
Beaumont	City	Riverside	Santa Ana	2016-2017	2016	2016-2017	2016
Big Bear Lake	City	San Bernardino	Santa Ana	2012-2017	2016	2011-2015	2014
Brea	City	Orange	Santa Ana	2001-2003	2002	2000-2002	2001
Buena Park	City	Orange	Santa Ana	2001-2003	2002	2000-2002	2001
Calimesa	City	Riverside	Santa Ana	2016-2017	2016	2016-2017	2016

Canyon Lake	City	Riverside	Santa Ana	2016-2017	2016	2016-2017	2016
Chino	City	San Bernardino	Santa Ana	2012-2017	2016	2011-2015	2014

**No contributing data points available.*

Appendix D: Data tables and analyses

Appendix D provides data tables containing reported costs of activities in multiple sheets, grouped by budgets and expenditures, cost category, entity, and/or representative year. Appendix D also provides all data-driven charts and tables from this report in dynamic form. Instructions are included in the "README" sheet to allow a user to change or add to the data tables and see those changes reflected in tabular and graphical form.

The data and analyses are included as a spreadsheet attachment: Appendix_D-Data_and_Analyses.xlsx.