Contra Costa County

Green Infrastructure Plan

July 2019

Acknowledgements

Contra Costa County acknowledges the contributing authors and reviewers of the Green Infrastructure Plan:

Contra Costa County

Public Works Department, Watershed Program
Public Works Department, Transportation Engineering Division
Public Works Department, Capital Projects Management Division
Public Works Department, Engineering Services Division
Public Works Department, Design and Construction Division
Public Works Department, Flood Control and Water Conservation District
Public Works Department, Information Technology Division
Department of Conservation and Development
Department of Conservation and Development, Advance and Current Planning
Department of Conservation and Development, Sustainability Program

Consultant Team

Geosyntec Consultants
SCI Consulting Group

Contents

Tables

Figures

Appendices

Acronyms

ABAG	Association of Bay Area Governments
AGOL	ArcGIS Online
BASMAA	Bay Area Stormwater Management Agencies Association
CASQA	California Stormwater Quality Association
CCW SWRP	Contra Costa Watersheds Stormwater Resource Plan
FC District	Contra Costa County Flood Control and Water Conservation District
GI	Green Infrastructure
GIS	Geographic Information System
LIDI	Low Impact Development Institute
MRP	Municipal Regional Stormwater Permit
MS4	Municipal Separate Storm Sewer System
MTC	Metropolitan Transportation Commission
NACTO	National Association of City Transportation Officials
NPDES	National Pollutant Discharge Elimination System
PCBs	Polychlorinated Biphenyls
RWQCB	Regional Water Quality Control Board
SFPUC	San Francisco Public Utilities Commission
TMDL	Total Maximum Daily Load
WLA	Waste Load Allocation

Executive Summary

The Contra Costa County (County) Green Infrastructure (GI) Plan provides a blueprint for how the County will add to and replace its "gray" infrastructure system of pipes and storm drains with "green" infrastructure or low impact development practices throughout unincorporated areas. The GI Plan is a requirement of the National Pollutant Discharge Elimination System (NPDES) Municipal Regional Stormwater Permit (MRP), issued by the San Francisco Bay Regional Water Quality Control Board (RWQCB) on November 19, 2015.[1] The County is one of 76 co-permittees regulated under the MRP. MRP Provision C.3.j. requires Permittees to develop long-term GI plans, to demonstrate how each will move away from traditional stormwater infrastructure and toward green stormwater infrastructure. By doing this, the Permittees will mitigate some of the impacts of urbanization on water quality to the creeks and waterways in the San Francisco Bay Area, and ultimately to the San Francisco Bay Estuary itself. In addition to improving water quality, GI will serve to offer a myriad of environmental, place-making, and community benefits, such as: increased green space, potential for carbon sequestration opportunities, mitigation of urban heat island effect, reduction of localized flooding, and enhancement of bicycle and pedestrian facilities. Staff from various County departments and divisions formed a Technical Advisory Group to provide input through development of this plan. As a result, this plan presents a practical strategy of how the County may implement GI throughout unincorporated areas.

The focus of the County GI Plan is the integration of stormwater treatment into County-owned properties, parking lots, and road right-of-way. As a long-term (2020-2040) blueprint, it seeks to show how the County intends to gradually transform its urban landscape and storm drainage systems by allowing runoff to flow through stormwater treatment facilities (i.e., bioswales and bioretention cells) that remove many urban pollutants before they enter the storm drain system.

[1] Order No. R2-2015-0049.

1 Introduction and Overview

1.1 Green Infrastructure and Regulatory Mandate

Green Infrastructure (GI) refers to constructing and retrofitting storm drainage systems to mimic natural processes by enabling stormwater to infiltrate the soil rather than to runoff into storm drains and pipes. This relatively new approach is being used to reduce runoff volumes, disperse runoff to vegetated areas, harvest and use runoff where feasible, promote infiltration and evapotranspiration, and use bioretention and other natural systems to detain and treat runoff before it reaches tributary creeks and, ultimately, San Francisco Bay. GI facilities include, but are not limited to: pervious pavement, infiltration basins, bioretention facilities, green roofs, and rainwater harvesting systems. GI can be incorporated into construction of new and redeveloped parcels, roads, and other infrastructure within the public right-of-way (ROW).

Unincorporated Contra Costa County, hereafter "County," is one of 76 local government entities, or permittees, subject to the requirements of the San Francisco Bay Regional Water Quality Control Board (RWQCB) Municipal Regional Stormwater Permit (MRP), which was last reissued in November 2015[2]. The MRP mandates implementation of a comprehensive program of stormwater control measures and actions designed to limit contributions of urban runoff pollutants to San Francisco Bay.

MRP Provision C.3.j.i. requires the County to prepare and implement a Green Infrastructure Plan, to be submitted with its Annual Report to the RWQCB that is due September 30, 2019.

1.2 Background on Mercury and PCBs in San Francisco Bay

Water quality in San Francisco Bay (Bay) is impaired by mercury and polychlorinated biphenyls (PCBs), along with other pollutants. Sources of these pollutants include urban stormwater. By reducing and treating stormwater flows, GI reduces the quantity of these pollutants entering the Bay and will serve to hasten its recovery.

MRP Provisions C.11 and C.12 require Contra Costa County Permittees to regionally reduce estimated PCBs loading by 23 grams/year and estimated mercury loading by 9 grams/year, using GI, by June 30, 2020. Each County Permittee must also project the load reductions achieved via GI by 2020, 2030, and 2040, showing that collectively across the MRP region, reductions will amount to 3 kg/year PCBs and 10 kg/year mercury by 2040.

The MRP pollutant-load reduction requirements are driven by Total Maximum Daily Load (TMDL) requirements adopted by the RWQCB for mercury (Resolution No. R2-2004-0082) and PCBs (Resolution No. R2-2008-0012). Each TMDL allocates allowable annual loads (waste load allocation, hereafter "WLA") to the Bay from identified sources, including urban stormwater.

The mercury TMDL addresses two water quality objectives. The first, established to protect people who consume Bay fish, applies to fish large enough to be consumed by humans. The objective is 0.2 milligrams

[2] Order R2-2015-0049

(mg) of mercury per kilogram (kg) of fish tissue (average wet weight concentration measured in the muscle tissue of fish large enough to be consumed by humans). The second objective, established to protect aquatic organisms and wildlife, applies to small fish (3-5 centimeters in length) commonly consumed by the California least tern, an endangered species. This objective is 0.03 mg mercury per kg fish (average wet weight concentration). To achieve the human health and wildlife fish tissue and bird egg monitoring targets and to attain water quality standards, the Bay-wide suspended sediment mercury concentration target is 0.2 mg mercury per kg dry sediment.

A roughly 50% decrease in sediment, fish tissue, and bird egg mercury concentrations is necessary for the Bay to meet water quality standards. Reductions in sediment mercury concentrations are assumed to result in a proportional reduction in the total amount of mercury in the system, which will result in the achievement of target fish tissue and bird egg concentrations.

The PCBs TMDL was developed based on a fish tissue target of 10 nanograms (ng) of PCBs per gram (g) of fish tissue. This target is based on a cancer risk of one case per an exposed population of 100,000 for the 95th percentile San Francisco Bay Area sport and subsistence fisher consumer (32 g fish per day). A food web model was developed by San Francisco Estuary Institute (SFEI) to identify the sediment target concentration that would yield the fish tissue target; this sediment target was found to be 1 microgram (µg) of PCBs per kg of sediment.

Twenty percent of the estimated allowable PCB external load was allocated to urban stormwater runoff. The Bay Area-wide WLA for PCBs for urban stormwater is 2 kg/yr by 2030. This value was developed based on applying the required sediment concentration (1 µg/kg) to the estimated annual sediment load discharged from local tributaries.

1.3 Objectives and Vision

This GI Plan is intended to facilitate efforts to transition from traditional gray to green infrastructure-centric approaches. The MRP sets forth three broad goals for these plans:

1. Ensure each Permittee has established the necessary procedures and practices to require and implement green infrastructure practices in public and private projects as part of its regular course of business.
2. Serve as a reporting guide and implementation tool to provide reasonable assurance that urban runoff TMDL waste-load allocations will be met, including the projected regional goal of controlling 3 kg/year of PCBs via green infrastructure by 2040.
3. Set targets for GI implementation and identify future actions needed to address the adverse water quality impacts of urbanization and urban runoff on receiving waters.

As required by Provisions C.3.a. through C.3.i. in the MRP, these Low Impact Development (LID) practices are already being implemented on private and public land development projects in the County. Specific methods and design criteria are spelled out in the Contra Costa Clean Water Program (CCCWP) *Stormwater C.3 Guidebook* (CCCWP, 2017), which the County has referenced in County Code Title 10, Division 1014 “Stormwater Management and Discharge Control”.

1.4 Plan Context and Elements

1.4.1 Planning Context

Municipal Geography

Contra Costa County comprises 805 square-miles, of which approximately 732 square-miles are land. The general dimensions of the County are approximately 40 miles from west-to-east and 20 miles north-to-south (Contra Costa County Department of Conservation and Development, 2010). From a geographic standpoint, the County is bounded by (in a clockwise direction) the San Francisco Bay-Delta to the north, Delta islands to the east, municipal boundary with Alameda County to the south-southeast, East Bay Hills to the south-southwest, San Francisco Bay to the west.

Throughout the County, there are nineteen incorporated cities/towns and forty-five Special Districts. Unincorporated areas are spread throughout the greater County, totaling approximately 491 square-miles, and are governed by thirteen Municipal Advisory Councils (MACs) that advise the Board of Supervisors. There is a MAC for each of the following communities: Alamo, Bay Point, Bethel Island, Byron, Diablo, Discovery Bay, El Sobrante, Kensington, Knightsen, North Richmond, Pacheco, Contra Costa Centre, and Rodeo. Though unincorporated areas include a variety of urban pockets, the majority of the footprint is rural. Figure 1 depicts unincorporated County areas within the urban limit line (dark grey).[3]

[3] http://www.cccounty.us/DocumentCenter/View/30951/Urban-Limit-Line-Map?bidId=, accessed April 1, 2019.

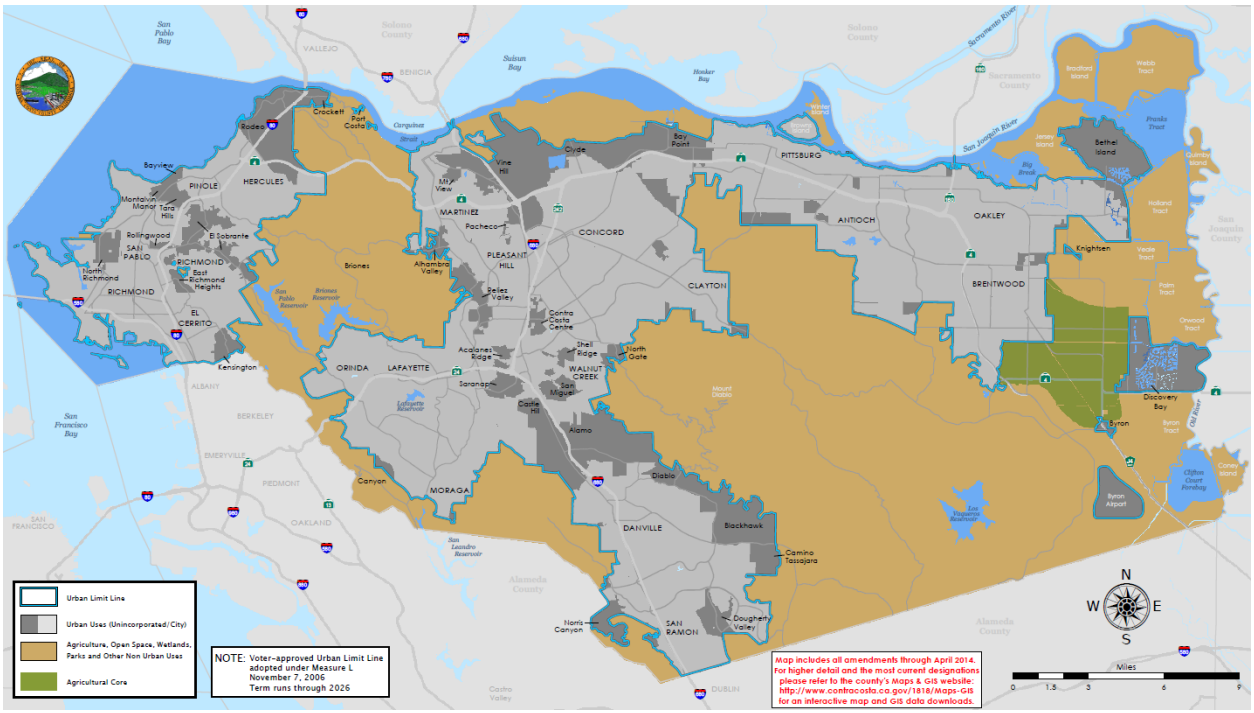


Figure 1. Depiction of Contra Costa County Unincorporated Areas within Urban Limit Line (dark grey).

Demographics

The County is comprised of a diverse social environment. The western and central portions of the County comprise urban and suburban environments, while the eastern portion of the unincorporated area is primarily agricultural, resembling that of neighboring San Joaquin County. The County's total population is 1,149,393 (2019), per the State of California Department of Finance's *Population Estimates for Cities, Counties, and the State* (State of California, 2018). For unincorporated County, the total population is estimated to be 172,513 (State of California, 2018).

From a community economic perspective, household incomes within unincorporated County are generally higher in the areas along Interstate (I) 680, south of State Route (SR) 24, and lower along the Bay and Bay-Delta lines, as well as to the east.[4]

Development and Redevelopment Trends

Historically, many cities have chosen not to annex adjacent urban unincorporated areas. One reason for this is that infrastructure improvements such as sanitary sewers, curbs, gutters, sidewalks, and street lights were not required at the time many of the unincorporated areas were developed. As a result, cities were hesitant to annex unincorporated areas where major capital expenditures were required to bring them up to city standards. This sentiment has persisted, with this factor continuing to discourage the annexation of already urbanized unincorporated areas adjacent to or surrounded by cities.

[4] http://ca-contracostacounty2.civicplus.com/5342/Demographics, accessed April 2, 2019.

Rural unincorporated areas of the County have remained either undeveloped or developed to low densities. Public policy has also played a role in discouraging the annexation of rural unincorporated areas, as most rural lands are located far from the boundaries of cities, often making the provision of urban services from cities impractical and economically infeasible. In addition, the County's Urban Limit Line, a proposition passed by voters in 1988 ("Measure C"), has discouraged urbanization outside of municipal boundaries.

Concerning the growth of housing throughout the County, since 1984, the trend has been consistent at approximately three-quarters in incorporated cities and one-quarter in unincorporated areas (Contra Costa County Department of Conservation and Development, 2010).

Commitment and Actions for Sustainability

The County has established a Sustainability Program, under the Department of Conservation and Development, with the mission to make "communities cleaner and healthier for families, children, and future generations." To help realize this mission, the program has six tenets: Livable Communities; Energy and Water; Planning for our Future; Waste Reduction; Leading by Example; Engage with the County. To further help manifest these efforts, the County has established both a Sustainability Commission and Committee.

Related to sustainability, the County also adopted a Municipal Climate Action Plan and a Countywide Climate Action Plan (Contra Costa County, 2008 and 2015, respectively). Both of these plans focus on greenhouse gas reduction countywide.

CEQA

This GI Plan is statutorily exempted under Public Resources Code (Contra Costa County CEQA Guidelines and California Administrative Code Sec. 15262 et seq.) because it involves feasibility or planning studies for possible future actions that the Board of Supervisors has neither approved nor adopted. Any future project that is to be constructed as recommended by the Plan will conduct a review of potential environmental impacts as required by CEQA.

1.4.2 Watersheds and Storm Drainage Infrastructure

Watersheds and Watershed Characteristics

As described in the Contra Costa Watersheds Stormwater Resource Plan (Contra Costa County Water Program, Public Review Draft 2018), hereafter "CCW SWRP", there are thirty-one (31) major watersheds and sub-watersheds throughout the County, which are linked by similar water quality stressors and regional water quality impairments due to urbanization (CCCWP, 2018). The CCW SWRP organized the County into five watershed-based planning units: East, Central, North, South, and West County. Unincorporated areas are located within each of the planning units. The specific watersheds throughout unincorporated areas, by planning unit, are as follows:

- North County Planning Unit: Alhambra Creek, Peyton Slough, Refugio Creek, Rodeo Creek, and various drainages to Carquinez Strait;

- South County Planning Unit: Upper Alameda Creek, Alamo Creek, Tassajara Creek, Upper San Leandro Creek, Moraga Creek, and Cayetano Creek;
- East County Planning Unit: East and West Antioch Creek, Marsh Creek (watershed includes Dry, Deer, and Sand Creeks), Kellogg Creek, Brushy Creek, and East County Delta Drainages;
- West County Planning Unit: Wildcat Creek, San Pablo Creek, Rheem Creek, Pinole Creek, Garrity Creek, Baxter Creek, Cerrito Creek, and West Richmond Creek; and
- Central County Planning Unit: Walnut Creek, San Ramon Creek, Tice Creek, Las Trampas Creek, Green Valley Creek, Pine Creek, Grayson Creek, Galindo Creek, Clayton Valley Drain, Mount Diablo Creek, Willow Creek, and Kirker Creek.

Figures 2 and 3 show the Watershed Planning Units and County jurisdictional boundaries, respectively. These figures illustrate the complexity of the County addressing GI plan implementation in the numerous watersheds shared with other jurisdictions.

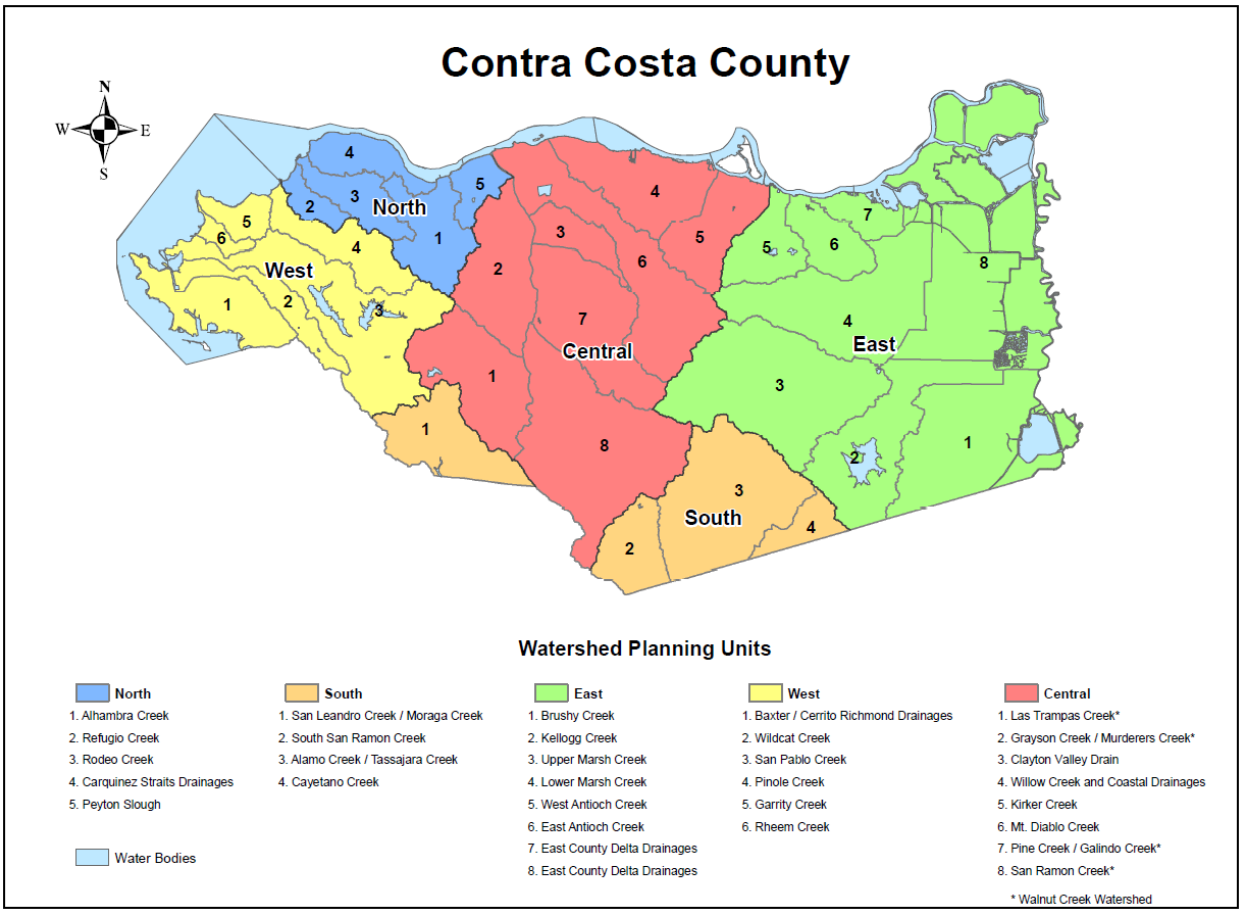


Figure 2. County Watershed Planning Units. (from CCW SWRP)

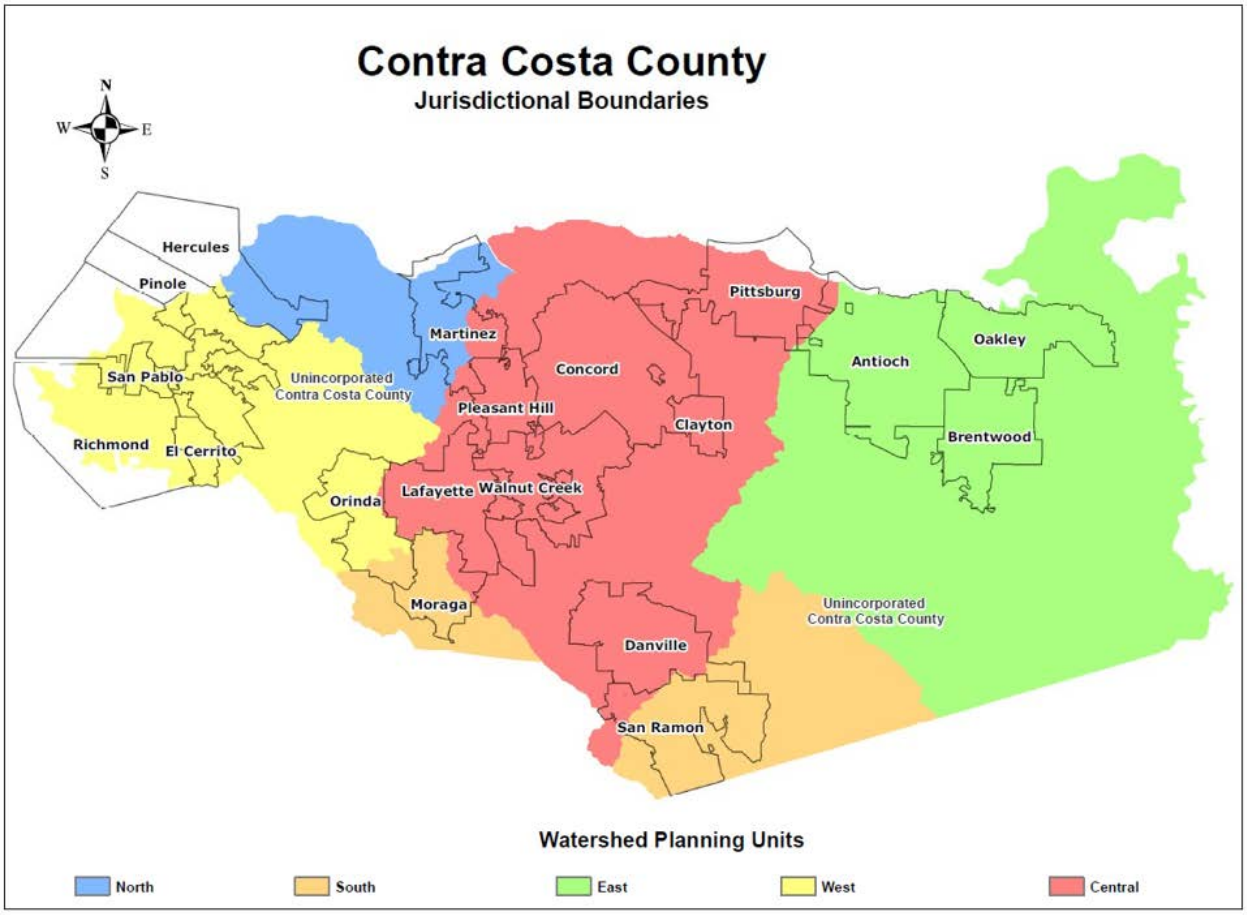


Figure 3. County Jurisdictional Boundaries by Watershed Planning Unit. (from CCW SWRP)

Volunteer interests are vital to fostering healthy watersheds. The numerous creek and related groups provide the challenge of coordinating multiple local groups, but demonstrate a high level of public interest in the natural and water quality values associated with the County's watersheds . Volunteer watershed groups tend to rally around specific creeks . The Contra Costa Watershed Forum , initiated in 1999, meets bi-monthly, and serves as a catalyst and clearinghouse for sharing information and providing unity and continuity among the varied watershed stewardship groups, as well as providing a medium for coordinating with agencies, including the County.

Major Drainages and Flood Control

Contra Costa County drainages include headwaters of creeks that drain through other counties before reaching the Bay. The Contra Costa County Watershed Atlas[5] (2003) provides data for all the major and minor watersheds in the county. The Atlas provides statistics for the watersheds including geophysical data, land use data, and some historical data.

[5] https://www.cccleanwater.org/watersheds/watersheds-in-contra-costa-county

Contra Costa County consists of 466,473 acres. The longest creek in the county (Marsh Creek) is 34.6 miles long. Table 1 below lists the major watersheds in order of watershed size and the estimated length of their respective longest creeks.

Table 1. Major Watersheds in Contra Costa County

Name	Area (acres)	Longest Branch of Creek (miles)
Walnut Creek (includes San Ramon, Pine, Grayson and Las Trampas Creeks)	93,556	28.74
Marsh Creek (includes Dry, Deer, and Sand Creeks)	60,066	34.57
San Pablo Creek	27,640	19.65
Mt. Diablo Creek	23,846	17.24
Alhambra Creek	10,735	7.99
Pinole Creek	9,705	10.95
Wildcat Creek	6,848	13.43

Mt Diablo dominates the landscape in Central County, being the headwaters of many of the largest watersheds. Mt Diablo is near the northern terminus of the Diablo Range which separates drainages of Central and East County. The Berkeley and Oakland Hills further define the upper watersheds of West and Central County. Watersheds in Contra Costa are steep at their headwaters and generally flow to flatter valleys or plains.

Contra Costa County Flood Control and Water Conservation District (FC District) manages major flood risk reduction planning and flood control projects. Divided into Flood Control Zones, the FC District manages flood control facilities in each Zone. The FC District is a partner in many ways to the County and is supportive of its GI planning efforts.

Major Watersheds with Facilities in Unincorporated County

The County Public Works Department maintains 150 miles of streams, channels, and other drainage facilities in unincorporated areas of the County. The FC District also manages and maintains large drainage infrastructure both in unincorporated areas and in most of the 19 cities in the County. As the focus of this GI plan is on unincorporated areas, the facility discussion below is exclusive to those drainage facilities.

In the community of North Richmond, three channelized streams are present: Wildcat Creek, San Pablo Creek, and Rheem Creek. All were improved by the US Army Corps of Engineers to reduce flood risk for the surrounding community. Wildcat and San Pablo Creeks are of a newer, more environmentally sensitive design. Rheem Creek has a typical trapezoidal rock lined channel which has limited riparian vegetation.

Garrity Creek has a minor flood control facility that receives stormwater from the unincorporated community of Montalvin Manor.

Rodeo Creek is the major stream that serves the unincorporated community of Rodeo and has its headwaters in the John Muir Land Trust-owned Fernandez Ranch Open Space. These upper reaches have significant instability, and this produces a heavy sediment and debris load in the creek. The Corps of Engineers improved the reach of the creek in the urban area of Rodeo in the 1960s and the lowest portion (near where it drains into San Pablo Bay) is a rectangular concrete channel.

Along the "north" Watershed Planning Unit (see Figure 2 above), there are a number of smaller drainages that serve the communities of Crockett and Port Costa.

The Walnut Creek Watershed is the main feature of the Central Watershed Planning Unit (Figure 2), and drains many unincorporated communities such as Saranap, Alamo, Blackhawk, and Diablo. Walnut Creek is the largest watershed in the County and consists of a number of important tributaries such as Tice, San Ramon, Las Trampas, Pine, and Pacheco.

The unincorporated community of Clyde drains to Mt. Diablo Creek, which passes nearby before entering Suisun Bay.

Further east, the unincorporated community of Bay Point is served by a number of smaller drainages that discharge into or through the marshlands along the edge of Suisun Bay.

In the eastern portion of the County, the communities of Knightsen and Byron are in an area of poor drainage, and much of their stormwater needs to be pumped over levees to reach the delta. Other areas, including the community of Discovery Bay, rely on Brushy and Kellogg Creeks to handle their stormwater requirements.

Finally, the portion of Marsh Creek at, and upstream of, the Marsh Creek Reservoir, serves the unincorporated lands in this watershed. Marsh Creek is the second largest watershed in the County, and is also notable for mercury contamination due to legacy mining activities in the upper watershed on the sides of Mt. Diablo.

Storm Sewer System, Challenges, and Opportunities

Similar to other facets of infrastructure, the age and state of repair of the storm drain system pose a challenge to the County. As indicated in Section 1.4.1 above, infrastructure in urban and rural unincorporated areas have had a lack of investment. Not only is there a need to rehabilitate or replace existing infrastructure, but there is also a need to maintain existing features.

The County maintains maps that depict the road, countywide, and Flood Control District drainage systems. Much of this data has been transferred into geographic information system (GIS) format and the County is in the planning phases of collecting and correcting the GIS drainage inventory data for use in developing an asset management program for maintenance, planning, and administrative purposes; see Section 5.2. This database also serves as a valuable resource for investigating potential locations of GI implementation.

Recent and Planned Drainage Improvements

There are a number of planned and/or current drainage improvement projects in the incorporated county, including the following:

- Wildcat and San Pablo Creeks Levee Remediation Project
- Marsh Creek Reservoir Capacity and Habitat Restoration
- Sustainable Capacity Improvement at Rodeo Creek

Funding for Maintenance and for Capital Improvements

The County has varying sources for drainage related capital improvements and maintenance of those drainage facilities. Through the FC District, a portion of property tax within the boundaries of some Flood Control Zones provide for design, construction, and maintenance of regional storm drainage facilities within the Zones. Development projects within some Drainage Areas are charged impact fees that fund construction of planned drainage facilities required to mitigate the increased runoff from development. The FC District has also established special assessments in some Drainage Areas to fund ongoing maintenance. The FC District struggles to fund basic maintenance of Corps of Engineer constructed facilities that it is obligated to maintain. The FC District also receives a $1/10^{th}$ of the 1% Ad valorem tax to provide District-wide operational and administrative funding.

Proposition 13 has hindered the ability of public agencies to raise requisite funds for infrastructure projects and maintenance. For instance, some of the Flood Control Zones have very low and even zero property tax revenue. A ballot initiative was attempted in late-2015 to amend the state Constitution in order to create an optional method for local agencies to raise funds for stormwater and major drainage projects. After polling in early-2016, it was determined that there was not sufficient public support to move forward with the initiative. Potential strategies to secure future GI funding are presented in Chapter 7 of this GI Plan.

1.4.3 Related Regional and Countywide Plans and Planning Documents

This GI Plan has been coordinated with the following regional stormwater documents:

- The CCW SWRP. The CCW SWRP was funded by State Water Resources Control Board under a Proposition 1 Grant, with matching contributions provided by Contra Costa municipalities individually and collectively through the CCCWP. The CCW SWRP identifies and prioritizes potential multi-benefit stormwater management projects, including GI projects, in watersheds and jurisdictions throughout Contra Costa County. Projects identified within the CCW SWRP are eligible to apply for future state funding. Many of the projects included in this GI Plan were drawn from the CCW SWRP project opportunity lists.
- The Contra Costa Countywide Reasonable Assurance Analysis (RAA). The RAA for Green Infrastructure is being prepared by Contra Costa municipalities collectively through the CCCWP and is consistent with guidance prepared by the Bay Area Stormwater Management Agencies Association (BASMAA, 2017a). The RAA for Green Infrastructure uses a water quality model coupled with continuous simulation hydrologic output to estimate baseline loadings of pollutants and the reductions that might be achieved through GI implementation in 2020, 2030, and 2040 under various scenarios, which include implementation of potential project locations identified in this Plan. RAA findings will be within the TMDL Implementation Plan, as part of the 2020 Annual Report submitted to the San Francisco Bay RWQCB.

1.4.4 Related Local Planning Documents

Green Infrastructure can be integrated into a diversity of public and private projects. Public projects can incorporate GI in streets, parks, schools, and other civic properties. In order to ensure that GI is considered and supported in the range of planning and design processes for these projects, the County will be reviewing and updating the planning documents listed in Table 2 to appropriately incorporate GI requirements.

Table 2. County Planning Documents to Align with GI Plan

Document	Responsible Department	Summary of Updates	Next Projected Update
General Plan	Department of Conservation and Development	GI Plan to be integrated into the Public Facilities/ Services Element	2020
Climate Action Plan	Department of Conservation and Development	Entire document to be updated to reflect the GI plan	2020
Complete Streets	Department of Conservation and Development	The County's Complete Streets Policy allows for the inclusion of some GI features, but it's advisable to incorporate GI explicitly into it so that, when feasible, "Complete streets" can be designed/function as "Sustainable Streets"	2020

In 2019 and 2020, the County will be updating the Climate Action Plan (CAP). The CAP identifies greenhouse gas emissions, both countywide and for County operations, and names strategies the County will take to reduce those emissions. In the 2015 CAP, actions were grouped into six categories: energy efficiency, renewable energy, land use and transportation, solid waste, water, and county operations. Green infrastructure falls into the land use and transportation categories. At the time of this writing, it is anticipated that the same categories will be used in the 2020 CAP Update.

In 2019, the County will update the emissions profile, as well as identify reduction targets and measures to reach those targets; the County Sustainability Commission is advising staff in this work. In 2020, the work will shift to the hearing and adoption process. The CAP is being developed and adopted in conjunction.

Complete streets improve mobility, safety, public health, and environmental sustainability. Where feasible and in context with local conditions, complete streets allow for GI, such as street trees and landscaping and planting strips. The County adopted a Complete Streets Policy in 2016 to ensure its commitment to maintaining and building streets that provide safe, comfortable, and convenient travel for all users, including pedestrians, bicyclists, seniors, people with disabilities, children, and users and operators of public transportation. The Complete Street Policy helps the County meet local and state-level safety and sustainability goals and policies. The Complete Streets Policy will be subsumed into the Transportation & Circulation Element in the 2020 County General Plan Update.

1.4.5 Outreach and Education

Outreach and education of County stakeholders has occurred relating to the GI Plan in a limited way, through Contra Costa Watershed Forum presentations in January and March 2019. In addition, the Watershed Program will engage with stakeholders in the coming months through presentations on the GI Plan to the MACs.

1.4.6 Policies, Ordinances, and Legal Mechanisms

A number of policies, ordinances, and legal mechanisms are in place to help enable the implementation of the goals and potential GI projects set forth in the Plan. These include the following, and are also described further in subsequent paragraphs:

1. CCCWP *Stormwater C.3 Guidebook*
2. Sustainable street and related LID guidance identified on the CCCWP website
3. *San Francisco Public Utilities Commission Stormwater Requirements and Design Guidelines Appendix B* (Green Infrastructure Details)
4. Participation in the BASMAA and CCCWP development committees.

The County uses its planning, zoning, and building authorities to require proposed new development and redevelopment projects to incorporate LID features and facilities in accordance with the Provision C.3, and the current edition of the CCCWP *Stormwater C.3 Guidebook*.

For "sustainable streets" and other streetscape improvements and projects, the National Association of City Transportation Officials (NACTO) *Urban Street Stormwater Guide* (NACTO, 2017), the *San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook* (San Mateo Countywide Water Pollution Prevention Program, 2009), and other resources available on the CCCWP website (www.cccleanwater.org), shall be consulted.

LID features and facilities will be designed and constructed in accordance with the applicable specifications and criteria in the *Stormwater C.3 Guidebook.* Additional details and specifications, as may be needed for design of street retrofit projects, may be adapted from Appendix B ("Green Infrastructure Details") of the San Francisco Public Utilities Commission (SFPUC) *San Francisco Stormwater Management Requirements and Design Guidelines* (SFPUC, 2016), the *Central Coast Low Impact Development Institute Bioretention Standard Details and Specifications* (California Stormwater Quality Association and Low Impact Development Institute, 2017), or other resources compiled by the CCCWP and available through their website.

Participation in the countywide interagency process, and specifically the development committees convened by the CCCWP and BASMAA, facilitate excellence and consistency in the design and construction of GI. Toward this end, the County will:

- Share with other Contra Costa municipalities, through the CCCWP, conceptual, preliminary, and final plans and specifications developed for GI projects.

- Identify significant GI projects, along with any issues encountered during design and construction, and present in online forums and in-person interagency workshops and meetings.
- Participate in evaluation and recommendation of design details and specifications for GI, furthering countywide consistency and cost-efficiency, and quality of the built facilities.
- Participate, as a reviewer, in the drafting and updating of a "GI Design Guide," the purpose of which will be to assist municipal capital improvement staff through the steps of project identification, evaluation, design, and construction.

2 Green Infrastructure Targets

MRP Provision C.3.j.i.(2)(c) requires that the Green Infrastructure Plan include "targets for the amount of impervious surface, from public and private projects, within the Permittee's jurisdiction to be retrofitted over the following time schedules… (i) By 2020, (ii) By 2030; and (iii) By 2040." This section describes the process used to develop projections for the impervious surface area to be retrofitted and treated with GI from private and public projects within County jurisdiction and presents the results.

2.1 Private Development Projections

Table 3 presents an estimate of the impervious area to be treated by GI via private development projects for 2020, 2030, and 2040. The impervious area treated by private development presented in Table 3 includes actual projects constructed through 2018 and projected private development project area for 2019/2020, 2021 through 2030, and 2031 through 2040.

To forecast future private development area, the County participated in a process coordinated through the CCCWP that used the output of UrbanSim, a model developed by the Urban Analytics Lab at the University of California under contract to the Bay Area Metropolitan Transportation Commission (MTC). The UrbanSim modeling system was developed to support the need for analyzing the potential effects of land use policies and infrastructure investments on the development and character of cities and regions. The Bay Area's application of UrbanSim was developed specifically to support the development of Plan Bay Area, the Bay Area's Sustainable Communities planning effort.

MTC forecasts growth in households and jobs and uses the UrbanSim model to identify development and redevelopment sites to satisfy future demand. Model inputs include parcel-specific zoning and real estate data; model outputs show increases in households or jobs attributable to specific parcels. The methods and results of the Bay Area UrbanSim model have been approved by both MTC and Association of Bay Area Governments (ABAG) Committees for use in transportation projections and the regional Plan Bay Area development process.

The CCCWP process used outputs from the Bay Area UrbanSim model to map parcels predicted to undergo development or redevelopment in each Contra Costa jurisdiction at each time increment specified in the MRP (2020, 2030, and 2040).[6] The resulting maps were reviewed by County staff for consistency with local knowledge, and local planning and economic development initiatives and revised as needed.

It is assumed that multifamily residential and commercial/industrial new development and redevelopment projects will incorporate stormwater treatment facilities, in accordance with MRP

[6] The UrbanSim model effectively translates Bay Area-wide growth assumptions (reflecting new development and redevelopment) into specific projects by acting as a "rational" developer looking to maximize the difference between pre- and post-redevelopment property values based on a series of algorithms relying on resources such as property value estimates produced by online resources such as Zillow or Redfin. Thus, the actual parcels projected to be redeveloped are approximate, but the MTC UrbanSim model outputs provided the Contra Costa Permittees with a common, defensible basis for projecting impervious area to be treated with LID due to private new development and redevelopment projects in the future.

Provisions C.3.b., C.3.c., and C.3.d. It is also expected that more than 50% of the existing impervious area in each parcel will be replaced if a parcel is redeveloped, and therefore the entire parcel will be subject to Provision C.3 requirements, consistent with the "50% rule" requirements of MRP Provision C.3.b.

Existing impervious surface for each affected parcel was estimated using the 2011 National Land Cover Database (United States Geological Survey, 2011). Estimates were spot-checked and revised based on local knowledge and available satellite imagery. The amounts of existing impervious surface retrofitted or forecasted to be retrofit with GI via private development shown in Table 3 were developed using these assumptions.

Table 3. Estimate of Impervious Surface Treated or Retrofit via Private Development

Year	Total Impervious Area (Acres)[1]	Comments
2003 - 2020	11	Includes private development projects constructed from 2003 – 2019 from the AGOL database[2] and UrbanSim projections for 2019 - 2020.
2021 - 2030	63	Predicted by UrbanSim
2031 - 2040	69	
2003 – 2040	143	Total Impervious Area Retrofit via Private Development

1. Total impervious area reported to nearest whole acre.
2. Refers to County's GI tracking system, see Chapter 5.

2.2 Public GI Implemented and Future Targets

Table 4, below, presents an estimate of the impervious area retrofit, or proposed to be retrofit, via public GI projects for 2020, 2030, and 2040. The projects summed for 2020 include already planned and constructured projects. For the period 2021 - 2040, the County GI project implementation goal is to plan and construct, on average, one retrofit project per year, provided that funds are procured (see Chapter 7). This strategy does not specify which potential project locations might be implemented by a certain date. Potential project locations have been identified through a prioritization analysis described in Section 3.1; the list of potential project locations is included as Appendix A. Though the County's goal is to implement one project per year, on average, the list includes thirty potential project locations in order to provide flexibility in project selection and scheduling.

Given the unknown schedule of GI implementation for any of the identified potential project locations, the total tributary impervious area retrofit with GI during the 2021 - 2030 and 2031 - 2040 time frames was estimated based on the proposed implementation frequency of one public GI retrofit project per year. This implementation frequency was multiplied by the normalized project impervious surface area of 1.4 acres per year. Table 4 below presents the resulting impervious area retrofit targets for public projects for 2020, 2030, and 2040.

Table 4. Estimate of Impervious Surface Retrofit via Public Project

Year	Total Impervious Area (Acres)[1]
2003 - 2020	15[2]
2021 - 2030	14
2031 - 2040	14

1. Total impervious area reported to nearest whole acre.
2. Represents total impervious area retrofit through existing public GI projects.

2.3 Projected Load Reductions

MRP Provisions C.11 and C.12 require the Contra Costa Permittees within San Francisco Bay RWQCB jurisdiction to collectively reduce estimated PCBs loading by 23 g/year and estimated mercury loading by 9 g/year using GI by June 30, 2020. Regionally, MRP Permittees must project the load reductions achieved via GI by 2020, 2030, and 2040 as part of the TMDL Implementation Plans due in 2020, showing that collectively, reductions will amount to 3 kg/year of PCBs and 10 kg/year of total mercury by 2040. A "Countywide Attainment Scenario Report" will be completed in 2020, which will provide a preliminary projection for load reductions achieved via GI by 2020, 2030, and 2040 at the Countywide level using the RAA model. The GI projects and project opportunities included in this Plan will be accounted for in the Countywide Attainment Scenario Report.

As part of the RAA process, the estimates of projected private development (described in Section 2.1) and the general and specific locations of public GI projects (summarized in Section 2.2 and detailed in Chapter 3) will be incorporated into a final water quality model and projected pollutant load reductions will be developed for 2020, 2030, and 2040. Details of methods, inputs, and model outputs will be included in the TMDL Implementation Plan and RAA Technical Report, which will be submitted to the San Francisco Bay RWQCB with the 2020 Annual Report.

3 Public Project Identification, Prioritization, and Mapping

3.1 Tools for Public Project Identification and Prioritization

Publicly-owned parcels and ROWs that could potentially be retrofit to include multi-benefit stormwater capture facilities were identified in the CCW SWRP. These potential project locations were used as the basis for identifying future public retrofit opportunities within the County for this GI Plan. A summary of the project identification and prioritization process conducted for the CCW SWRP is described below; additional details may be found in the CCW SWRP.

3.1.1 SWRP Project Opportunity Identification

The CCW SWRP identified public retrofit opportunities through a request for planned projects, sent to the Contra Costa County Permittees, along with a GIS-based project opportunity analysis, conducted using data received from the Permittees through a data request. Information related to the identification of potential project locations was received from 25 jurisdictions, government agencies, non-governmental organizations, and watershed groups.

The desktop GIS analysis entailed screening for publicly-owned parcels and ROW without physical feasibility constraints that would preclude implementation of a stormwater capture measure. The project opportunity analysis consisted of the following steps:

1. Identify publicly-owned parcels through parcel ownership and/or tax-exempt status.
2. Screen identified publicly-owned parcels to identify those at least 0.1 acres in size; and with average slopes less than 10%.
3. Identify ROW using the county-wide roadway data layer. Roadways considered were state and county highways and connecting roads, as well as local, neighborhood, and rural roads.
4. Identify land uses associated with identified parcels and surrounding identified ROW with a combination of ABAG land use categories and use codes provided by the Contra Costa County Assessor.
5. Screen all identified locations for physical feasibility. The following screening relating to physical constraints was applied to identified sites (to the extent that the necessary data had been provided or obtained):
    a. Regional facilities were not considered for parcels that were greater than 500 feet from a storm drain, due to limited feasibility in treating runoff from a larger drainage area.
    b. Parcel-based facilities were not considered for sites that were more than 50% undeveloped land uses, due to the limited potential for pollutant of concern load reduction.
    c. Parcels with significant drainage area outside of urbanized areas were removed, as these sites would not provide opportunity for significant pollutant of concern load reduction.

d. Sites more than 50% within environmentally sensitive areas (ESAs), such as designated wetlands and other biologically sensitive areas, were removed so as not to disturb these habitats.

e. Sites with more than 50% overlying landslide hazard zones were removed to avoid the potential for increasing landslide risk.

The remaining identified public parcels and ROW were considered preliminarily feasible for implementation of stormwater capture measures and were analyzed using a metrics-based multi-benefit analysis. The results of the metrics-based multi-benefit analysis provided some information helpful for consideration of GI priorities throughout unincorporated areas of the County. A summary of the project opportunity classification and scoring conducted for the SWRP is provided in the following section.

3.1.2 SWRP Project Opportunity Metrics-Based Multi-Benefit Analysis

To conduct the project opportunity metrics-based multi-benefit analysis required as part of the SWRP, additional data was analyzed, and classifications were made regarding the project opportunities. First, project opportunities were classified using the following information:

1. Stormwater capture project type
2. Infiltration feasibility
3. Facility type
4. Drainage area information.

Details regarding each of these classifications are provided below.

Stormwater Capture Project Type

All physically feasible project opportunities that did not include a previously defined non-GI stormwater capture facility (e.g. stream restoration projects provided by stakeholders as part of the SWRP project request), were assumed to be feasible for GI implementation as part of the SWRP project opportunity classification. The projects identified through the GIS opportunity analysis and stakeholder stormwater capture projects process were categorized as parcel-based, regional, or ROW/green street projects; see Table 5 below.

Table 5. Green Infrastructure Project Types and Categorization Criteria

GI Project Type	Definition	Description
ROW/green street projects	Treating the road and portions of adjacent parcels	• All street-based projects.
Regional Projects	Treating a large area draining to the parcel	• The parcel contains at least 0.5 acre of undeveloped or pervious area (as identified through the land use class); and • The drainage area is larger than the parcel itself and the location is sufficiently close to a storm drain (i.e., within 500 feet, where storm drain pipe data is available).
Parcel-based projects	Treating the drainage area only on the identified parcel	• All other parcel locations.

Infiltration Feasibility

All SWRP project opportunity locations were categorized as feasible, infeasible, or partially feasible for infiltration, based on underlying hydrologic soil group, depth to groundwater (as data available), nearby soil or groundwater contamination, and presence of underlying geotechnical hazards; see Table 6 below.

Table 6. SWRP Project Opportunity Infiltration Feasibility Categorization Criteria

Infiltration Feasibility Category	Description
Hazardous/infeasible for infiltration	Projects that are located: • More than 50% overlying liquefaction hazards; • Within 100 feet of a site with soil or groundwater contamination (e.g., based on proximity to active GeoTracker[1] or EnviroStor[2] sites).
Infiltration safe but only partially feasible	None of the above constraints exist, but the soil underlying the facility is relatively poorly draining (identified as hydrologic soil group [HSG] C or D).
Infiltration feasible	The site has none of the infiltration hazards present and the soil underlying the facility is relatively well draining (identified as HSG A or B).

1. GeoTracker is a California State Water Resources Control Board website which tracks sites with the potential to impact water quality in California, including contaminated sites (https://geotracker.waterboards.ca.gov/).
2. EnviroStor is the Department of Toxic Substances Control's data management system for tracking cleanup, permitting, enforcement and investigation efforts at hazardous waste facilities and sites with known contamination or sites where there may be reasons to investigate further (https://www.envirostor.dtsc.ca.gov/public/).

For the purpose of SWRP project opportunity multi-benefit scoring, locations feasible for infiltration were assumed to retain the full water quality volume. At locations that are partially feasible for infiltration, it was assumed that infiltration would be promoted in the facility, but the full water quality volume would not be infiltrated due to poor drainage. These areas were assumed to infiltrate to the extent possible using a raised underdrain. Locations that are hazardous for infiltration were assumed to implement non-infiltrating GI projects (i.e., lined bioretention) and were assumed to retain no volume.

SWRP Project Opportunity Facility Type

Each SWRP project opportunity location was assigned a facility type. For potential projects identified by the Permittees and/or stakeholders, a facility type was assigned based on the description or classification provided by the agency or project proponent. For project opportunities identified through GIS analysis, the facility type was assumed to be GI, with infiltration capability defined based on the infiltration feasibility screening. The resulting SWRP multi-benefit stormwater capture project types, considered for the GI Plan, included:

- Capture and Reuse
- Constructed Wetland
- Lined Bioretention
- Unlined Bioretention
- Unlined Swale
- Water Quality Basin.

Flood control facilities and habitat restoration project opportunities were open for consideration by the County, if feasible to include GI.

SWRP Project Opportunity Drainage Area

For each identified project opportunity, the drainage area was identified and characterized as follows:

1. All project opportunities with identified drainage areas were characterized as provided by project proponents.
2. For ROW opportunities for which the drainage area had not been characterized, the roadway and an assumed tributary width (i.e., 50 feet per side) that extends into the adjacent parcels was considered the drainage area.
3. For parcel-based project opportunities for which the drainage area had not been characterized, the entire parcel was assumed to make up the drainage area.
4. For regional project opportunities for which the drainage area had not been characterized, the drainage area characterization (i.e., slope and land use) was approximated.

The drainage areas defined as part of the SWRP were applied to the project opportunities associated with the geographic areas found potentially feasible for retrofit that the County identified through this GI Plan. As such, these drainage areas could change, if and when facilities are identified and located for capture of these geographic areas.

SWRP Project Opportunity Metrics-Based Multi-Benefit Analysis Scoring

Using the information compiled in the identified project opportunity database, each SWRP identified project received a score using a metrics-based multi benefit analysis. A description of each project criteria that was used to analyze and score projects is provided below:

- **Parcel area** (regional and parcel-based GI opportunities only) – This scoring component awarded more points for larger parcels.
- **Slope** – This scoring component awarded more points to flatter slopes and is related to ease of construction and implementation.
- **Infiltration feasibility** – More points were awarded to projects that overlie infiltrating soils.
- **PCBs/mercury yield classification in project drainage area** – This scoring component is related to the influent TMDL pollutant loads; higher potential load reduction achieved higher points.
- **Removes pollutant loads from stormwater** – Points were awarded to facilities designed as GI or treatment control facilities for this scoring component.
- **Augments water supply** – Increasing points were awarded based on potential water supply provided for this scoring component.
- **Provides flood control benefits** – Flood control facilities received points specific to providing flood control benefits for this scoring component.
- **Re-establishes natural water drainage systems or develops, restores, or enhances habitat and open space** – Hydromodification control, stream restoration, and habitat restoration projects received points specific to providing these environmental benefits, for this scoring component.
- **Provides community enhancement and engagement** – Projects that specifically provide public use areas or public education components with potential opportunities for community engagement and involvement were given points specific to providing community benefits, for this scoring component.

All classified and scored projects were compiled into a master database as part of the CCW SWRP and organized by the Permittee. The CCW SWRP-identified project opportunities located within County jurisdiction were provided for review. The project classification information and SWRP score were provided for informational purposes.

3.1.3 Additional Criteria Used by Municipal Staff

This section presents the methodology used by the County to identify potential public project locations included in this GI Plan. From the CCW SWRP analysis described in section 3.1, approximately 3,800 potential project locations were identified throughout unicorporated areas. The County screened this list to eliminate infeasible and low priority potential project locations. The initial screening excluded the following from the CCW SWRP locations:

- Those located in new urban/open space land uses
- Old urban ROW locations that were not prioritized
- Low priority locations.

The initial screening resulted in a list of 856 potential public project locations for further consideration. These 856 locations were then categorized using the following criteria:

- Adjacent to PCBs source property
- Located in old industrial land use area
- Located in old urban land use areas
- County-identified opportunities
- Located outside the Urban Limit Line.

After further refinement, 206 potential public project locations were presented to the County GI Plan Technical Advisory Group (TAG) for vetting. The County GI Plan TAG consisted of personnel from several County departments notably: Public Works Department, Divisions of Transportation Engineering, Capital Projects Management, Engineering Services, Design and Construction, and Information Technology; Public Works Department, Flood Control and Water Conservation District; Public Works Department, Watershed Program; and Department of Conservation and Development. Members of the TAG reviewed early drafts of the GI Plan to evaluate and vet potential GI project locations, based on their knowledge of unincorporated areas of County, as well as GI implementation goals and objectives. As a result of the TAG's review, 109 GI project locations were identified as potentially feasible.

3.2 Project List and Maps

This project location evaluation effort, combined with additional discussions among TAG members, desktop feasibility analyses, and visits to selected locations, resulted in the winnowing down of these 109 locations to the 30 locations included in the list and maps in Appendix A. The geographic distribution of these 30 potential GI locations is shown in Figure 4, on the following page; this map is also included in Appendix A.

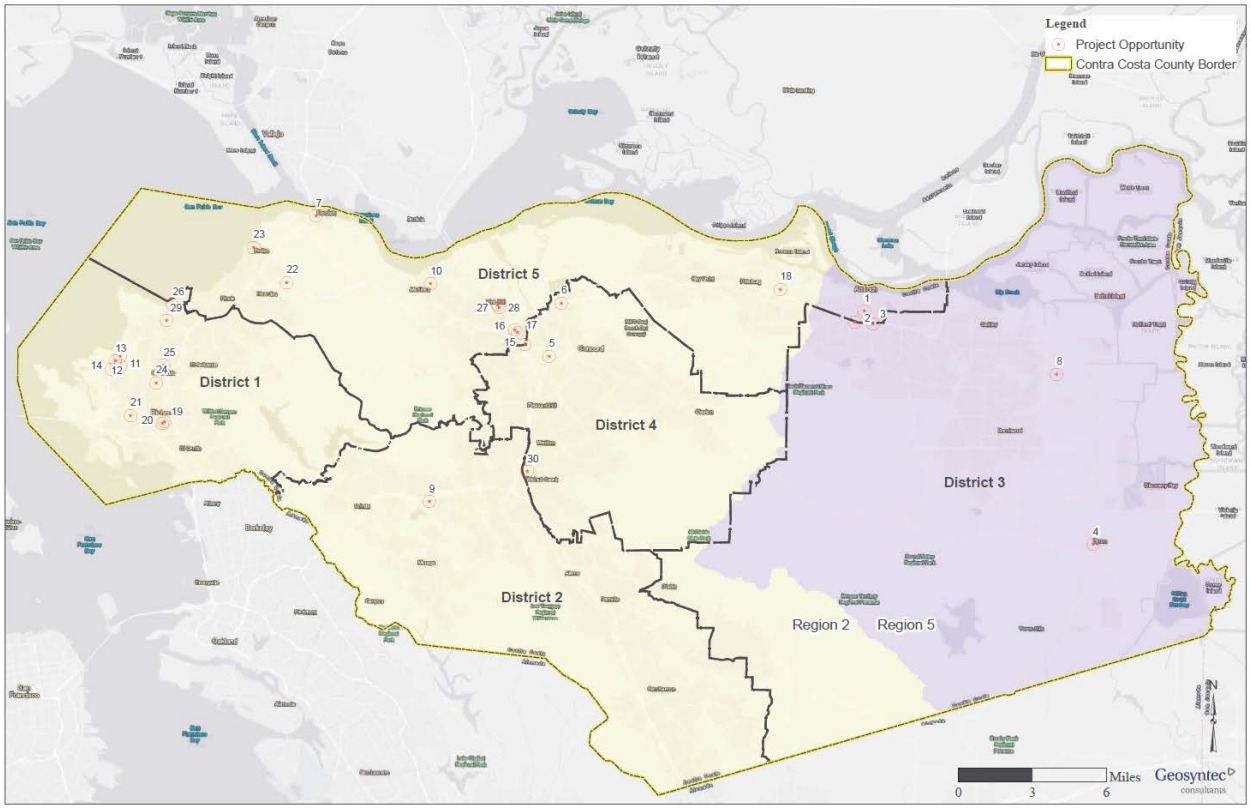


Figure 4. Geographic Distribution of the Potential GI Project Locations.

These potential project locations will be further assessed for feasibility and either eliminated or identified as public project opportunities, as the County implements this GI Plan.

As stated in Section 2.2, the County intends to design and implement, on average, one public GI retrofit project per year between 2021 and 2040. These twenty projects are anticipated to be selected from the thirty identified in Appendix A. The GI Plan will be amended or updated as required by the San Francisco Bay RWQCB, such that other locations, if deemed feasible as potential projects, may be added over time.

4 Early Implementation Projects

4.1 Review of Capital Improvement Projects

MRP Provision C.3.j.ii. requires that Permittees prepare and maintain a list of public and private green infrastructure projects planned for implementation during the current permit term, and public projects that have potential for green infrastructure measures. The County submitted an initial list of public and private GI projects with the fiscal year (FY) 2015-16 Annual Report to the San Francisco Bay RWQCB, and updated the list in the FY 2016-17 and FY 2017-18 Annual Reports. The creation and maintenance of this list was supported by the following guidance developed by BASMAA: "*Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Program Projects*" (BASMAA, 2016); see Appendix B.

4.2 List of Projects Identified

Watershed Program staff have been in regular contact and coordination with the Public Works Department Divisions of Transportation Engineering, Design and Construction, and Capital Projects Management, to identify potential GI facilities for new or redeveloped County buildings and parking lots, in an effort to fulfill the expectation of the MRP C.3.j provision of "no missed opportunities". Consequently, staff from the Watershed Program and Capital Projects Management Division have been cooperating in identifying when C.3 facilities are needed, as well as when they are developing stormwater control and operations and maintenance plans for them. Those C.3 regulated projects include the following capital improvement projects on County property:

- County Administration Building, 651 Pine St., Martinez
- Office of Emergency Services, 50 Glacier Drive, Martinez
- Contra Costa County Surface Parking Lot, 651 Pine St., Martinez
- Surplus Storage Yard Parking Lot, 50 Glacier Drive, Martinez
- Animal Services Facility Parking Lot and play area expansion, 4800 Imhoff Drive, Martinez
- Martinez Detention Facility parking deck, Willow Street, Martinez.

One example of a ROW project that has implemented GI is the Rio Vista Sidewalk Project, which was constructed in 2018 and incorporated permeable pavement.

In addition, a non-C.3 complete street project in North Richmond, the "Fred Jackson Way First Mile/Last Mile", has been adapted to be a sustainable street by adding GI and other urban greening features. This will be constructed over the next two years and will serve as a County GI demonstration project, as part of the "North Richmond Watershed Connections" (Connections) project; see Appendix C for an exhibit of the Connections project.

The above identified projects are listed in Table 7, along with project status.

Table 7. Capital Improvement Projects with Green Infrastructure Potential (identified 2015-2019)

Project Name	Description	Potential Tributary Impervious Area (acre)	Project Status
Animal Services Facility Parking Lot and Play Area Expansion	New 26 stall parking expansion and dog play area	0.31	Planning
Rodeo Downtown Sidewalk	Sidewalk improvements, including bioretention area	1.27	Design – begin construction 2019
Fred Jackson Way "First Mile/Last Mile"	Construct sidewalk and bike lanes on Fred Jackson Way from Grove Avenue to Brookside Drive	1.93	Design – begin construction 2021
Martinez Detention Facility Parking Deck	New Elevated Parking Deck located at Martinez Detention Facility	0.62	Construction – scheduled to complete Oct. 2019
Office of Emergency Services	Replacement of two County buildings	2.54	Construction – scheduled to complete Jan. 2020
County Administration Building	Office building replacement and new parking structure.	0.83	Construction – scheduled to complete April 2020
Contra Costa County Surface Parking Lot	New Administration Parking Lot	1.41	Completed
Rio Vista Sidewalk	Sidewalk improvements, including permeable pavement	0.02	Completed

Source: County Public Works Department, Transportation Engineering Division (April, July 2019).

5 Tracking and Mapping Public and Private Projects Over Time

5.1 Tools and Process Overview

The CCCWP has developed a county-wide GIS platform for maintaining, analyzing, displaying, and reporting relevant municipal stormwater program data and information related to MRP Provisions C.10 and C.11/C.12. This tool is also being used to track and report on GI project implementation.

The CCCWP stormwater GIS platform features web maps and applications created using the ESRI[7] ArcGIS Online (AGOL) for Organizations environment. This environment can access GIS data, custom web services, and reports hosted within an Amazon cloud service running ESRI ArcGIS Server technology.

The *C.3 Project Tracking and Load Reduction Accounting Tool* within the CCCWP AGOL system is used to track and report on GI project implementation. It is currently used to track and map existing private and public projects incorporating GI. In the future, it may also be used to map planned GI projects and will allow for ongoing review of opportunities for incorporating GI into existing and planned capital improvement projects. The AGOL system can be used to develop maps that can be displayed on public websites and/or distributed to the public. These maps can be developed to contain information regarding the GI project data input into the AGOL system.

The *C.3 Project Tracking and Load Reduction Accounting Tool* is intended to be used to allow for estimates of potential project load reduction for PCBs and mercury and presently supports the BASMAA Interim Accounting Methodology for certain load reduction activities. The tool is planned to be updated with the RAA methodology that is being developed for the County, with that functionality anticipated by the end of the current Permit term (December 2020).

5.2 Online Asset Management Tool

The County already actively utilizes AGOL as a database tool and maintains up-to-date facility data for existing and proposed C.3 and public GI projects. The County is working toward the development of a web-based graphical user interface asset management tool, which would be used for managing infrastructure data, and for supporting planning, maintenance and inspection efforts. In order to develop this asset management tool, the existing AGOL datasets can be leveraged and important data gaps identified to determine what additional data collection may be needed. This new tool can then be utilized for planning, maintenance, and reporting purposes. Planning efforts could benefit by having the potential project locations (presented in Appendix A) as an overlay. Maintenance efforts may be facilitated by allowing field staff to inspect and report current asset conditions, which can inform a maintenance manager as to how resources should be allocated. Reporting functions can benefit users of various County departments and divisions. For instance, this could be used simultaneously by the Transportation Engineering Division, of the Public Works Department, for tracking the progress on capital improvement projects related to GI, while also be used by the Maintenance Division for keeping a record of timing, type, and extent of maintenance for existing facilities. It also be used by the Department of Conservation and

[7] Environmental Systems Research Institute.

Development for determining when a permitted project has completed its C.3 requirements that are part of its conditions of approval.

The County would benefit from an easy-to-use and well-integrated asset management tool. It would provide a foundation for future coordinated planning efforts across various County departments and divisions to achieve multiple objectives, such as: asset management performance indicators, identification of drainage and flood control needs, development of capital improvement schedules, and identification of water reuse opportunities. Properly managing green infrastructure assets is a crucial aspect of practical implementation of this GI Plan. This undertaking will enable County staff to coordinate more effectively and efficiently in the operations, inspection, and maintenance of GI assets.

6 Design Guidelines and Specifications

6.1 Guidelines for Streetscape and Project Design

When determining design elements to be included in streetscape improvements and complete streets projects, it is recommended that project managers and designers consult the NACTO *Urban Street Stormwater Guide* (NACTO, 2017), the *San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook*, specifically Chapter 5: Key Design and Construction Details, (San Mateo Countywide Water Pollution Prevention Program, 2009), and other streetscape resources available on the CCCWP website. These references are provided in Appendix D. Additionally, the BASMAA *Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Program Projects* (BASMAA, 2016) is a valuable resource; see Appendix B.

6.2 Specifications and Typical Design Details

GI features and facilities will be designed and constructed in accordance with the applicable specifications and criteria in the CCCWP *Stormwater C.3 Guidebook* (CCCWP, 2017). Additional details and specifications are available from SFPUC, California Stormwater Quality Association (CASQA) and Low Impact Development Institute (LIDI), and BASMAA. These may be adapted from Appendix B ("Green Infrastructure Details") of the SFPUC *San Francisco Stormwater Management Requirements and Design Guidelines* (SFPUC, 2016), the *Central Coast Low Impact Development Institute Bioretention Standard Details and Specifications* (CASQA and LIDI, 2017), the BASMAA Urban Greening Typical GI Details (BASMAA, 2017b), or other resources compiled by the CCCWP and available through their website. These references are provided in Appendix E.

6.3 Sizing Requirements

For public GI retrofit projects, regional and parcel-based projects should be sized, to the extent possible, to meet the "Volume Hydraulic Design Basis"[8] that is included in MRP Provision C.3.d.i.(1). For regional projects, as defined in Table 5, sizing will be conducted on a project-specific basis and may include consideration of treatment facilities, other pollutant priorities (e.g., trash), or other factors present in the watershed.

For public GI retrofit projects located in the ROW, it is recommended to follow the BASMAA-released *Guidance for Sizing Green Infrastructure Facilities in Street Projects with companion analysis: Green Infrastructure Facility Sizing for Non-Regulated Street Projects* (BASMAA, 2019). This reference is provided in Appendix F.

[8] From MRP Provision C.3.d.i.(1): Treatment systems whose primary mode of action depends on volume capacity shall be designed to treat runoff equal to:

(a) The maximum stormwater capture volume based historical rainfall records, essentially runoff from the 85th percentile 24-hour storm event; or

(b) The volume of annual runoff required to achieve greater-than or equal to 80 percent capture using local rainfall data; in accordance to Section 5 of CASQA's *Stormwater Best Practice Handbook, New Development and Redevelopment* (2003).

7 Funding Options

7.1 Funding Strategies Developed Regionally

Provision C.3.j.i(2)(k) of the MRP states that GI plans are to include "an evaluation of prioritized project funding options, including, but not limited to: Alternative Compliance funds; grant monies, including transportation project grants from federal, State, and local agencies; existing Permittee resources; new tax or other levies; and other sources of funds." This chapter provides an evaluation of funding sources to help facilitate implementation.

7.1.1 Funding Context

Though GI falls generally under the umbrella of stormwater management, it also expands the meaning of stormwater management as municipalities have long conceived it. Just as more municipalities are realizing that stormwater management should be considered an enterprise or utility that is on-par with water and sewer utilities, others are beginning to realize that stormwater management has already outgrown its "utility" status. Stormwater management does not fit neatly into public works functions, but has a range of purposes that must be integrated into municipal planning and land use responsibilities. It is also pushing the limits of what a municipality is empowered to do regarding behavior and practices on private property. This is manifest in the range of documents that make up the GI Plans.

Funding for GI is no less vexing. Under the gray infrastructure model, stormwater funding was used for management and upgrade/expansion of traditional public stormwater infrastructure (inlets, pipes, pump stations, creeks, channels, and levees). Under the new model of green infrastructure, GI serves to extend the benefits of stormwater management, though the funding framework for GI/LID is not well developed.

Traditional stormwater funding has always been a challenging field with many hurdles that are changing as rapidly as the regulations pertaining to stormwater quality. Dedicated and sustainable stormwater funding is usually found in the form of a property-related fee (similar to water and sewer fees). Proposition 218 requires these to be focused around services provided and each property's share of the cost of those services. GI expands the universe of infrastructure beyond the traditional drainage facilities to roads, landscaped areas, and other features not traditionally thought of as Municipal Separate Storm Sewer System (MS4) facilities. As a result, great care must be taken as traditional stormwater funding sources are applied to the GI goals.

Proposition 218 was a constitutional amendment approved by California voters in 1996 and was intended to make it more difficult for municipalities to raise taxes, assessments, and fees, (including property-related fees). As currently interpreted by the courts, Proposition 218 requires that stormwater fees must be approved through a ballot measure, necessitating a much higher approval threshold than for the utilities of water, sewer, and refuse collection, which must only conduct a public hearing. The result is that, in the past two decades, only a handful of municipalities have been able to put any new stormwater revenue mechanisms in place. This has been detrimental to achieving the "one water" goals that are so important in resolving water supply shortages and pollution, and other water resources challenges.

7.1.2 Regionally Developed Planning/Funding Resources

This section both identifies and builds on a couple foundational resources that offer general background information and guidance in formulating funding strategies for GI.

BASMAA – Roadmap for Funding Solutions for Sustainable Streets

BASMAA published the "*Roadmap for Funding Solutions for Sustainable Streets*" in April 2018 (BASMAA, 2018). That report was "developed to identify and remedy obstacles to funding for Sustainable Street projects, which are defined as projects that include both Complete Street improvements and green stormwater infrastructure." The actions contained in the report "are designed to improve the capacity…to fund Sustainable Streets projects that support compliance with regional permit requirements to reduce pollutant loading…while also helping to achieve the region's greenhouse gas reduction targets." Those actions include maximizing available resources and as well as identifying new funding streams.

Although municipal ROW represents only a fraction of the acreage within its boundaries, roadways present some of the best opportunities for GI implementation. Roadways tend to be the first opportunity to grab concentrated, untreated storm flows and route them to (or become) GI facilities.

The BASMAA "Roadmap" provides excellent guidance on making the most of these benefits.

CASQA – Stormwater Funding Resource Website

CASQA has developed a Stormwater Funding Resource webpage. Although it does not focus specifically on GI funding, much of its content is applicable to various aspects of GI funding. It can be found at the following url: https://www.casqa.org/resources/funding-resources. It contains sections that examine sustainable funding, creating a stormwater utility, project funding, and examples of regional funding efforts.

7.2 Local Funding Strategies

It has become evident that downstream funding needs will be substantial and varied in scope. Green infrastructure, by its very nature, is a flexible and variable approach to reducing stormwater pollutants, and therefore will continue to evolve in the coming years in its efficacy, costs, and approaches.

There are several ways to categorize funding. This section looks at whether funding is either on-going, one-time, or debt financing (one-time funds that are repaid in an ongoing manner). This section also distinguishes between balloted and non-balloted, as any funding source that requires a ballot measure will bring more challenges. Figure 5 below helps to visualize these two axes and illustrates a few examples of each.

Figure 5. General Funding Category Matrix.

	Sustainable / Ongoing	One-Time	Long-Term Debt
Balloted	Taxes, Fees & Assessments		GO Bonds *
Non-Balloted	Regulatory Fees Re-Alignment Developer Fees	Grants	COPs ** Revolving Fund

** General Obligation Bonds; ** Certificates of Participation*

Green Infrastructure costs can be divided into three primary elements: planning, design and construction, and operation and maintenance. It is, however, worth noting that not all of these elements can be funded by all funding sources. For example, bond funding is typically only applicable to capital improvement projects and cannot fund early planning or future maintenance. Appendix G contains a matrix of funding sources that cross-reference each source against the types of activity to which it does or does not apply.

7.2.1 Traditional Funding Mechanisms

This section discusses common existing funding mechanisms such as fees, taxes, grants and debt issuance. As indicated in the preceding matrix (Figure 5), some of these mechanisms require a ballot measure, which is discussed separately.

Balloted Mechanisms

There are two basic types of balloted measures appropriate for stormwater funding, namely, property-related fees and special taxes. Successfully implemented balloted approaches have the greatest capacity to significantly and reliably fund stormwater management, but they are often very challenging to enact. Generally, the most important key to a successful ballot measure is to propose a project or program that is seen by the voting community to have a value commensurate with the tax or fee. The two greatest challenges are to craft a measure that meets this threshold, and then to effectively communicate the information to the community.

Since balloted funding mechanisms tend to be the most flexible and sustainable, they are often seen as underpinning an agency's entire program. Not only can they pay directly for services or projects, but a dedicated and sustainable revenue stream can also be leveraged to help secure grants, loans, partnerships, and many other opportunities that present themselves. Without such a dedicated revenue stream, those opportunities must often be missed. Examples of balloted mechanisms include:

- Property-related fees. These are similar to fees imposed for water, sewer, and solid waste services. The primary difference between those fees and fees for stormwater services are that stormwater fees are required to be approved through a ballot measure in accordance with Proposition 218 where a simple 50% majority is required for passage (where one parcel equals one vote). In all other ways they are identical to the other utility fees: they require a fair-share apportionment of costs to rate payers as detailed in a rate study or other cost of service analysis;

they cannot charge more than the proportionate cost of service (e.g., discounts or exemptions cannot be subsidized by other ratepayers); and all revenues must be spent only on the stormwater services. Property-related fees are the most common sustainable revenue mechanism employed by municipalities for stormwater management services. As GI stretches the traditional definition of stormwater management, so too, must a GI-related fee mechanism be "stretched" to encompass the scope of GI.

- Special taxes. These are decided by registered voters and require a two-thirds majority for approval. Special taxes are well known to Californians and are utilized for all manner of services, projects, and programs. They are usually legally very stout and flexible and can support an issuance of debt such as loans or bonds in most cases. There are several types of special taxes, but the most common for stormwater services are parcel taxes. Other types of special taxes include sales, business license, vehicle license, utility users, and transient occupancy taxes. These types can also be implemented as a general (not special) tax, where they would only require a simple 50% majority for passage. But to qualify as a general tax, it must be pledged only for an agency's general fund, in which case any GI or stormwater services must compete with other general funded services such as police, fire and parks. Although a general tax requires only a simple majority, voters tend to show better support for special taxes where the purpose of the tax is explicitly identified.
- General obligation bonds. These are familiar to the voting public. Such bond measures require a two-thirds majority for passage. Bonds are issued to raise funding up front and are repaid through a tax levied against property on the annual property tax bill. One primary restriction on these bonds is that they can only be used for capital projects. While that includes land acquisition, planning, design and construction, the costs for maintenance and operations cannot be paid from the bond proceeds.

Challenges with balloted approaches extend beyond the requirement for voter approval. They include a lack of familiarity by stormwater and GI professionals, the need for extensive community engagement and education, as well as political strategizing. Over the past 15 years, there have been fewer than thirty community-wide measures attempted for stormwater throughout California, and the success rate is just over 50%. Though that has generally been the case, during the most-recent election cycle (November 2018), in both the City of Berkeley and the County of Los Angeles County, voters approved funding measures. Los Angeles' bond, "Measure W," was approved with 69% of the vote; this measure enacts a parcel tax of 2.5 cents per square-foot of impermeable surface.

Though challenging, keys to a successful balloted approach include:

- Evaluate your community's needs and develop a plan for meeting them. This often will come from a needs analysis or a master plan. The more popular projects are ones that the community sees as fixing a problem they know about.
- Know your community's priorities. If agency needs are not seen as priorities by the community, a ballot measure will likely fail. Priorities are usually measured by a public opinion survey, which would identify priorities as well as willingness to pay for the proposed program. Top priorities

identified in the survey should be folded-back into the proposed measure to demonstrate that the agency is responsive to the community's input.

- Communicate with the voters. Community engagement must be tailored to fit the measure. It can range from a brief set of outreach materials (i.e. website and/or flyer) to a comprehensive branding and information effort that can take several months or longer, complete with town hall meetings and media coverage. Knowing your stakeholders and opinion leaders is a must, and special efforts with those groups are always recommended. Note that advocacy by a public agency is strictly forbidden by law, so legal counsel should be involved at some point to help distinguish between outreach and advocacy.
- Know where you stand with the voters. Questions to raise internally include: do voters trust the agency; do they believe that it will deliver on it promises; and how have past ballot measures worked out? If you know the answers to questions like these, and if your answers are not positive or supportive of advancing the measure, then it will be important to develop some corrective strategies before embarking on it.
- Plan for the needed resources. Many public agencies hire professional consultants for critical elements of this process from needs analysis to surveys and community engagement. While these consultants can be costly, it is usually well worth the expense if they can deliver a successful measure. Considerable agency staff time may also be required, since this is a very iterative process that must be presented to the public by agency representatives, not consultants.

Senate Bill (SB) 231, passed by the California State Legislature and signed by the Governor in October 2017, modified the Proposition 218 Omnibus Act, by adding a definition of sewer that included storm drainage. By doing this, stormwater fees can be enacted, or increased without a ballot measure. The legality of the statute, however, will be tested by the authors of Proposition 218 (Howard Jarvis Taxpayers Association) who have promised to sue any municipality that takes advantage of SB 231 by enacting or increasing stormwater fees. So, unless municipalities wish to have this law tested against Proposition 218 judicially, or wish to coordinate among each other in doing so, they should continue to submit stormwater fees to a ballot.

Non-Balloted Mechanisms

Non-balloted funding mechanisms include regulatory fees, developer impact fees, and other opportunistic approaches to funding. Table 8 lists a few of the more common approaches. While these funding approaches do not require voter approval, they still impact various segments of the community and therefore will feel the effects of local politics.

Table 8. Common Approaches to Non-Balloted Funding Mechanisms

Type of Approach	Examples	Comments
Regulatory Fees	• Plan Check Fees • Inspection Fees	Proposition 26 (2010) has significantly limited the applicability.
Realignment of Services	• Water Supply • Sewer • Refuse Collection	Leverage and integrate stormwater elements that qualify under water, sewer, and/or refuse collection categories.
Business License Fees	• Business License Fee	Applies to commercial operations with clear impacts on stormwater such as restaurants and vehicle repairs.
AB 1600 Fees	• Developer Impact Fees	Similar to impact fees aimed at improving water and sewer systems, or parks and schools.
Integration into Projects with Existing Funding	• Transportation or Utility Projects	Takes advantage of multi-benefit projects that also further stormwater goals.

Two of the most applicable approaches for the County to consider are, developer impact fees and realignment, as described below:

- Developer impact fees. These fees are monetary exactions placed on the conditions of approval for a new development. These are also called AB 1600 fees and must be identified in a nexus study of some sort. One of the challenges of utilizing developer impact fees for GI is demonstrating the nexus of the development to impacts on stormwater quality. Most new development is already subject to Provision C.3, which may be considered adequate to cover those impacts. Therefore, care must be taken before charging additional impact fees.
- Realignment. This term is applied to reorganizing the internal work flow and/or financial tracking of revenues and expenditures of certain stormwater management activities that support other non-balloted fee structures (i.e. water, sewer, and refuse collection). The most common example is that of trash capture. The MRP, where it is functioning as a stormwater pollutant reduction permit, requires the County to implement a trash capture plan. Collecting trash, however, is a function of the community's trash collection system, which does not require voter approval for fee increases. Therefore, the County could charge all of its trash capture expenses (capital, operations and maintenance, and administrative) directly to properties that contribute to the trash burden.

Grants and Loans

Grants and loans are typically one-time funds from an outside source. Because of their one-time nature, they are best suited for finite projects or programs (rather than ongoing and recurring operational and maintenance programs). Grants do not have to be repaid whereas loans do require repayment (usually with interest). Both require an agency to apply and are usually competitive. Most grants are targeted to specific programs or features, so crafting a project to fit with the grant goals and objectives is challenging. Federal, state and regional grant programs have funding available to local governments to support GI efforts. Several current grant programs are listed in Appendix G. Below are listed some benefits and challenges with both types of funding:

Benefits:

- Grants can fund programs or systems that would otherwise take up significant general fund revenues.
- Grants often fund new and innovative ideas that a local agency might otherwise be reluctant to take on using general funds.
- Grants can be leveraged with other sources of funding, which can serve to increase the viability, benefits, and/or size of a GI project.
- Successful implementation of a grant-funded project can establish a positive precedent that can lead to receipt of other grants.
- Certain loan programs such as the State Revolving Fund can offer lower-than-market interest rates and less security requirements.

Challenges:

- Timelines for grants often do not fit with an agency's timelines for project implementation.
- Coordinating multiple grants for a single project can be particularly challenging as timelines and matching fund requirements may not align.
- Most grants require an agency to furnish matching funds from outside of the grant, so they cannot generally be considered as stand-alone sources of funding.
- Grants and some loans are competitive in nature, and have limited funding levels.
- Grants are often limited to specific goal and objectives that may not fit with those of the agency (such as GI goals).
- Alternatively, some grants may require multiple objectives be fulfilled as part of a project, some of which may not be consistent with, or applicable to the mission of the agency.
- Grant applications can require considerable staff time and coordination resources, with no guaranty of success.
- Most grants require that the agency commit to providing post-project maintenance without providing the associated funding for it.
- Loans and bond programs require ongoing, dedicated funding to make debt payments.

While grants and loans can be sought for funding critical projects such as GI, they are best when underwritten by some sort of ongoing revenue source that can provide matching funds, post-project operation and maintenance funds, or debt payments. The California Clean Water State Revolving Fund is one type of revolving fund loan may be a good option.

7.2.2 Special Financing Districts

Special financing districts are financial structures created by local agencies for the purpose of levying taxes, fees or assessment for specific improvements and/or services provided. While most special

financing districts require a ballot process, they are often employed with new development projects when all the property(ies) are owned by one entity. As such, the balloting is an administrative function with an assured outcome.

There are four basic types of special financing districts that apply to GI: benefit assessments; community financing districts (CFD, or Mello-Roos); business improvement districts (BID); and enhanced infrastructure financing districts (EIFD). Each of these can be used to support debt service. Further detail regarding each is provided below:

- Benefit assessments. These are relatively restrictive in that they must account for any general benefit to property not within the district, which in turn cannot be included in the assessment calculation for the properties. With GI, the general benefits could be considerable thereby diluting the funding potential for this option. This option requires a simple 50% majority (with ballots weighted by the amount of the assessment), and public or tax-exempt properties cannot be exempted.
- CFDs. These districts utilize a tax (not an assessment) and are the most flexible. There is no general benefit restriction, and there is flexibility in exempting various types of properties (government, tax exempt, etc.). As a special tax, a two-thirds majority is required for approval.
- BIDs. These are limited to business districts, which can be inclusive of a specified residential area/district; they can be used to assess property owners and/or business owners for certain improvements and services. Green infrastructure features can function as aesthetic improvements that are popular with business districts (e.g., permeable pavers on streets, GI bulb-outs, and rain gardens). The most applicable version of a BID that is applicable to GI implementation and maintenance is a “Green Benefits District” that has been successfully pioneered by the City of San Francisco/SFPUC.
- EIFDs. These are a form of tax increment financing that captures the increase in property tax as properties within the district are developed to a higher assessed value. This is a relatively new mechanism (signed into law in 2014) and has only been implemented a handful of times around the state. The proceeds are intended to be used to enhance the properties within the district, usually through infrastructure improvements, which, in turn, fuels the property assessment increase. The most common infrastructure enhancements have been in the areas of transportation and parks, but utilities have also benefited. There is a potential for using this mechanism for GI, although there hasn't been a successful implementation along those lines yet.

7.2.3 Alternative Compliance

The MRP contains a vast array of elements for which compliance is required. In some cases, straightforward compliance may be impractical or impossible, and the RWQCB has shown a willingness to consider alternate compliance in one form or another. Provision C.2.e.i allows the following alternative compliance options:

- Construction of a joint stormwater treatment facility
- Construction of a stormwater treatment system off-site (on public or private property)

- Payment of an in-lieu fee toward the cost of a regional project.

The first two options do not generate revenue for use on a regional GI project, but they could deliver GI facilities that further the goals of the GI Plan. The in-lieu fees option can be cultivated into a source of revenue to be used in pursuit of the Plan. This can be particularly useful in cases where a GI project, whether regional in scope or smaller, can deliver "more bang for the buck." In other words, a well-designed regional project can often deliver more GI benefit per dollar than distributed GI facilities. It is in those cases where an in-lieu fee program can be useful.

A subset of in-lieu fees is to use a mitigation approach for developments or other properties that need to offset impacts to the community and/or environment. This can be implemented on an ad hoc basis and negotiated on a case-by-case basis both in terms of the mitigation contribution and how the funds are to be used by the County.

Another type of alternative compliance program is a credit trading program. Credits created by one project are traded to another project that may not be able to meet MRP requirements. Such a program is typically managed by a governmental agency and can create incentives to treat stormwater in excess of the MRP requirements on regulated sites, while also creating incentives to install systems that treat stormwater on non-regulated sites.

7.2.4 Partnerships

While teaming up with other agencies or other organizations may not generate additional funding directly, partnerships can offer many other benefits that can support overall resources needed to deliver GI projects. These can come in the form of economy-of-scale savings or multi-benefit projects that can achieve multiple goals for a single price. Several such strategies, as well as some other beneficial strategies, are discussed below.

- Multi-agency partnerships. Such partnerships are the most common. Large or regional projects may not fit easily within a municipal boundary, so a partnership between stakeholders may facilitate implementation. Green infrastructure works best on a watershed basis, another way geography transcends stakeholder boundaries. Another benefit is the resource sharing that comes along with a multi-agency partnership, helping projects to cost less overall.
- Transportation opportunities. These are also a common way for GI features to be implemented. Complete streets and green streets movements, as well as MRP requirements for transportation projects, have all helped promote GI as a standard design feature for transportation projects. Agencies may consider providing additional treatment capacity when conditions are favorable. In these situations, the additional investment could result in a higher quality treatment and a cost savings for the agency by providing GI credits beyond the subject project and extend these credits for a second capital project site where conditions are more restrictive.
- Caltrans mitigation. Caltrans, which has its own MS4 permit, is allowed to meet requirements outside of their own ROW, when onsite opportunities are not sufficient. As a result, Caltrans looks for opportunities to collaborate with local agencies to find off-site GI solutions while bringing their

own funding sources. This is similar to the alternative compliance model mentioned in Section 7.2.3 above.

- Public-Private Partnerships (P3s). This strategy has the potential to help many communities optimize their limited resources through agreements with private parties to help build and maintain public infrastructure. The state enacted legislation in 2007 that enabled the P3 model, and since then agencies have used P3s for public infrastructure projects. This strategy could be particularly applicable for North Richmond and/or Bay Point.
- Not-for-Profit (NFP). These types of work forces can be a valuable resource to help make scarce resources stretch further. This strategy is based on a "community-based" habitat stewardship and protection approach and has been incorporated into the missions of numerous environmental NFPs. This approach is widely supported by the public, as the passage of recent water, park and open space ballot measures in the San Francisco Bay Area and greater California have demonstrated. This approach has also been used for both GI construction and post-project maintenance. Some NFPs have been training "green collar" workers to both build and maintain GI features on behalf of municipalities, as is occurring in Richmond. This kind of community-based model can serve to foster a public/non-profit partnership where NFP's perform "fee-for-service" contracts with agencies to help plant/construct and/or maintain GI features. This is a relatively new and innovative variation to the P3 approach described above. Benefits of a NFP collaboration include public education and building community support for an agency's clean water program.
- Volunteers. Volunteer work forces can also be a resource for GI projects. Relying on work performed by a strictly volunteer workforce has drawbacks including recruiting, overseeing, training and managing volunteers as well as the reliability and quality of work. In some cases, volunteer work forces are sponsored or managed by a NFP, which may offset some of the drawbacks. Benefits of a volunteer program include public education and building community support for an agency's clean water program.
- Philanthropy. This is an option that could have some potential for attracting funding or other resources. Many large corporations often look for ways to benefit the communities in which they reside, and GI facilities can provide them beneficial visibility while they help move projects forward.

7.3 Optimal Strategies for Contra Costa County

The GI Plan and the potential projects identified within it are wide ranging and cover a variety of scopes, locations, sizes, impacts, benefits and costs. Likewise, the funding tools and options for those projects are also varied (as indicated above), with some applicable for built-out communities and others more appropriate for where redevelopment or infill housing is occurring. To assist the County in the task of pairing projects with funding, it is useful to begin by focusing on the most promising funding strategies. Nine funding strategies have been identified, with the advantages and disadvantages of and the "best applications" for each strategy compared in a GI funding summary matrix shown as Table 9 on the following pages.

Table 9. Optimal GI Funding Strategies for Contra Costa County

Strategy		Requirements	Pros	Cons	Best Applications	Planning / Design	Capital	O & M
1	Stormwater Fee	* Define services and service area(s); * Rate study; * Ballot Approval	* Excellent financial foundation for stormwater and GI; * Flexible and legally stout; * Can be used for matching funds for grants; * Debt can be issued in most cases; * SB 231 may open the way for no balloting	* Ballot measure required; * Significant public outreach recommended	* Should be considered for all applications; * May work best in sub=regional or watershed areas; * Revenue can be used flexibly; * Excellent for maintenance costs	X	X	X
2	Green Benefits District (GBD)	* Usually used in small areas such as business districts or neighborhoods; * Define services and service area; * Weighted ballot Approval	* Services can be narrowly defined for GI; * Can include both residential and commercial; * Can fund both construction and maintenance; * Local control over services and finances; * Opportunity for volunteerism to control costs; * Provides enhancements over baseline services	* Ballot measure required; * Cannot use debt financing; * Local consensus can be disrupted by dissenting businesses	Best in: * New or Re-developments; Also good in: * Existing areas; or * Mixed development; Excellent for maintenance costs and P3 approaches for sit	X	X	X
3	Enhanced Infrastructure Financing District	<u>With No Debt</u>: * Establish a Public Finance Authority; * Adopt a Financing Plan; * Resolution(s) from participating agencies <u>With Debt</u>: * All of the above; * Get approval from at least 55% of voters in District	* Can fund many types of projects; * Does not require a vote (unless debt is part of the plan, then a 55% majority is required); * Can include multiple municipalities and special districts, so area can be tailored to needs (e.g. watersheds, high legacy pollutant areas, countywide)	* Has not been applied to GI; * Cannot be used for operations, maintenance or repairs; * Education districts are not permitted to participate; * GI is only a small piece of what an EIFD can do - it may take a back seat to other, larger community concerns	* Best in a redeveloping area; * Only eligible for CIP (not O&M); * Most likely to work when incorporated into a full EIFD scope	X	X	

Strategy		Requirements	Pros	Cons	Best Applications	Planning / Design	Capital	O & M
4	Not-for-Profit (NFP) Partnership	* Contract or MOU; * Based on qualifications	* Provide expertise for GI or related services; * Costs may be greatly reduced from market rate; * Usually community-based and sometimes local; * Can be applied to both construction and maintenance especially in green benefit districts * Can Increase community interest	* May be restricted to certain scope or locations; * May need to meet prevailing wage requirements; * Limited competition may drive costs up	* Applicable to most GI projects; * Best when incorporated into design and build processes; * Excellent for maintenance activities;	X	X	X
5	Community Development Corporation	* Contract or MOU; *Determined by mission statement	* Provide expertise for GI or related services; * Works at the neighborhood level; * Can be applied to both construction and maintenance; * Can Increase community interest	* May be restricted to certain scope or locations; * May need to meet prevailing wage requirements; * Limited competition may drive costs up	* Applicable to most GI projects; * Best when incorporated into design and build processes; * Excellent for maintenance activities	X	X	X
6	Volunteers	* To be effective, volunteers need organization and oversight; * Can be used to supplement paid contractors, or perform entire projects	* "Free" labor; * Some volunteers provide needed expertise; * Increases awareness of GI program; * Some non-profit organizations have ready-made volunteer groups that are trained and organized; * Can build public support for dedicated revenue mechanism such as a fee; * Education program for community	* Requires significant staff resources to recruit, organize, train and plan & supervise the work; * Can be unreliable - hard to build schedule and cost forecasts around volunteer work force; * Can create conflict with prevailing wage requirements; * Difficult to incorporate into project construction work	* Can be used to reduce maintenance costs for most projects; * May be applicable to certain construction projects as well	X	X	X

Strategy		Requirements	Pros	Cons	Best Applications	Planning / Design	Capital	O & M
7	Developer Fees, In-Lieu Fees & Credit Trading Program	Develop program of regional projects and costs apportioned to development (nexus study per AB 1600)	* Collective funding can help fund regional projects where best return on GI investment occurs; * Helps struggling development meet GI requirements	* Nexus study must demonstrate connection between development and GI need; * Administration of funds requires resources; * Credit Trading will require program creation	* Best when utilized to fund regional projects; * Can apply to development anywhere within jurisdiction	X	X	X
8	Mitigation Fees Fund	Local mitigation funds from polluters or other entities needing to offset impacts to a community and or the environment.	* Be aware of opportunities & apply when practical * Flexible in how applied (ad hoc basis)	* Projecting revenue is difficult; * May need to comply with Prop 26	Be aware of opportunities & apply when practical	X	X	X
9	Other Opportunistic Strategies	* Grants; * Transportation; * Caltrans Mitigation; * Realignment	Be aware of opportunities & apply when practical	Requires diligence and awareness of candidate programs and projects	Be aware of opportunities & apply when practical	varies		

8 Adaptive Management

8.1 Process for Plan Updates

The County will amend or update the GI Plan as required by the San Francisco Bay RWQCB. Plan revisions may include updates of public and private GI projects implemented and public GI projects identified for future implementation. Components of this Plan will also be included in other future County planning documents, as indicated in Section 1.3.4.

8.2 Pursuing Future Funding Sources

The County is pursuing a number of funding strategies, as described in Chapter 7 and further evaluated in Appendix G, to support implementation of GI projects. For strategies deemed viable for unincorporated areas, a process will be developed to allow for a consistent, clear methodology to enact any appropriate strategy when needed for future GI implementation.

8.3 Alternative Compliance and Credit Trading Investigations

The Cities of San Pablo, Walnut Creek, and Richmond (in conjunction with cities across the San Francisco Bay Area) are proposing to establish a water quality trading/banking system for Contra Costa County to address the countywide load reduction requirements of the PCBs and mercury TMDLs. A water quality trading system has the ability to more efficiently and affordably improve water quality, reduce compliance pressures on Permittees, and decrease the overall costs of water quality improvements. In pursuit of such a system, these three cities have applied for an EPA grant.

9 References

Bay Area Stormwater Management Agencies Association (BASMAA), 2016. Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Program Projects. Prepared by BASMAA Development Committee.

BASMAA, 2017a. Bay Area Reasonable Assurance Analysis Guidance Document. Prepared by Geosyntec Consultants and Paradigm Environmental. June.

BASMAA, 2017b. BASMAA Urban Greening Typical GI Details. Prepared for San Francisco Estuary Partnership Urban Greening Bay Area. Available at: https://www.sfestuary.org/wp-content/uploads/2017/07/FinalGIDetails_Compiled.pdf.

BASMAA, 2018. Roadmap of Funding Solutions for Sustainable Streets. Prepared for San Francisco Estuary Partnership Urban Greening Bay Area. Available at: http://basmaa.org/Announcements/roadmap-of-funding-solutions-for-sustainable-streets.

BASMAA, 2019. Guidance for Sizing Green Infrastructure Facilities in Street Projects with companion analysis: Green Infrastructure Facility Sizing for Non-Regulated Street Projects. Prepared by Dan Cloak Environmental Consulting, EOA, Inc., and Dubin Environmental.

California Stormwater Quality Association (CASQA) and Low Impact Development Institute (LIDI), 2017. CASQA-LIDI Bioretention Details. Available at: https://www.casqa.org/sites/default/files/downloads/2._20170831_generic_drawing_combined_bioretention_details_and_specs.pdf.

Contra Costa Clean Water Program (CCCWP), 2003 (available digitally 2004). Watershed Atlas. Available at: http://cocowaterweb.org/wp-content/uploads/Watershed-Atlas.pdf.

CCCWP, 2017. Stormwater C.3 Guidebook, 7th Edition. Available at: https://www.cccleanwater.org/userfiles/kcfinder/files/Stormwater_C3_Guidebook_7th_Edition_2017-05-12%281%29.pdf.

CCCWP, 2018. Contra Costa Watersheds Stormwater Resource Plan. Public Review Draft.

Contra Costa County, 2008. Municipal Climate Action Plan. Available at: http://ca-contracostacounty.civicplus.com/DocumentCenter/View/2905/Municipal-Climate-Action-Plan-1208-Attachment-A?bidId=.

Contra Costa County, 2015. Climate Action Plan. Available at: http://www.co.contra-costa.ca.us/DocumentCenter/View/39791/Contra-Costa-County-Climate-Action-Plan.

Contra Costa County Department of Conservation and Development (DCD), 2005 (reprint 2010). General Plan 2005-2020. Available at: http://www.co.contra-costa.ca.us/4732/General-Plan. Accessed April 2019.

Contra Costa County DCD, 2016. Complete Streets Policy of Contra Costa County. Available at: http://www.co.contra-costa.ca.us/DocumentCenter/View/42238/23923_Exhibit-A---Complete-Streets-Policy-Final-Draft?bidId=.

Gobas, F. and Wilcockson, F., 2003. San Francisco Bay PCB Food - Web Model. SFEI Contribution No. 90. San Francisco Estuary Institute , Simon Fraser University, EVS Environmental Consultants: Oakland, CA.

National Association of City Transportation Officials, 2017. Urban Street Stormwater Guide. Island Press.

San Francisco Bay Regional Water Quality Control Board (RWQCB), 2004. Amending the Water Quality Control Plan for the San Francisco Bay Region to Establish a Total Maximum Daily Load and Implementation Plan for Mercury in San Francisco Bay (Resolution R2-2004-0082).

San Francisco Bay RWQCB, 2008. Amending the Water Quality Control Plan for the San Francisco Bay Region to Establish a Total Maximum Daily Load and Implementation Plan for PCBs in the San Francisco Bay (Resolution R2-2008-0012).

San Francisco Bay RWQCB, 2015. Municipal Regional Stormwater Permit (Order No. R2-2015-0049).

San Francisco Bay RWQCB, 2019. Conditional Acceptance of Guidance for Sizing Green Infrastructure Facilities in Streets Projects. Memorandum. June 21.

San Francisco Public Utilities Commission, 2016. San Francisco Stormwater Management Requirements and Design Guidelines, Appendix B: Green Infrastructure Typical Details and Specifications.

San Mateo Countywide Water Pollution Prevention Program, 2009. San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook. Prepared by Nevue Ngan Associates and Sherwood Design Engineers.

State of California, Department of Finance, 2018. E-1 Population Estimates for Cities, Counties and the State with Annual Percent Change — January 1, 2017 and 2018. Sacramento, California. May.

United States Geological Survey, 2011. National Land Cover Database. Multi-Resolution Land Characteristics Consortium. Available at: https://www.mrlc.gov/data/nlcd-2011-land-cover-conus-0.

Appendix A. Potential Public Green Infrastructure Retrofit Project Locations List and Maps

Appendix A. Potential Public Green Infrastructure Retrofit Project Locations List and Maps

This appendix includes the list and associated maps of potential public green infrastructure retrofit project locations, also referred to as potential project locations:

1. Table A.1. List of Potential Public Green Infrastructure Retrofit Project Locations

2. Figure A.1. Potential Project Location Distribution Map

3. Maps 1 through 30.

Table A.1. includes thirty potential project locations, listed alphabetically. Figure A.1. is a County-wide perspective of the potential project locations, including demarcation of Regional Water Quality Control Board jurisdictions, and delineation of County Supervisor Districts. The individual potential project location maps show the approximate parcel or roadway Right-of-Way in yellow. Some maps show a pale yellow delineation; this is referred to as “Other Potential Project Location” in the legend, and represents another listed potential project location which overlaps on the map extent of the subject location. Where available, the maps also show other features (from map legend): parcel boundary, storm drain line, channel, and storm drain inlet.

Table A.1. List of Potential Public Green Infrastructure Retrofit Project Locations

No.	Location	CCW SWRP ID	Project Type	Location Area (acre)[a]	Impervious Surface (acre)[a]
1	Antioch	planned_699	Planned Unlined Bioretention	0.9	0.7
2	Antioch	planned_705	Planned Unlined Bioretention	0.7	0.4
3	Antioch	planned_712	Planned Unlined Bioretention	0.2	0.2
4	Byron	planned_600	Planned Unlined Swale	2.9	1.7
5	Concord	planned_836; planned_837	Planned Unlined Bioretention	0.9	0.6
6	Concord	planned_930	Planned Unlined Bioretention	1.3	0.9
7	Crockett-Port Costa	ROW_6054	ROW Opportunity	0.7[b]	0.7[b]
8	Knightsen	planned_360	Planned Water Quality Basin	0.7[b]	0.4[b]
9	Lafayette	planned_1079	Planned Unlined Bioretention	1.1	0.5
10	Martinez	planned_1139; planned_1140	Planned Unlined Bioretention	0.4	0.4
11	North Richmond	ROW_2768	ROW Opportunity	8.1	4.7
12	North Richmond	ROW_8096	ROW Opportunity	3.3[b]	2.1[b]
13	North Richmond	ROW_14519	ROW Opportunity	13.6[b]	8.6[b]
14	North Richmond	ROW_14957	ROW Opportunity	6.4[b]	2.2[b]
15	Pacheco	ROW_224	ROW Opportunity	1.3	0.9
16	Pacheco	ROW_13183	ROW Opportunity	1.7	1.1
17	Pacheco	ROW_16577	ROW Opportunity	2.5	1.7
18	Pittsburg	planned_713	Planned Unlined Bioretention	1.8	1.2
19	Richmond	planned_1284	Planned Unlined Bioretention	0.1	0.1
20	Richmond	planned_1290	Planned Unlined Bioretention	2.9	2.2
21	Richmond	planned_1292	Planned Unlined Bioretention	1.4	1.0
22	Rodeo	Parcel_256018	Parcel-Based Opportunity	2.3[b]	2.3[b]
23	Rodeo	planned_1097	Planned Unlined Bioretention	0.3	0.2
24	San Pablo	planned_1272	Planned Unlined Bioretention	3.8	3.3
25	San Pablo (Greenwood and Fordham)	N/A	ROW Opportunity	0.4[b]	0.4[b]
26	San Pablo (Montarabay)	planned_1177	County Requested	1.9[b]	1.9[b]
27	Unincorporated Martinez Neighborhoods	Parcel_243602	Parcel-Based Opportunity	2.0	1.3
28	Unincorporated Martinez Neighborhoods	planned_943	Planned Unlined Bioretention	0.3	0.1
29	Unincorporated Richmond Neighborhoods	planned_1182	Planned Unlined Bioretention	0.2	0.1
30	Walnut Creek	planned_966	Planned Unlined Bioretention	0.6	0.5
			Total =	65 acres	42 acres

Notes:
1. The above list resulted from prioritization, TAG review, site visits, and addtitional feedback from the County.
2. Location Area and Impervious Surface quantities from Countywide Attainment Tool (denoted [a]), else GIS (denoted [b]).
3. The "Location Area" column represents the approximate footprint of the parcel or ROW. It is not the drainage area.
4. The "Impervious Surface" column represents the impervious surface area within the Location Area.

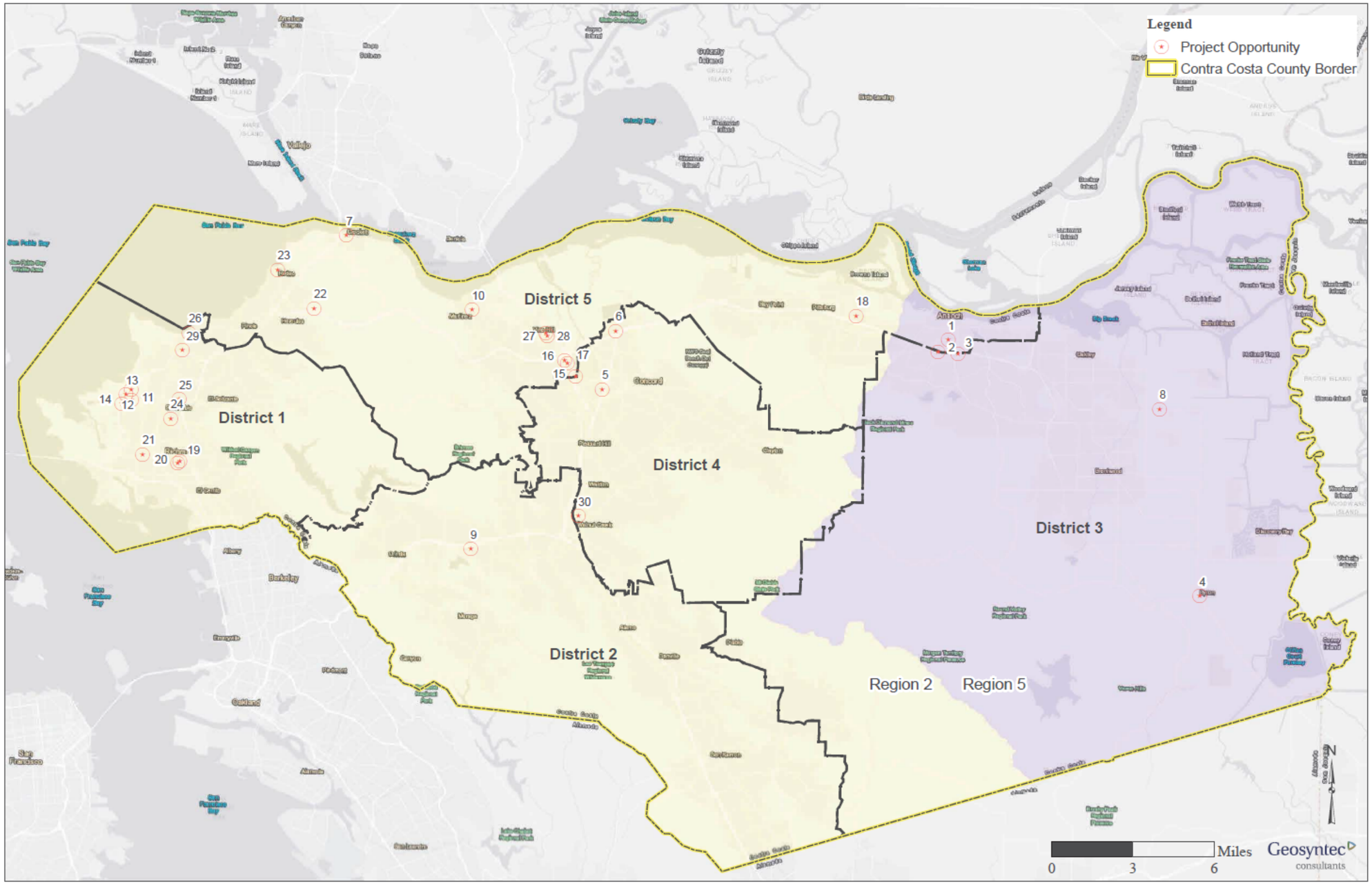
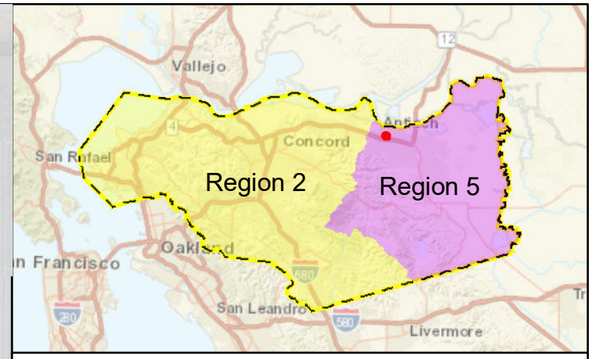


Figure A.1. Potential Project Location Distribution Map.



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 1

APN 067221014

Street Name

CCW SWRP ID planned_699

Location Antioch

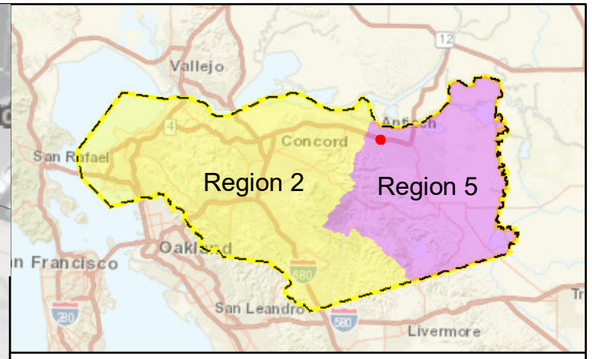
N

0 30 60 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A	July 2019	Map 1



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 2

APN 067342002

Street Name

CCW SWRP ID planned_705

Location Antioch

N

Feet

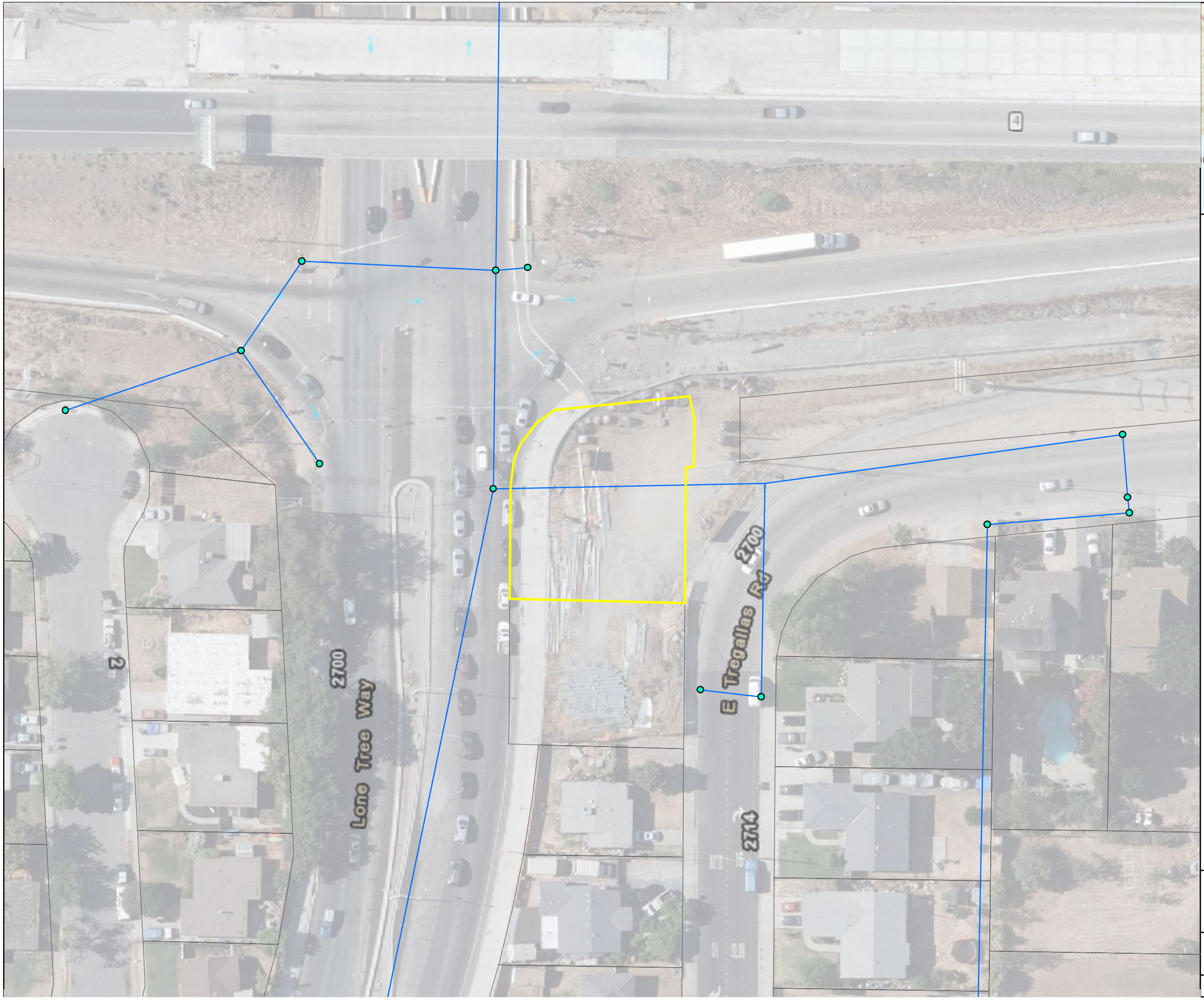
0 30 60

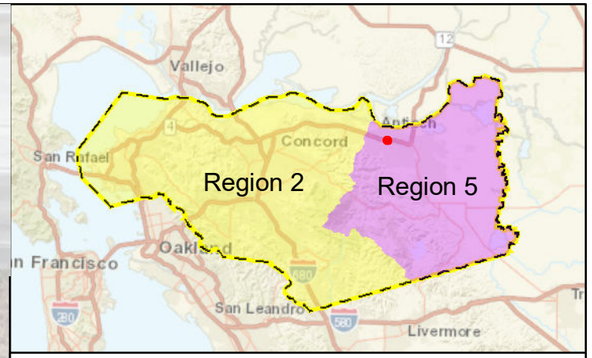
Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 2





Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 3

APN 068151017

Street Name

CCW SWRP ID planned_712

Location Antioch

N

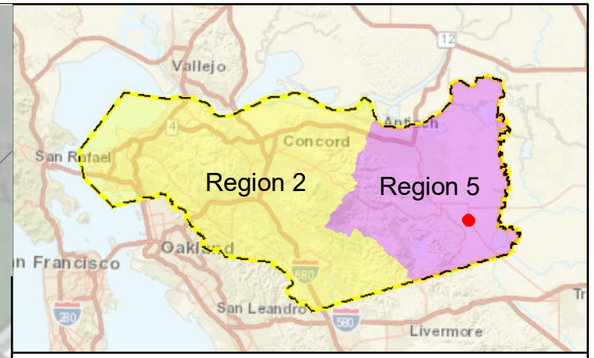
0 30 60 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 3



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 4

APN

Street Name

CCW SWRP ID planned_600

Location Byron

N

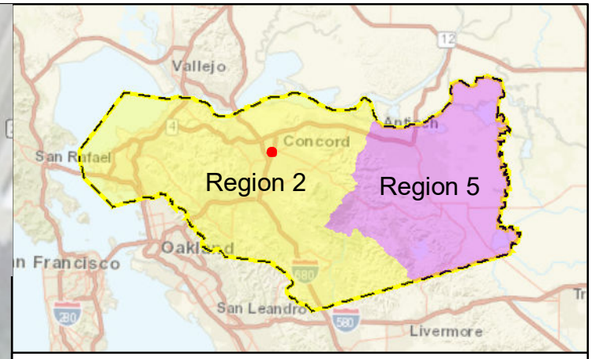
0 110 220 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 4



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 5

APN 126020106 and 126020101

Street Name

CCW SWRP ID planned_836 and planned_837

Location Concord

N

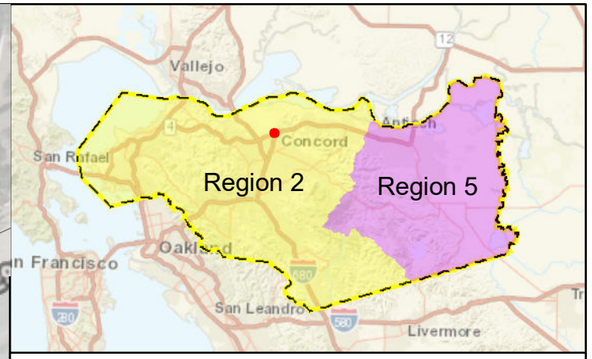
0 50 100 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 5



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 6

APN 159080036

Street Name

CCW SWRP ID planned_930

Location Concord

N

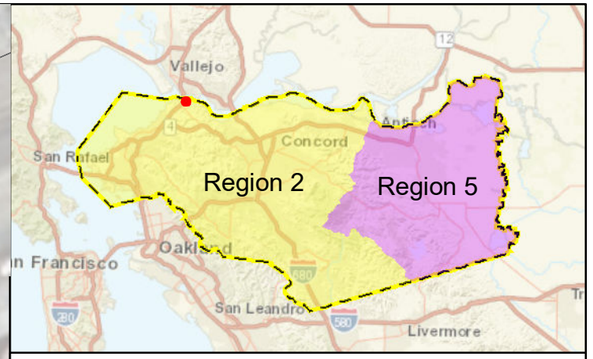
0 30 60 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 6



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 7

APN

Street Name DOWRELIO DR

CCW SWRP ID ROW_6054

Location Crockett-Port Costa

N

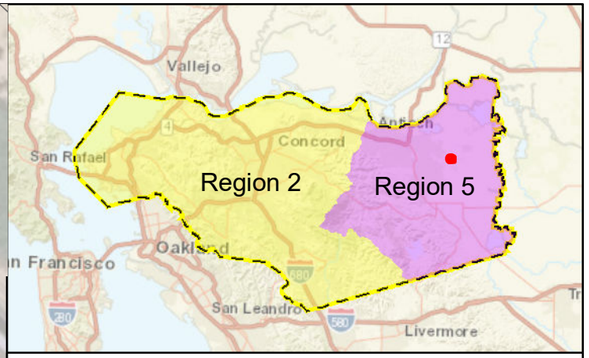
0 50 100 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 7



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 8

APN

Street Name

CCW SWRP ID planned_360

Location Knightsen

N

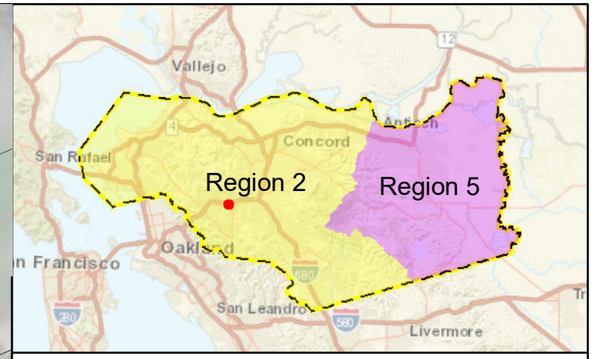
0 80 160 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 8



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 9

APN 241010049

Street Name

CCW SWRP ID planned_1079

Location Lafayette

N

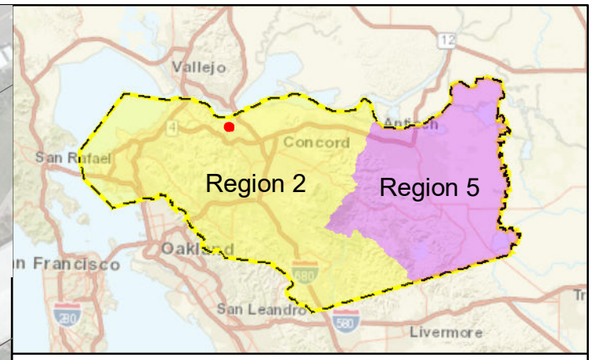
0 50 100 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 9



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 10

APN 373202002 and 373202003

Street Name

CCW SWRP ID planned_1139 and planned_1140

Location Martinez

N

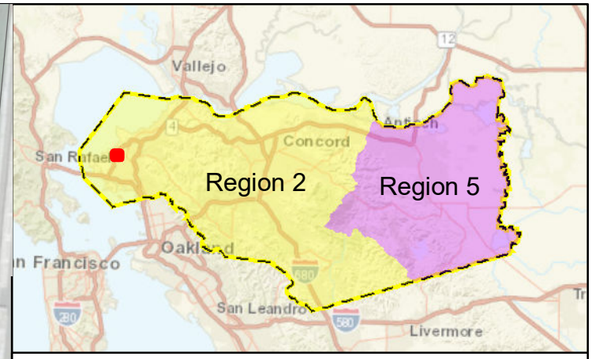
0 40 80 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 10



Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 11

APN

Street Name BROOKSIDE DR

CCW SWRP ID ROW_2768

Location North Richmond

N

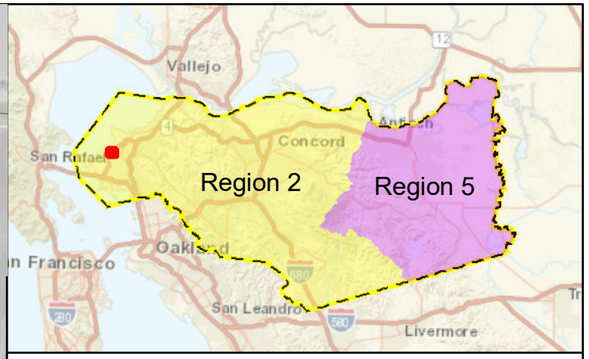
0 190 380 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 11



Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 12

APN

Street Name GOODRICK AVE

CCW SWRP ID ROW_8096

Location North Richmond

N

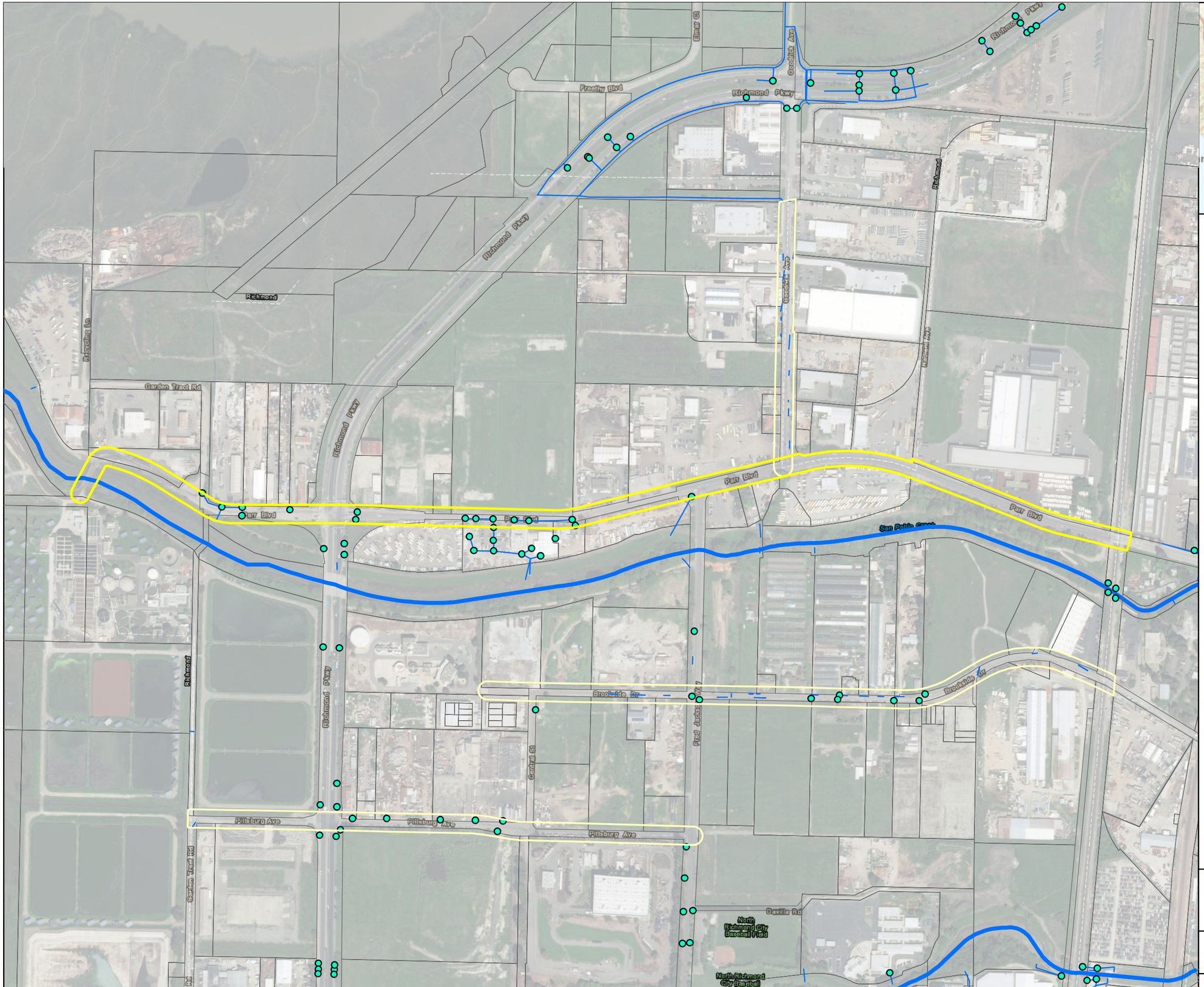
0 160 320 Feet

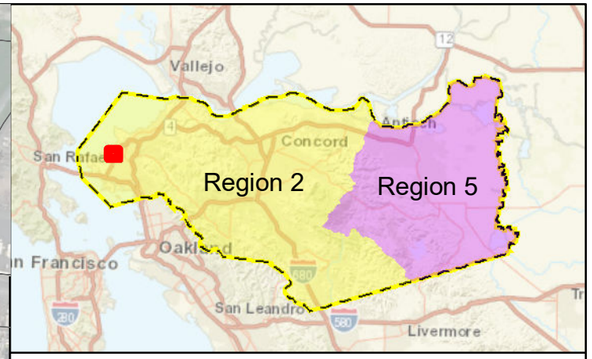
Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 12





Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 13

APN

Street Name PARR BLVD

CCW SWRP ID ROW_14519

Location North Richmond

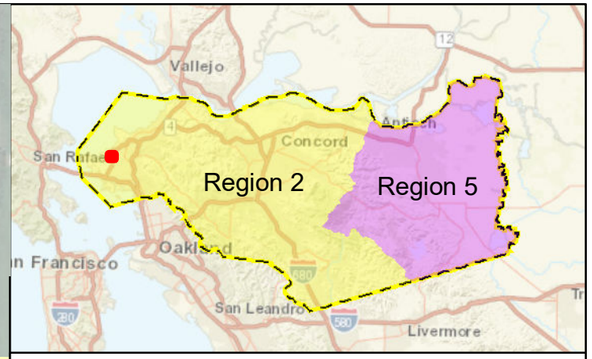
N

0 330 660 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A	July 2019	Map 13



Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 14

APN

Street Name PITTSBURG AVE

CCW SWRP ID ROW_14957

Location North Richmond

N

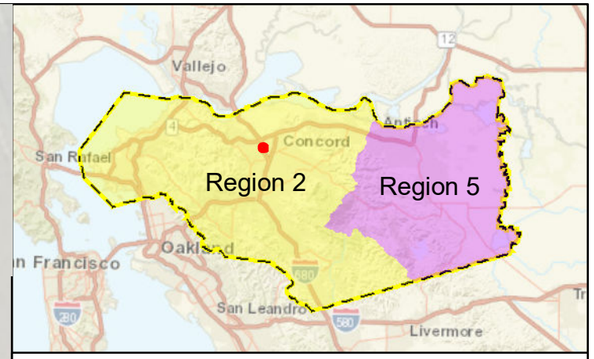
0 160 320 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 14



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 15

APN

Street Name 2ND AVE S

CCW SWRP ID ROW_224

Location Pacheco

N

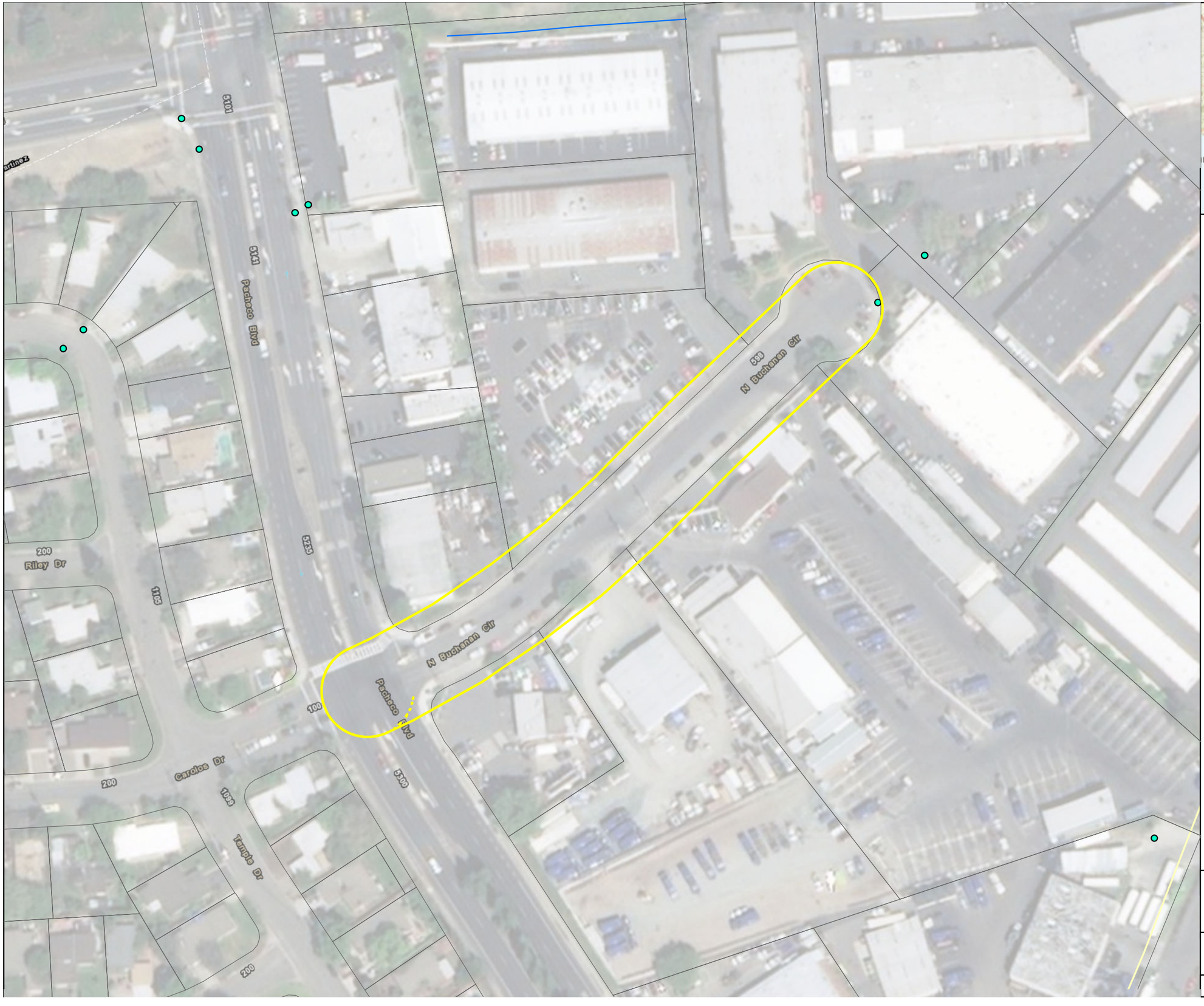
0 60 120 Feet

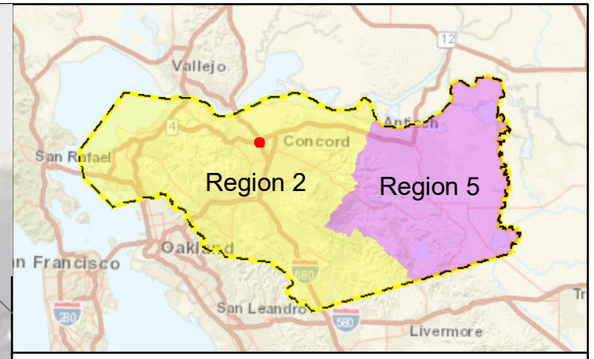
Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 15





Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 16

APN

Street Name N BUCHANAN CIR

CCW SWRP ID ROW_13183

Location Pacheco

N

0 60 120 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 16

Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 17

APN

Street Name S BUCHANAN CIR

CCW SWRP ID ROW_16577

Location Pacheco

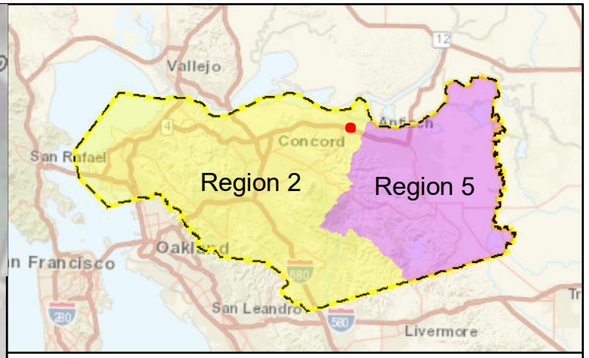
N

0 110 220 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A	July 2019	Map 17



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 18

APN 073140018

Street Name

CCW SWRP ID planned_713

Location Pittsburg

N

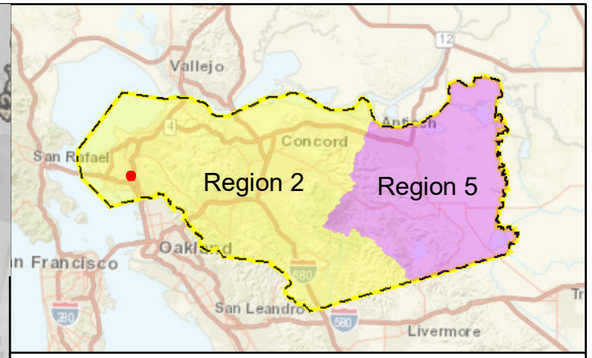
0 50 100 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 18



Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 19

APN 517320017

Street Name

CCW SWRP ID planned_1284

Location Richmond

N

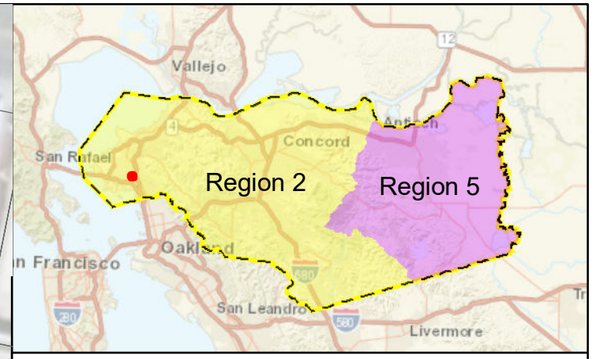
0 40 80 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 19



Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 20

APN 517340004

Street Name

CCW SWRP ID planned_1290

Location Richmond

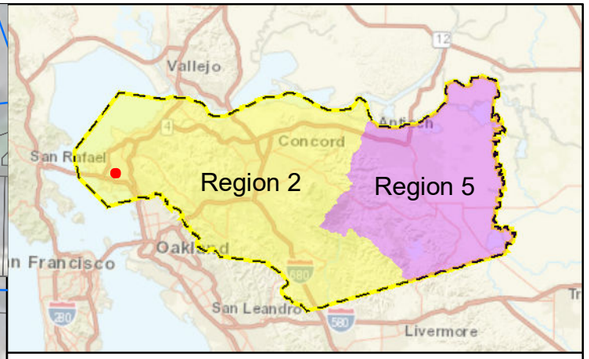
N

0 50 100 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A	July 2019	Map 20



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No	21
APN	540082033
Street Name	
CCW SWRP ID	planned_1292
Location	Richmond

N

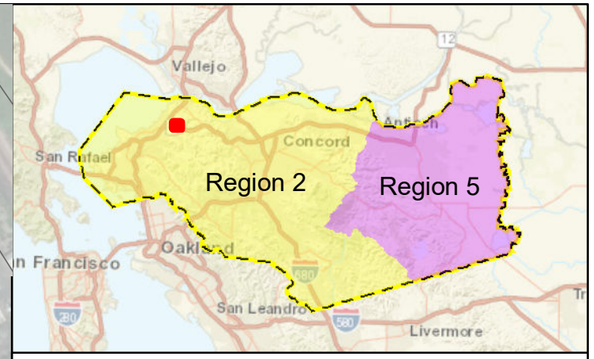
0 50 100 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 21



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 22

APN Goldfields GI

Street Name

CCW SWRP ID Parcel_256018

Location Rodeo

N

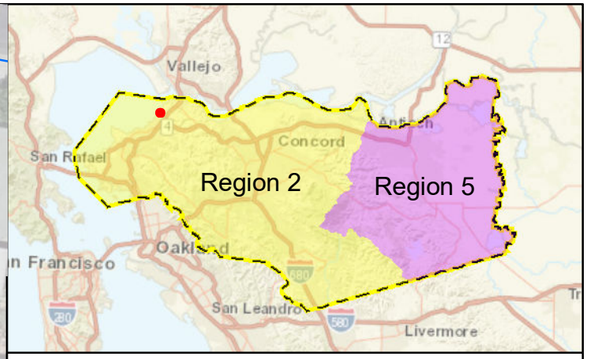
0 220 440 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 22



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 23

APN 357171006

Street Name

CCW SWRP ID planned_1097

Location Rodeo

N

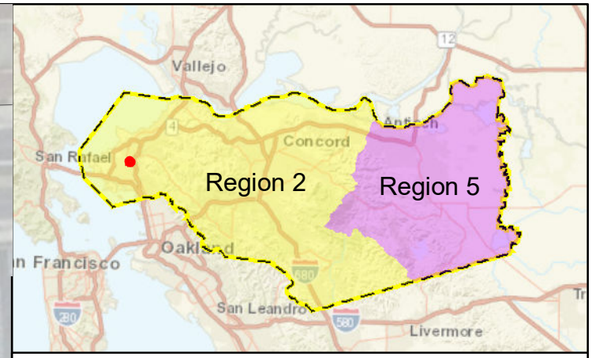
0 40 80 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 23



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 24

APN 417310008

Street Name

CCW SWRP ID planned_1272

Location San Pablo

N

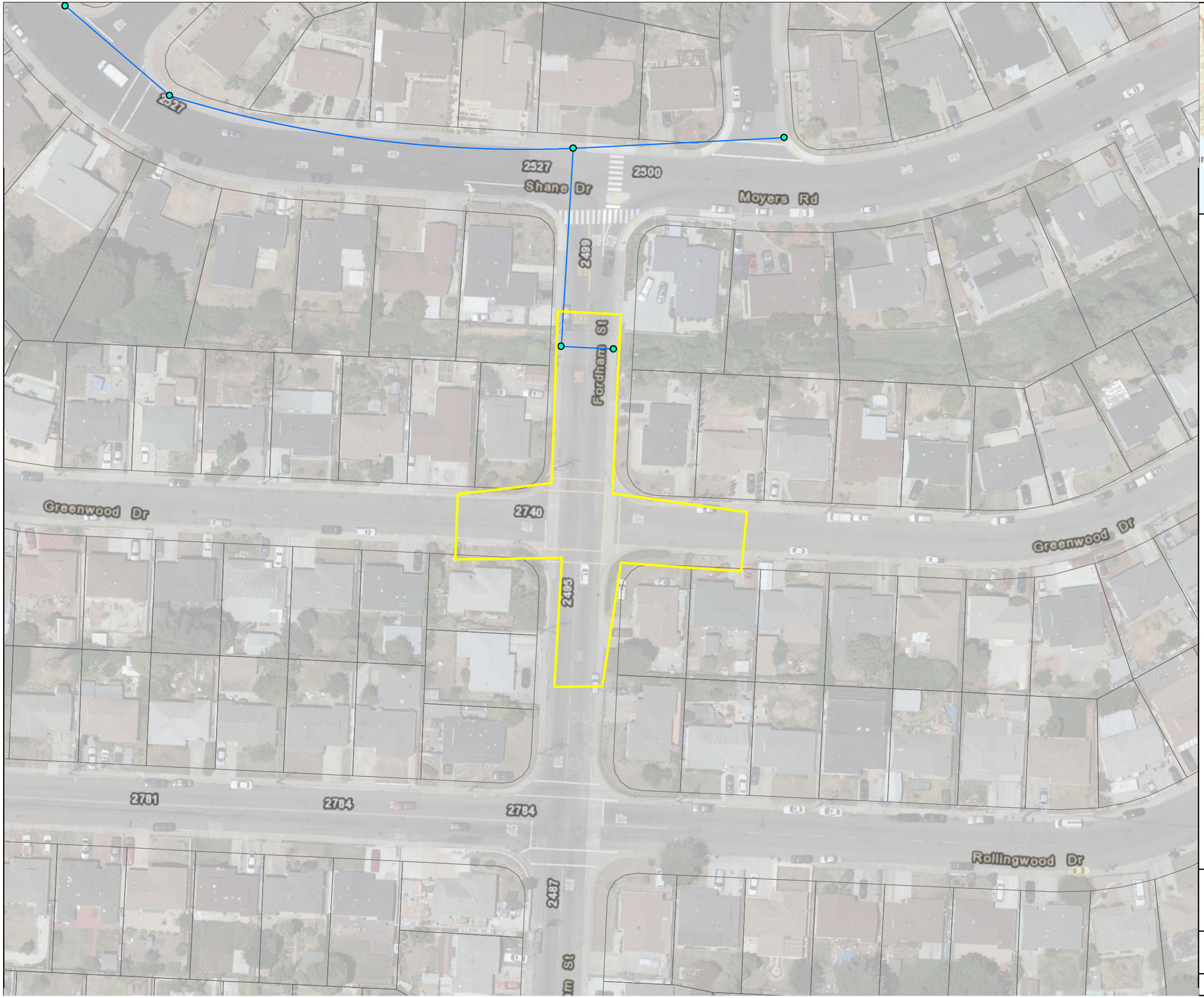
0 60 120 Feet

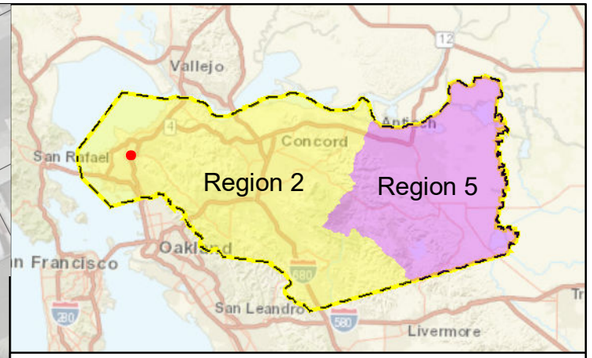
Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 24





Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 25

APN

Street Name Greenwood Dr. and Fordham St.

CCW SWRP ID N/A

Location San Pablo

N

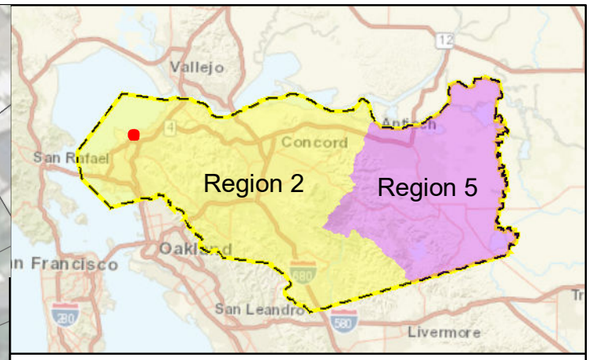
0 40 80 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 25



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 26

APN 403020013

Street Name

CCW SWRP ID planned_1177

Location San Pablo

N

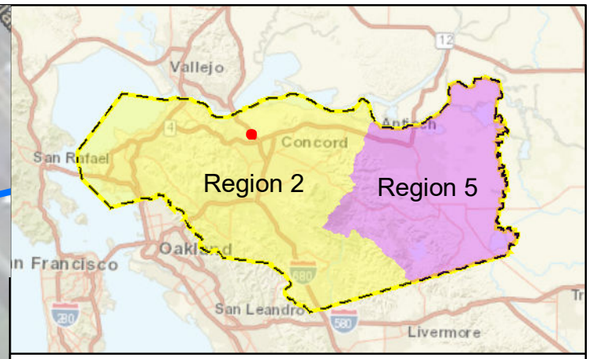
0 80 160 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 26



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 27

APN 380260002

Street Name

CCW SWRP ID Parcel_243602

Location Unincorporated Martinez Neighborhoods

N

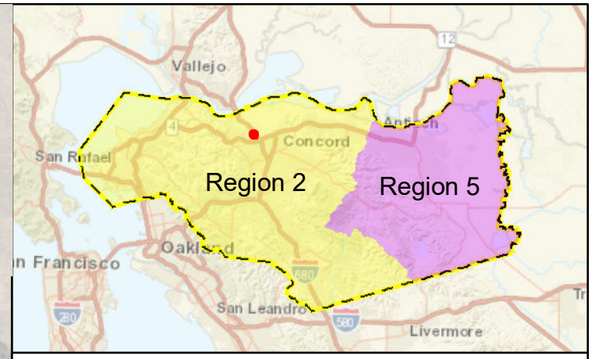
0 50 100 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 27



Legend

- Potential Project Location
- Other Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 28

APN 161261004

Street Name

CCW SWRP ID planned_943

Location Unincorporated Martinez Neighborhoods

N

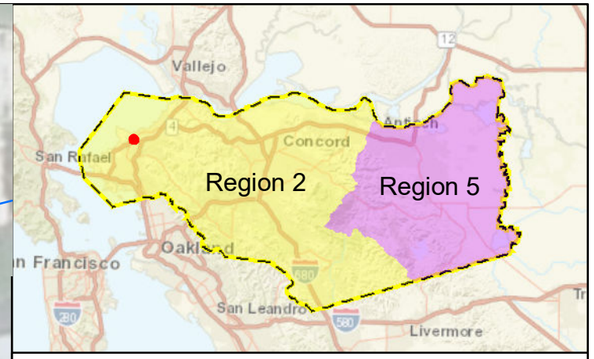
0 40 80 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 28



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No	29
APN	405121002
Street Name	
CCW SWRP ID	planned_1182
Location	Unincorporated Richmond Neighborhoods

0 50 100 Feet

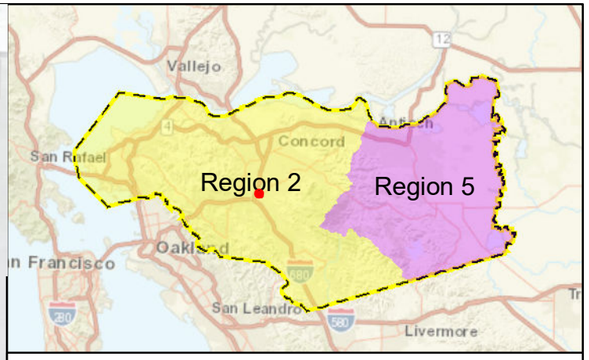
N

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A | July 2019

Map 29



Legend

- Potential Project Location
- Parcel Boundary
- Storm Drain Line
- Channel
- Storm Drain Inlet

Proj. No 30

APN 173142016

Street Name

CCW SWRP ID planned_966

Location Walnut Creek

N

0 40 80 Feet

Contra Costa Public Works GI Plan
Potential Project Locations

Geosyntec consultants

WW2048A	July 2019	Map 30

Appendix B. Guidance for Identifying Green Infrastructure Potential in Municipal Capital Improvement Program Projects

BASMAA Development Committee

Guidance for Identifying Green Infrastructure Potential
in Municipal Capital Improvement Program Projects
May 6, 2016

Background

In the recently reissued Municipal Regional Stormwater Permit ("MRP 2.0"), Provision C.3.j. requires Permittees to develop and implement Green Infrastructure Plans to reduce the adverse water quality impacts of urbanization on receiving waters over the long term. Provisions C.11 and C.12 require the Permittees to reduce discharges of Mercury and PCBs, and portion of these load reductions must be achieved by implementing Green Infrastructure. Specifically, Permittees collectively must implement Green Infrastructure to reduce mercury loading by 48 grams/year and PCB loading by 120 grams/year by 2020, and plan for substantially larger reductions in the following decades. Green Infrastructure on both public and private land will help to meet these load reduction requirements, improve water quality, and provide multiple other benefits as well. Implementation on private land is achieved by implementing stormwater requirements for new development and redevelopment (Provision C.3.a. through Provision C.3.i.). These requirements were carried forward, largely unchanged, from MRP 1.0.

MRP 2.0 defines Green Infrastructure as:

> Infrastructure that uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water.

In practical terms, most green infrastructure will take the form of diverting runoff from existing streets, roofs, and parking lots to one of two stormwater management strategies:

1. Dispersal to vegetated areas, where sufficient landscaped area is available and slopes are not too steep.
2. LID (bioretention and infiltration) facilities, built according to criteria similar to those currently required for regulated private development and redevelopment projects under Provision C.3.

In some cases, the use of tree-box-type biofilters may be appropriate[1]. In other cases, where conditions are appropriate, existing impervious pavements may be removed and replaced with pervious pavements.

In MRP 2.0, Provision C.3.j. includes requirements for Green Infrastructure planning and implementation. Provision C.3.j. has two main elements to be implemented by municipalities:

1. Preparation of a Green Infrastructure Plan for the inclusion of LID drainage design into storm drain infrastructure on public and private land, including streets, roads, storm drains, etc.
2. Early implementation of green infrastructure projects ("no missed opportunities"),

This guidance addresses the second of these requirements. The intent of the "no missed opportunities" requirement is to ensure that no major infrastructure project is built without assessing the opportunity for incorporation of green infrastructure features.

Provision C.3.j.ii. requires that each Permittee prepare and maintain a list of green infrastructure projects, public and private, that are already planned for implementation during the permit term (not including C.3-regulated projects), and infrastructure projects planned for

[1] Standard proprietary tree-box-type biofilters are considered to be non-LID treatment and will only be allowed under certain circumstances. Guidance on use and sizing of these facilities will be provided in a separate document.

implementation during the permit term that have potential for green infrastructure measures. The list must be submitted with each Annual Report, including:

> "… a summary of how each public infrastructure project with green infrastructure potential will include green infrastructure measures to the maximum extent practical during the permit term. For any public infrastructure project where implementation of green infrastructure measures is not practicable, submit a brief description for the project and the reasons green infrastructure measures were impracticable to implement".

This requirement has no specified start date; "during the permit term" means beginning January 1, 2016 and before December 31, 2020. The first Annual Report submittal date will be September 30, 2016.

Note that this guidance primarily addresses the review of proposed or planned public projects for green infrastructure opportunities. The Permittee may also be aware of proposed or planned private projects, not subject to LID treatment requirements, that may have the opportunity to incorporate green infrastructure. These should be addressed in the same way as planned public projects, as described below.

Procedure for Review of Planned Public Projects and Annual Reporting

The municipality's Capital Improvement Program (CIP) project list provides a good starting point for review of proposed public infrastructure projects. Review of other lists of public infrastructure projects, such as those proposed within separately funded special districts (e.g., lighting and landscape districts, maintenance districts, and community facilities districts), may also be appropriate. This section describes a two-part procedure for conducting the review.

Part 1 – Initial Screening

The first step in reviewing a CIP or other public project list is to screen out certain types of projects from further consideration. For example, some projects (e.g., interior remodels, traffic signal replacement) can be readily identified as having no green infrastructure potential. Other projects may appear on the list with only a title, and it may be too early to identify whether green infrastructure could be included. Still others have already progressed past the point where the design can reasonably be changed (this will vary from project to project, depending on available budget and schedule).

Some "projects" listed in a CIP may provide budget for multiple maintenance or minor construction projects throughout the jurisdiction or a portion of the jurisdiction, such as a tree planting program, curb and sidewalk repair/upgrade, or ADA curb/ramp compliance. It is recommended that these types of projects not be included in the review process described herein. The priority for incorporating green infrastructure into these types of projects needs to be assessed as part of the Permittees' development of Green Infrastructure Plans, and standard details and specifications need to be developed and adopted. During this permit term, Permittees will evaluate select projects, project types, and/or groups of projects as case studies and develop an approach as part of Green Infrastructure planning.

The projects removed through the initial screening process do not need to be reported to the Water Board in the Permittee's Annual Report. However, the process should be documented and records kept as to the reason the project was removed from further consideration. Note that projects that were determined to be too early to assess will need to be reassessed during the next fiscal year's review.

The following categories of projects may be screened out of the review process in a given fiscal year:

1. **Projects with No Potential -** The project is identified in initial screening as having no green infrastructure potential based on the type of project. For example, the project does not include any exterior work. Attachment 1 provides a suggested list of such projects that Permittees may use as a model for their own internal process.

2. **Projects Too Early to Assess –** There is not yet enough information to assess the project for green infrastructure potential, or the project is not scheduled to begin design within the permit term (January 2016 – December 2020). If the project is scheduled to begin within the permit term, an assessment will be conducted if and when the project moves forward to conceptual design.
3. **Projects Too Late to Change –** The project is under construction or has moved to a stage of design in which changes cannot be made. The stage of design at which it is too late to incorporate green infrastructure measures varies with each project, so a "percent-complete" threshold has not been defined. Some projects may have funding tied to a particular conceptual design and changes cannot be made even early in the design process, while others may have adequate budget and time within the construction schedule to make changes late in the design process. Agencies will need to make judgments on a case-by-case basis.
4. **Projects Consisting of Maintenance or Minor Construction Work Orders –** The "project" includes budgets for multiple maintenance or minor construction work orders throughout the jurisdiction or a portion of the jurisdiction. These types of projects will not be individually reviewed for green infrastructure opportunity but will be considered as part of a municipality's Green Infrastructure Plan.

Part 2 – Assessment of Green Infrastructure Potential

After the initial screening, the remaining projects either already include green infrastructure or will need to go through an assessment process to determine whether or not there is potential to incorporate green infrastructure. A recommended process for conducting the assessment is provided later in this guidance. As a result of the assessment, the project will fall into one of the following categories with associated annual reporting requirements. Attachment 2 provides the relevant pages of the FY 15-16 Annual Report template for reference.

- **Project is a C.3-regulated project and will include LID treatment.**

  Reporting: Follow current C.3 guidance and report the project in Table C.3.b.iv.(2) of the Annual Report for the fiscal year in which the project is approved.

- **Project already includes green infrastructure and is funded**.

  Reporting: List the project in "Table B-Planned Green Infrastructure Projects" in the Annual Report, indicate the planning or implementation status, and describe the green infrastructure measures to be included.

- **Project may have green infrastructure potential** pending further assessment of feasibility, incremental cost, and availability of funding.

  Reporting: If the feasibility assessment is not complete and/or funding has not been identified, list the project in "Table A-Public Projects Reviewed for Green Infrastructure" in the Annual Report. In the "GI Included?" column, state either "TBD" (to be determined) if the assessment is not complete, or "Yes" if it has been determined that green infrastructure is feasible. In the rightmost column, describe the green infrastructure measures considered and/or proposed, and note the funding and other contingencies for inclusion of green infrastructure in the project. Once funding for the project has been identified, the project should be moved to "Table B-Planned Green Infrastructure Projects" in future Annual Reports.

- **Project does not have green infrastructure potential.** A project-specific assessment has been completed, and Green Infrastructure is impracticable.

  Reporting: In the Annual Report, list the project in "Table A-Public Projects Reviewed for Green Infrastructure". In the "GI Included?" column, state "No." Briefly state the reasons for the determination in the rightmost column. Prepare more detailed documentation of the reasons for the determination and keep it in the project files.

Process for Assessing Green Infrastructure Potential of a Public Infrastructure Project

Initial Assessment of Green Infrastructure Potential

Consider opportunities that may be associated with:

- Alterations to roof drainage from existing buildings
- New or replaced pavement or drainage structures (including gutters, inlets, or pipes)
- Concrete work
- Landscaping, including tree planting
- Streetscape improvements and intersection improvements (other than signals)

Step 1: Information Collection/Reconnaissance

For projects that include alterations to building drainage, identify the locations of roof leaders and downspouts, and where they discharge or where they are connected to storm drains.

For street and landscape projects:

- Evaluate potential opportunities to substitute pervious pavements for impervious pavements.
- Identify and locate drainage structures, including storm drain inlets or catch basins.
- Identify and locate drainage pathways, including curb and gutter.

Identify landscaped areas and paved areas that are adjacent to, or down gradient from, roofs or pavement. These are potential facility locations. *If there are any such locations, continue to the next step.* Note that the project area boundaries may be, but are not required to be, expanded to include potential green infrastructure facilities.

Step 2: Preliminary Sizing and Drainage Analysis

Beginning with the potential LID facility locations that seem most feasible, identify possible pathways to direct drainage from roofs and/or pavement to potential LID facility locations—by sheet flow, valley gutters, trench drains, or (where gradients are steeper) via pipes, based on existing grades and drainage patterns. Where existing grades constrain natural drainage to potential facilities, the use of pumps may be considered (as a less preferable option).

Delineate (roughly) the drainage area tributary to each potential LID facility location. Typically, this requires site reconnaissance, which may or may not include the use of a level to measure relative elevations.

Use the following preliminary sizing factor (facility area/tributary area) for the potential facility location and determine which of the following could be constructed within the existing right-of-way or adjacent vacant land. Note that these sizing factors are guidelines (not strict rules, but targets):

- Sizing factor ≥ 0.5 for dispersal to landscape or pervious pavement[2] (i.e., a maximum 2:1 ratio of impervious area to pervious area)
- Sizing factor ≥ 0.04 for bioretention
- Sizing factor ≥ 0.004 (or less) for tree-box-type biofilters

For bioretention facilities requiring underdrains and tree-box-type biofilters, note if there are potential connections from the underdrain to the storm drain system (typically 2.0 feet below soil surface for bioretention facilities, and 3.5 feet below surface for tree-box-type biofilters).

[2] Note that pervious pavement systems are typically designed to infiltrate only the rain falling on the pervious pavement itself, with the allowance for small quantities of runoff from adjacent impervious areas. If significant runoff from adjacent areas is anticipated, preliminary sizing considerations should include evaluation of the depth of drain rock layer needed based on permeability of site soils.

If, in this step, you have confirmed there may be feasible potential facility locations, *continue to the next step*.

Step 3: Barriers and Conflicts

Note that barriers and conflicts do not necessarily mean implementation is infeasible; however, they need to be identified and taken into account in future decision-making, as they may affect cost or public acceptance of the project.

Note issues such as:

- Confirmed or potential conflicts with subsurface utilities
- Known or unknown issues with property ownership, or need for acquisition or easements
- Availability of water supply for irrigation, or lack thereof
- Extent to which green infrastructure is an "add on" vs. integrated with the rest of the project

Step 4: Project Budget and Schedule

Consider sources of funding that may be available for green infrastructure. It is recognized that lack of budget may be a serious constraint for the addition of green infrastructure in public projects. For example, acquisition of additional right-of-way or easements for roadway projects is not always possible. Short and long term maintenance costs also need to be considered, and jurisdictions may not have a funding source for landscape maintenance, especially along roadways. The objective of this process is to identify opportunities for green infrastructure, so that if and when funding becomes available, implementation may be possible.

Note any constraints on the project schedule, such as a regulatory mandate to complete the project by a specific date, grant requirements, etc., that could complicate aligning a separate funding stream for the green infrastructure element. Consider whether cost savings could be achieved by integrating the project with other planned projects, such as pedestrian or bicycle safety improvement projects, street beautification, etc., if the schedule allows.

Step 5: Assessment—Does the Project Have Green Infrastructure Potential?

Consider the ancillary benefits of green infrastructure, including opportunities for improving the quality of public spaces, providing parks and play areas, providing habitat, urban forestry, mitigating heat island effects, aesthetics, and other valuable enhancements to quality of life.

Based on the information above, would it make sense to include green infrastructure into this project—*if funding were available for the potential incremental costs of including green infrastructure in the project?* Identify any additional conditions that would have to be met for green infrastructure elements to be constructed consequent with the project.

Attachment 1

Examples of Projects with No Potential for Green Infrastructure

- ☐ Projects with no exterior work (e.g., interior remodels)
- ☐ Projects involving exterior building upgrades or equipment (e.g., HVAC, solar panels, window replacement, roof repairs and maintenance)
- ☐ Projects related to development and/or continued funding of municipal programs or related organizations
- ☐ Projects related to technical studies, mapping, aerial photography, surveying, database development/upgrades, monitoring, training, or update of standard specs and details
- ☐ Construction of new streetlights, traffic signals or communication facilities
- ☐ Minor bridge and culvert repairs/replacement
- ☐ Non-stormwater utility projects (e.g., sewer or water main repairs/replacement, utility undergrounding, treatment plant upgrades)
- ☐ Equipment purchase or maintenance (including vehicles, street or park furniture, equipment for sports fields and golf courses, etc.)
- ☐ Irrigation system installation, upgrades or repairs

Attachment 2

Excerpts from the C.3 Section of the FY 15-16 Annual Report Template: Tables for Reporting C.3-Regulated Projects and Green Infrastructure Projects

C.3.b.iv.(2) ►Regulated Projects Reporting Table (part 1) – Projects Approved During the Fiscal Year Reporting Period

Project Name Project No.	Project Location[9], Street Address	Name of Developer	Project Phase No.[10]	Project Type & Description[11]	Project Watershed[12]	Total Site Area (Acres)	Total Area of Land Disturbed (Acres)	Total New Impervious Surface Area (ft^2)[13]	Total Replaced Impervious Surface Area (ft^2)[14]	Total Pre-Project Impervious Surface Area[15](ft^2)	Total Post-Project Impervious Surface Area[16](ft^2)
Private Projects											
Public Projects											

Comments:

Guidance: If necessary, provide any additional details or clarifications needed about listed projects in this box. Do not leave any cells blank.

[9]Include cross streets
[10]If a project is being constructed in phases, indicate the phase number and use a separate row entry for each phase. If not, enter "NA".
[11]Project Type is the type of development (i.e., new and/or redevelopment). Example descriptions of development are: 5-story office building, residential with 160 single-family homes with five 4-story buildings to contain 200 condominiums, 100 unit 2-story shopping mall, mixed use retail and residential development (apartments), industrial warehouse.
[12]State the watershed(s) in which the Regulated Project is located. Downstream watershed(s) may be included, but this is optional.
[13]All impervious surfaces added to any area of the site that was previously existing pervious surface.
[14]All impervious surfaces added to any area of the site that was previously existing impervious surface.
[15]For redevelopment projects, state the pre-project impervious surface area.
[16]For redevelopment projects, state the post-project impervious surface area.

C.3.b.iv.(2) ►Regulated Projects Reporting Table (part 2) – Projects Approved During the Fiscal Year Reporting Period (public projects)

Project Name Project No.	Approval Date[29]	Date Construction Scheduled to Begin	Source Control Measures[30]	Site Design Measures[31]	Treatment Systems Approved[32]	Operation & Maintenance Responsibility Mechanism[33]	Hydraulic Sizing Criteria[34]	Alternative Compliance Measures[35/36]	Alternative Certification[37]	HM Controls[38/39]
Public Projects										

Comments:

Guidance: If necessary, provide any additional details or clarifications needed about listed projects in this box. Note that MRP Provision C.3.c. contains specific requirements for LID site design and source control measures, as well as treatment measures, for all Regulated Projects. Entries in these columns should not be "None" or "NA". Do not leave any cells blank.

[29]For public projects, enter the plans and specifications approval date.
[30]List source control measures approved for the project. Examples include: properly designed trash storage areas; storm drain stenciling or signage; efficient landscape irrigation systems; etc.
[31]List site design measures approved for the project. Examples include: minimize impervious surfaces; conserve natural areas, including existing trees or other vegetation, and soils; construct sidewalks, walkways, and/or patios with permeable surfaces, etc.
[32]List all approved stormwater treatment system(s) to be installed onsite or at a joint stormwater treatment facility (e.g., flow through planter, bioretention facility, infiltration basin, etc.).
[33]List the legal mechanism(s) (e.g., maintenance plan for O&M by public entity, etc…) that have been or will be used to assign responsibility for the maintenance of the post-construction stormwater treatment systems.
[34]See Provision C.3.d.i. "Numeric Sizing Criteria for Stormwater Treatment Systems" for list of hydraulic sizing design criteria. Enter the corresponding provision number of the appropriate criterion (i.e., 1.a., 1.b., 2.a., 2.b., 2.c., or 3).
[35]For Alternative Compliance at an offsite location in accordance with Provision C.3.e.i.(1), on a separate page, give a discussion of the alternative compliance site including the information specified in Provision C.3.b.v.(1)(m)(i) for the offsite project.
[36]For Alternative Compliance by paying in-lieu fees in accordance with Provision C.3.e.i.(2), on a separate page, provide the information specified in Provision C.3.b.v.(1)(m)(ii) for the Regional Project.
[37]Note whether a third party was used to certify the project design complies with Provision C.3.d.
[38]If HM control is not required, state why not.
[39]If HM control is required, state control method used (e.g., method to design and size device(s) or method(s) used to meet the HM Standard, and description of device(s) or method(s) used, such as detention basin(s), biodetention unit(s), regional detention basin, or in-stream control).

C.3.j.ii.(2) ► Table A - Public Projects Reviewed for Green Infrastructure

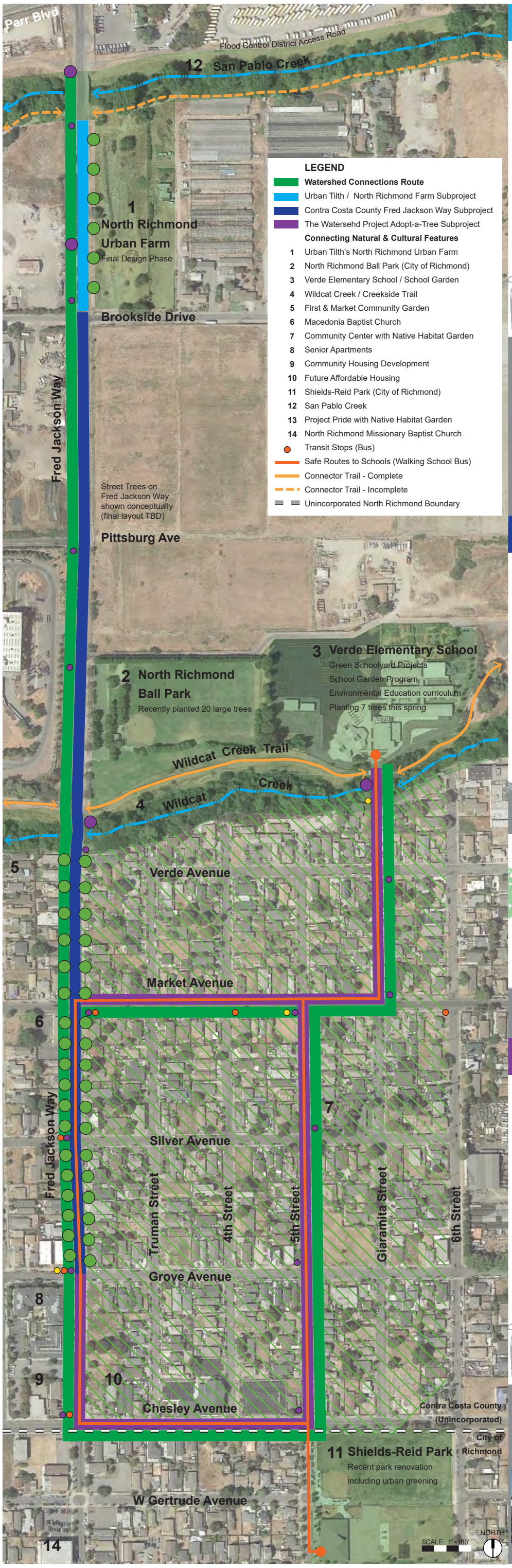
Project Name and Location[43]	Project Description	Status[44]	GI Included?[45]	Description of GI Measures Considered and/or Proposed or Why GI is Impracticable to Implement[46]
EXAMPLE: Storm drain retrofit, Stockton and Taylor	Installation of new storm drain to accommodate the 10-yr storm event	Beginning planning and design phase	TBD	Bioretention cells (i.e., linear bulb-outs) will be considered when street modification designs are incorporated

C.3.j.ii.(2) ► Table B - Planned Green Infrastructure Projects

Project Name and Location[47]	Project Description	Planning or Implementation Status	Green Infrastructure Measures Included
EXAMPLE: Martha Gardens Green Alleys Project	Retrofit of degraded pavement in urban alleyways lacking good drainage	Construction completed October 17, 2015	The project drains replaced concrete pavement and existing adjacent structures to a center strip of pervious pavement and underlying infiltration trench.

[43] List each public project that is going through your agency's process for identifying projects with green infrastructure potential.
[44] Indicate status of project, such as: beginning design, under design (or X% design), projected completion date, completed final design date, etc.
[45] Enter "Yes" if project will include GI measures, "No" if GI measures are impracticable to implement, or "TBD" if this has not yet been determined.
[46] Provide a summary of how each public infrastructure project with green infrastructure potential will include green infrastructure measures to the maximum extent practicable during the permit term. If review of the project indicates that implementation of green infrastructure measures is not practicable, provide the reasons why green infrastructure measures are impracticable to implement.
[47] List each planned (and expected to be funded) public and private green infrastructure project that is not also a Regulated Project as defined in Provision C.3.b.ii. Note that funding for green infrastructure components may be anticipated but is not guaranteed to be available or sufficient.

Appendix C. North Richmond Watershed Connections Exhibit



Fred Jackson Way Rain Gardens

Project Lead: Urban Tilth

Urban Greening: 6 Trees, 3,475 s.f. planting area with native species

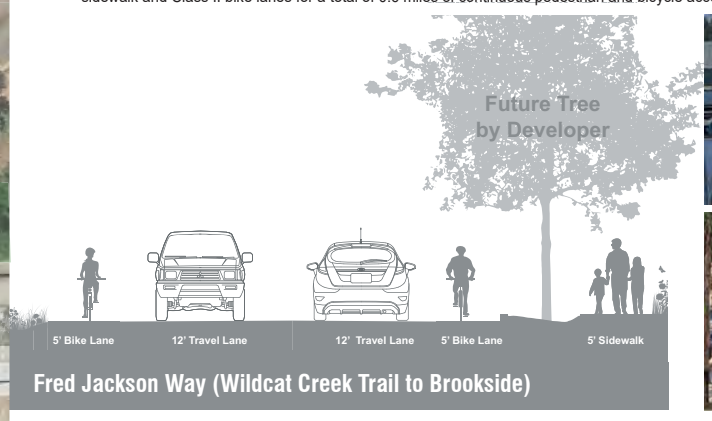
Stormwater Management: 3,475 s.f. rain garden treats 3,110,400 gallons of stormwater annually

Fred Jackson Way First Mile/Last Mile Urban Greening

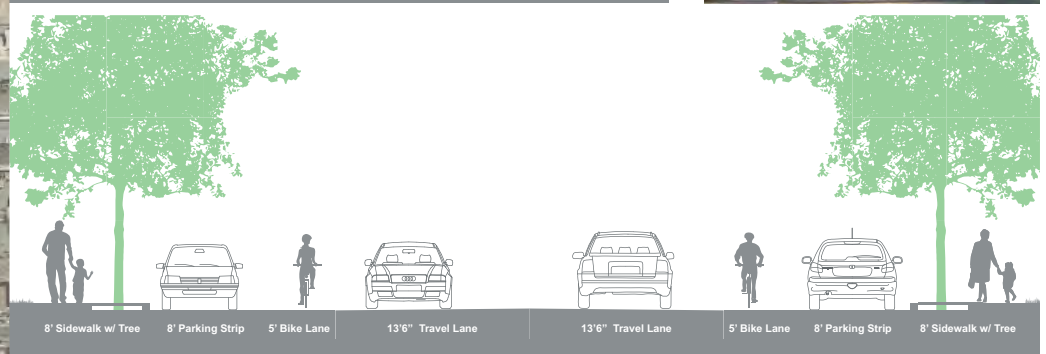
Project Lead: Contra Costa County Public Works Department

Urban Greening: 37 Trees (shown conceptually, see design plan for layout)

This is a Contra Costa County Department of Public Works Project. The ATP-funded project includes ADA accessible sidewalks with street trees along 0.3-mile roadway from Grove Avenue to Wildcat Creek Trail. It extends an additional 0.3 miles northerly to Brookside Drive to construct sidewalk and Class II bike lanes for a total of 0.6 miles of continuous pedestrian and bicycle access.



Fred Jackson Way (Wildcat Creek Trail to Brookside)



Fred Jackson Way (Grove Street to Wildcat Creek Trail)

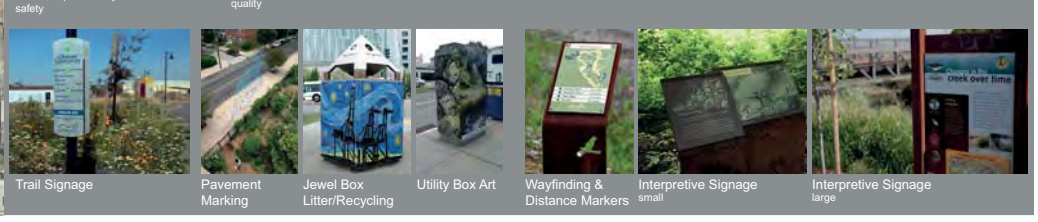
Clean & Green Adopt-a-Tree Program & Walkable Watersheds

Project Lead: The Watershed Project

Urban Greening: Adopt-a-Tree Program / 50 Trees (refer to design plan for opportunity sites)

Walkable Watersheds: 4 interpretive features, 15 wayfinding markers, painted pavements, art

Water Quality / Litter Reduction: 3 "jewel boxes" (litter/recycling receptacles with mosaic art)



NORTH RICHMOND WATERSHED CONNECTIONS

A MULTI-BENEFIT URBAN GREENING DEMONSTRATION PROJECT

URBAN TILTH GROW YOUR OWN RICHMOND, CA

Contra Costa County Public Works Department

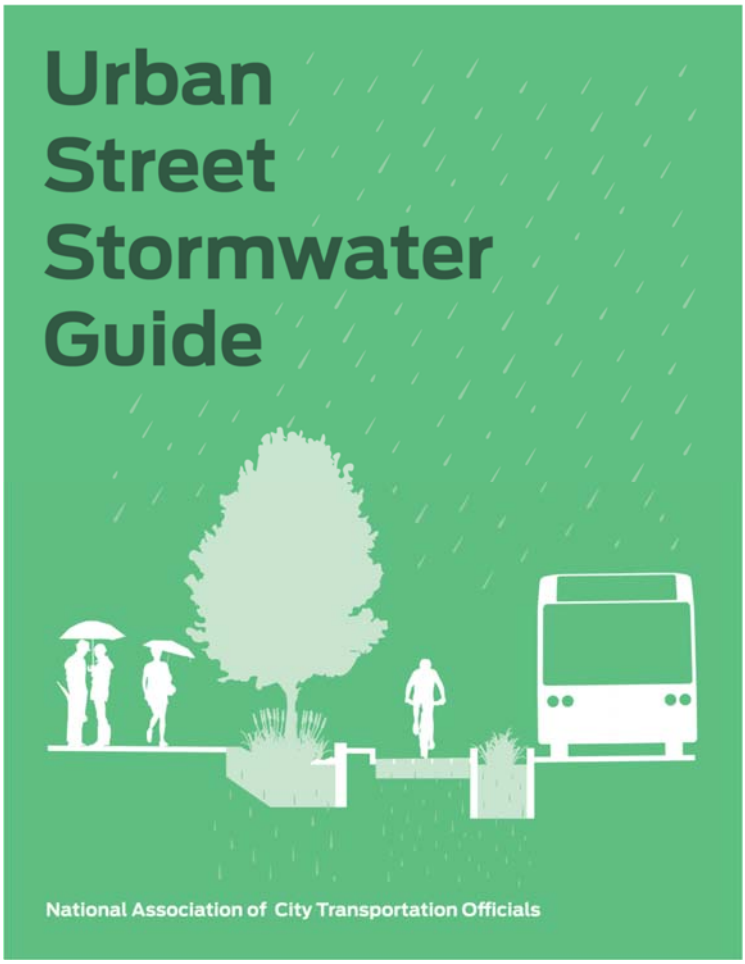
the watershed project

Appendix D. Green Infrastructure Guidelines for Streetscapes and Project Design

Appendix D. Green Infrastructure Guidelines for Streetscapes and Project Design

This appendix provides reference and links to industry-recognized design guidelines for use by County staff in GI project planning and concept design:

1. National Association of City Transportation Officials, *Urban Street Stormwater Guide*, 2017.
2. San Mateo Countywide Water Pollution Prevention Program, *San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook*, First Edition, 2009.



Access via: https://nacto.org/publication/urban-street-stormwater-guide/

San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook

First Edition ~ January 2009

SAN MATEO COUNTYWIDE
Water Pollution Prevention Program
Clean Water. Healthy Community.

Prepared by:

Nevue Ngan Associates
Sherwood Design Engineers

<< *El Camino Real*
Green Street Concept Sketch
San Mateo County, California

Access via:
https://www.flowstobay.org/documents/municipalities/sustainable%20streets/San%20Mateo%20Guidebook.pdf

Appendix E. Green Infrastructure Specifications and Typical Design Details

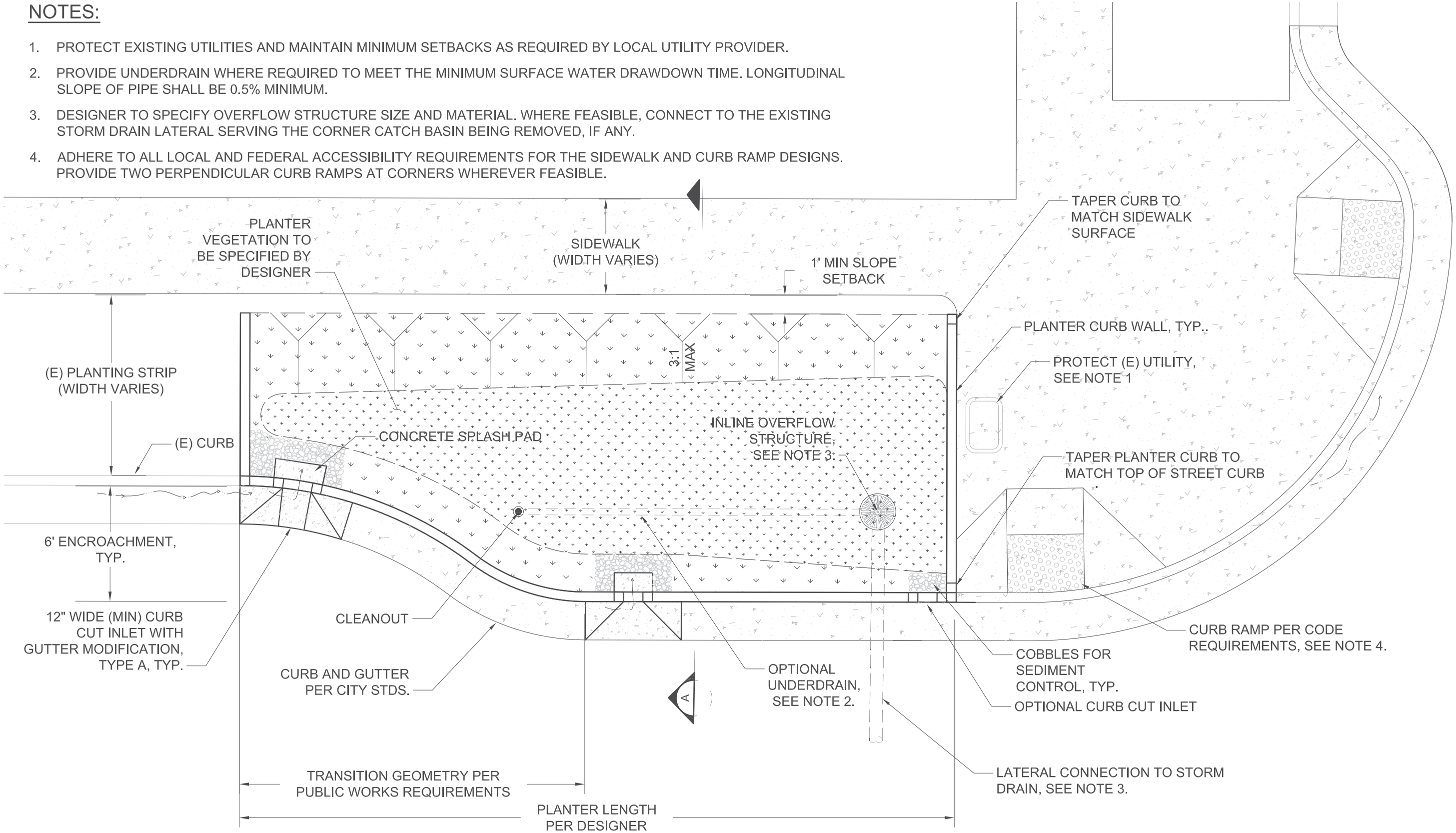
Appendix E. Green Infrastructure Specifications and Typical Design Details

This appendix provides references and link to industry-recognized specifications and typical design details for use by County staff when developing GI design:

1. BASMAA, *Urban Greening Typical GI Details*, 2017.
2. CASQA and LIDI, *Bioretention Details*, 2017.
3. SFPUC, *San Francisco Stormwater Management Requirements and Design Guidelines*, Appendix B, 2016.

NOTES:

1. PROTECT EXISTING UTILITIES AND MAINTAIN MINIMUM SETBACKS AS REQUIRED BY LOCAL UTILITY PROVIDER.
2. PROVIDE UNDERDRAIN WHERE REQUIRED TO MEET THE MINIMUM SURFACE WATER DRAWDOWN TIME. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% MINIMUM.
3. DESIGNER TO SPECIFY OVERFLOW STRUCTURE SIZE AND MATERIAL. WHERE FEASIBLE, CONNECT TO THE EXISTING STORM DRAIN LATERAL SERVING THE CORNER CATCH BASIN BEING REMOVED, IF ANY.
4. ADHERE TO ALL LOCAL AND FEDERAL ACCESSIBILITY REQUIREMENTS FOR THE SIDEWALK AND CURB RAMP DESIGNS. PROVIDE TWO PERPENDICULAR CURB RAMPS AT CORNERS WHEREVER FEASIBLE.



BASMAA URBAN GREENING TYPICAL GI DETAILS
BULBOUT ALTERNATIVE 1
SLOPED SIDES, INLINE OVERFLOW STRUCTURE, CURB CUT INLET TYPE A

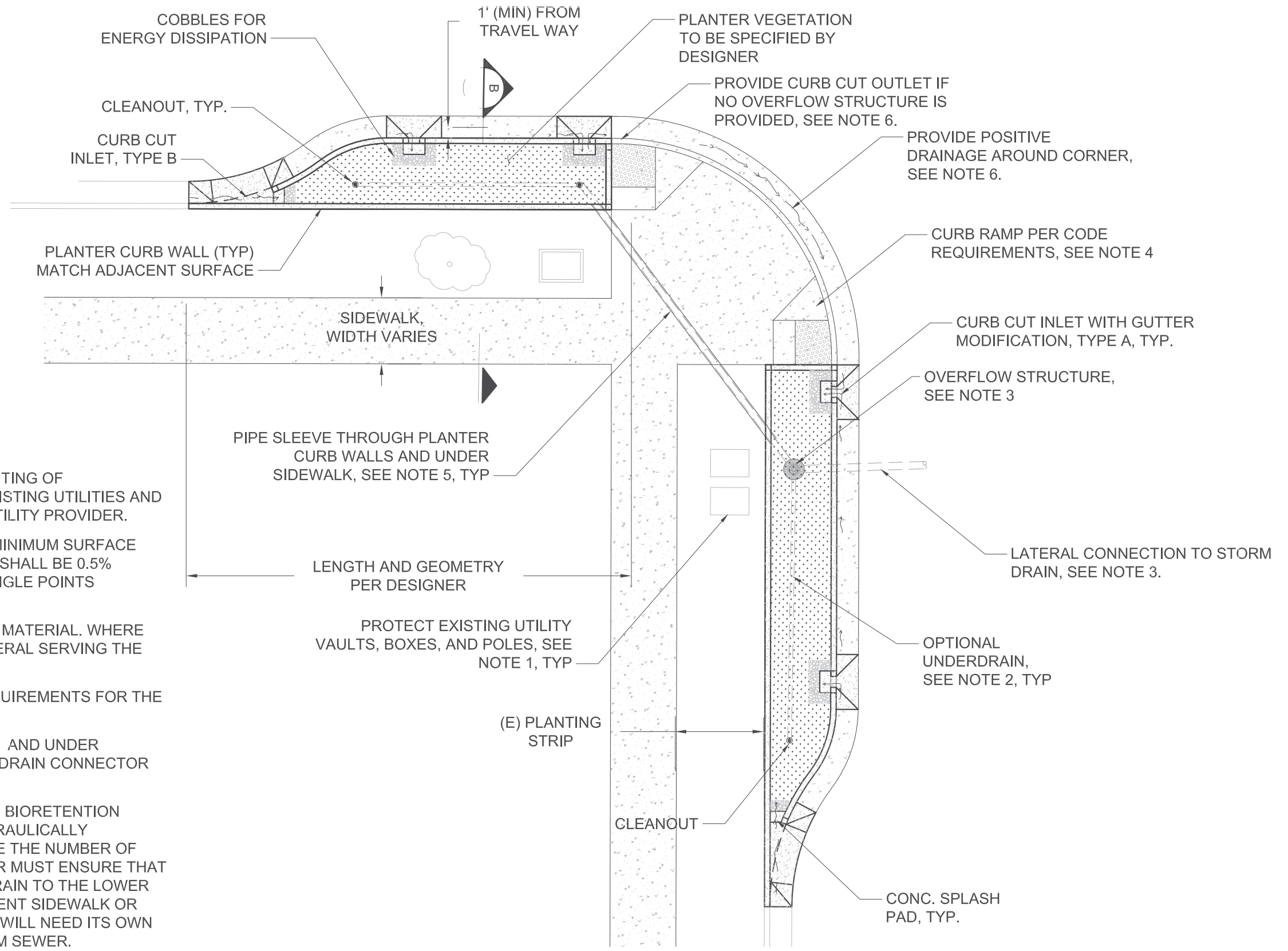
SCALE: 1"=5'

DRAWN BY: BF

CHECKED BY: SD

DATE : APRIL 14, 2017

SHEET NUMBER C-1.1



NOTES:

1. AVOID UTILITY CONFLICTS WHEREVER FEASIBLE IN THE SITING OF BIORETENTION PLANTERS. IF UNAVOIDABLE, PROTECT EXISTING UTILITIES AND MAINTAIN MINIMUM SETBACKS AS REQUIRED BY LOCAL UTILITY PROVIDER.
2. PROVIDE UNDERDRAIN WHERE REQUIRED TO MEET THE MINIMUM SURFACE WATER DRAWDOWN TIME. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% MINIMUM. PROVIDE CLEANOUT AT UPSTREAM END AND ANGLE POINTS EXCEEDING 45 DECREES.
3. DESIGNER TO SPECIFY OVERFLOW STRUCTURE SIZE AND MATERIAL. WHERE FEASIBLE, CONNECT TO THE EXISTING STORM DRAIN LATERAL SERVING THE CORNER CATCH BASIN BEING REMOVED, IF ANY.
4. ADHERE TO ALL LOCAL AND FEDERAL ACCESSIBILITY REQUIREMENTS FOR THE SIDEWALK AND CURB RAMP DESIGNS.
5. PROVIDE PIPE SLEEVES THROUGH PLANTER CURB WALLS AND UNDER SIDEWALK TO ALLOW FOR THE PASSING OF SOLID UNDERDRAIN CONNECTOR PIPES.
6. IF THE GRADES AND EXISTING SITE CONSTRAINTS ALLOW, BIORETENTION PLANTERS ON EITHER SIDE OF THE CORNER CAN BE HYDRAULICALLY CONNECTED TO OPTIMIZE TREATMENT AREA AND REDUCE THE NUMBER OF CONNECTIONS TO THE STORM SEWER SYSTEM. DESIGNER MUST ENSURE THAT THE HIGHER BIORETENTION PLANTER CAN POSITIVELY DRAIN TO THE LOWER BIORETENTION PLANTER WITHOUT FLOODING THE ADJACENT SIDEWALK OR ROADWAY. IF INFEASIBLE, EACH BIORETENTION PLANTER WILL NEED ITS OWN OVERFLOW STRUCTURE AND CONNECTION TO THE STORM SEWER.

BASMAA URBAN GREENING TYPICAL GI DETAILS
BULBOUT ALTERNATIVE 2
WALLED BIORETENTION ON BOTH SIDES OF CORNER, CURB CUT INLETS TYPE A & B

SCALE: 1"=10'

DRAWN BY: BF

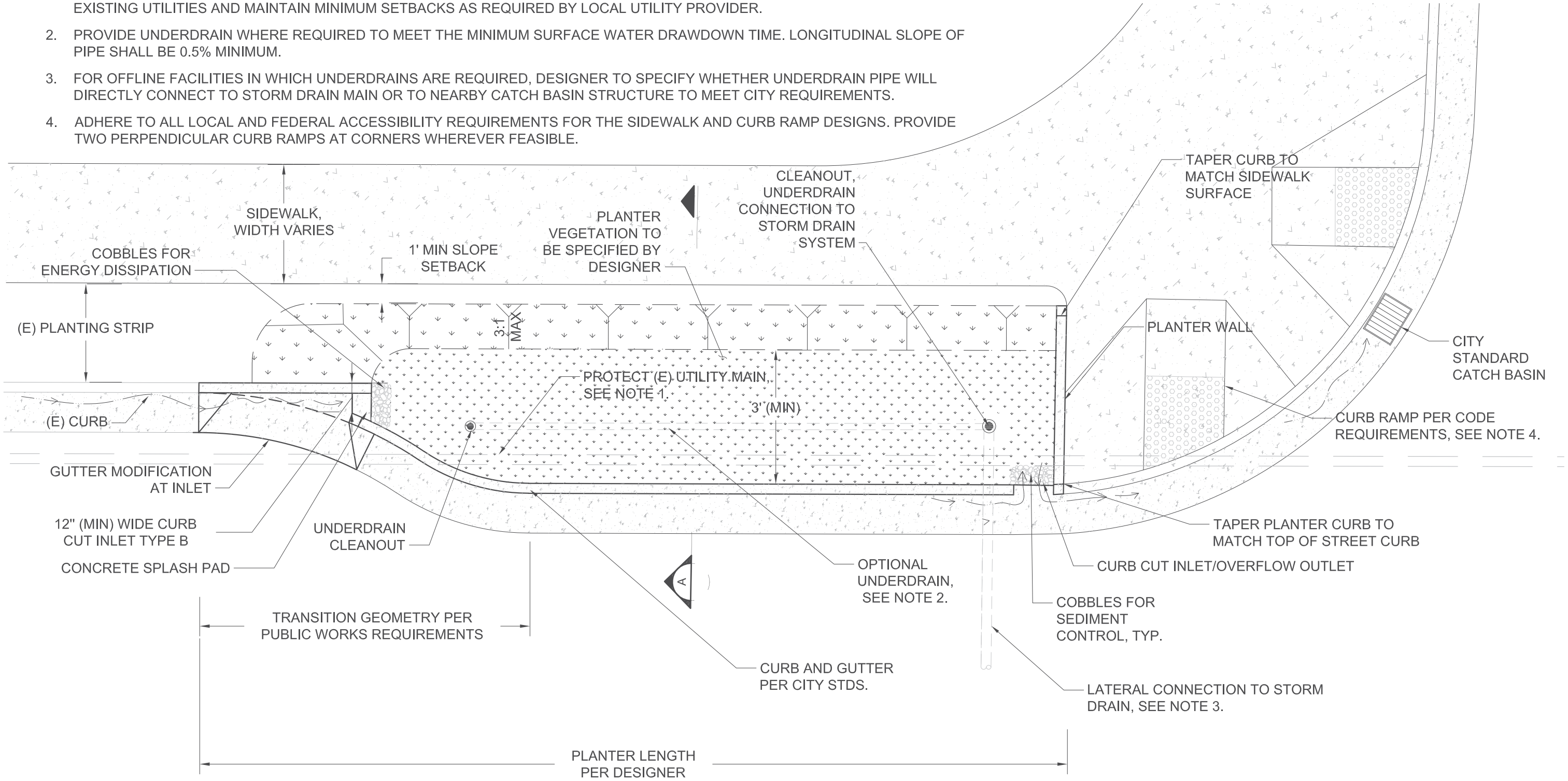
CHECKED BY: SD

DATE : APRIL 14, 2017

SHEET NUMBER C-1.2

NOTES:

1. AVOID UTILITY CONFLICTS WHENEVER POSSIBLE IN THE SITING OF BIORETENTION PLANTERS. IF UNAVOIDABLE, PROTECT EXISTING UTILITIES AND MAINTAIN MINIMUM SETBACKS AS REQUIRED BY LOCAL UTILITY PROVIDER.
2. PROVIDE UNDERDRAIN WHERE REQUIRED TO MEET THE MINIMUM SURFACE WATER DRAWDOWN TIME. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% MINIMUM.
3. FOR OFFLINE FACILITIES IN WHICH UNDERDRAINS ARE REQUIRED, DESIGNER TO SPECIFY WHETHER UNDERDRAIN PIPE WILL DIRECTLY CONNECT TO STORM DRAIN MAIN OR TO NEARBY CATCH BASIN STRUCTURE TO MEET CITY REQUIREMENTS.
4. ADHERE TO ALL LOCAL AND FEDERAL ACCESSIBILITY REQUIREMENTS FOR THE SIDEWALK AND CURB RAMP DESIGNS. PROVIDE TWO PERPENDICULAR CURB RAMPS AT CORNERS WHEREVER FEASIBLE.



BASMAA URBAN GREENING TYPICAL GI DETAILS
BULBOUT ALTERNATIVE 3
SLOPED AND WALLED SIDES, CURB CUT INLET TYPE B, CURB CUT OVERFLOW ONLY

SCALE: 1"=5'

DRAWN BY: BF

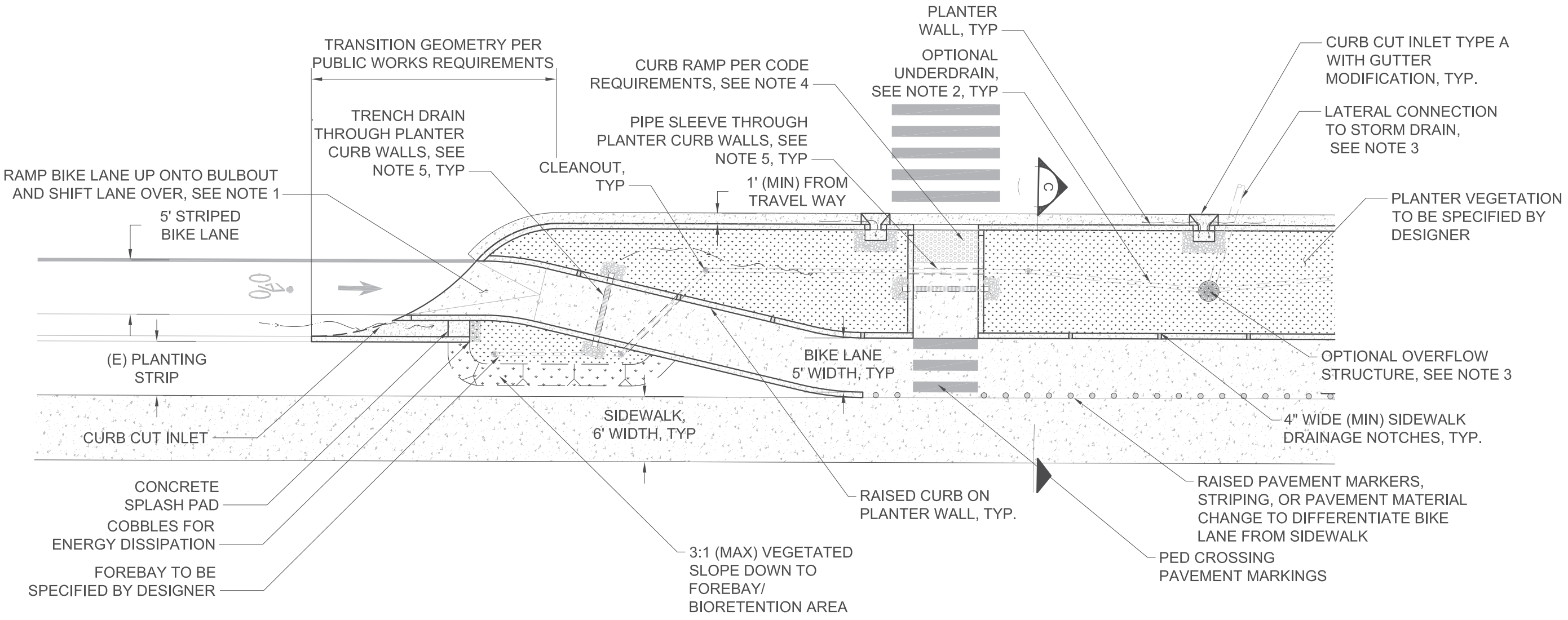
CHECKED BY: SD

DATE : APIRL 14, 2017

SHEET NUMBER C-1.3

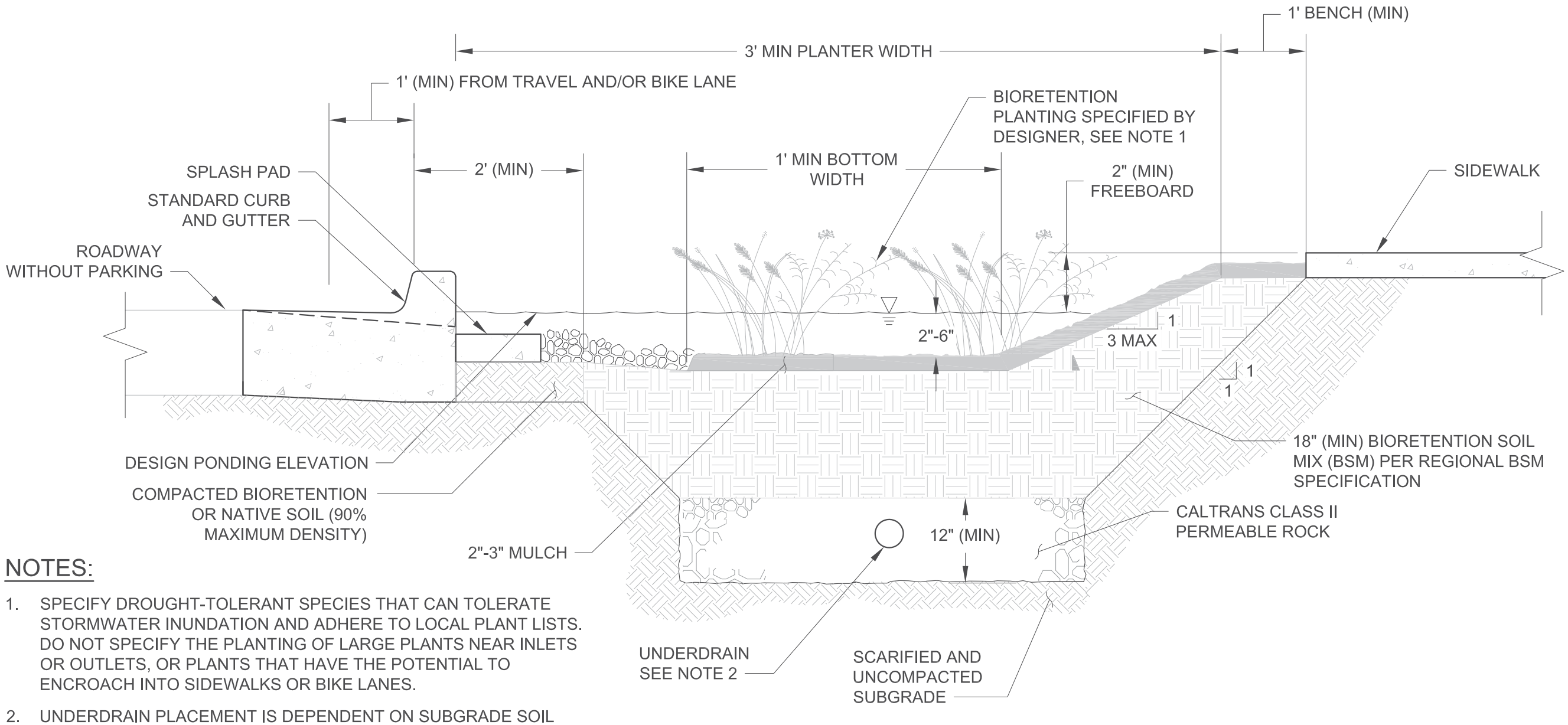
NOTES:

1. FOR HORIZONTAL BIKE LANE SHIFT, PROVIDE MAXIMUM 1:5 TRANSITION RATE.
2. PROVIDE UNDERDRAIN WHERE REQUIRED TO MEET THE MINIMUM SURFACE WATER DRAWDOWN TIME. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% MINIMUM. PROVIDE CLEANOUT AT UPSTREAM END AND ANGLE POINTS EXCEEDING 45 DEGREES.
3. DESIGNER TO SPECIFY OVERFLOW STRUCTURE SIZE AND MATERIAL. WHERE FEASIBLE, CONNECT TO THE EXISTING STORM DRAIN LATERAL SERVING THE CORNER CATCH BASIN BEING REMOVED, IF ANY.
4. ADHERE TO ALL LOCAL AND FEDERAL ACCESSIBILITY REQUIREMENTS FOR THE SIDEWALK AND CURB RAMP DESIGNS.
5. PROVIDE TRENCH DRAINS THROUGH PLANTER CURB WALLS TO ALLOW FOR THE HYDRAULIC CONNECTION OF SEPARATED BIORETENTION PLANTERS AND PIPE SLEEVES FOR THE PASSING OF SOLID UNDERDRAIN CONNECTOR PIPES.



BASMAA URBAN GREENING TYPICAL GI DETAILS
BULBOUT ALTERNATIVE 4
MIDBLOCK BULBOUT WITH RAISED BIKE LANE AND PEDESTRIAN CROSSING

SCALE: 1"=10'	DATE : APRIL 14, 2017
DRAWN BY: BF	
CHECKED BY: SD	SHEET NUMBER C-1.4



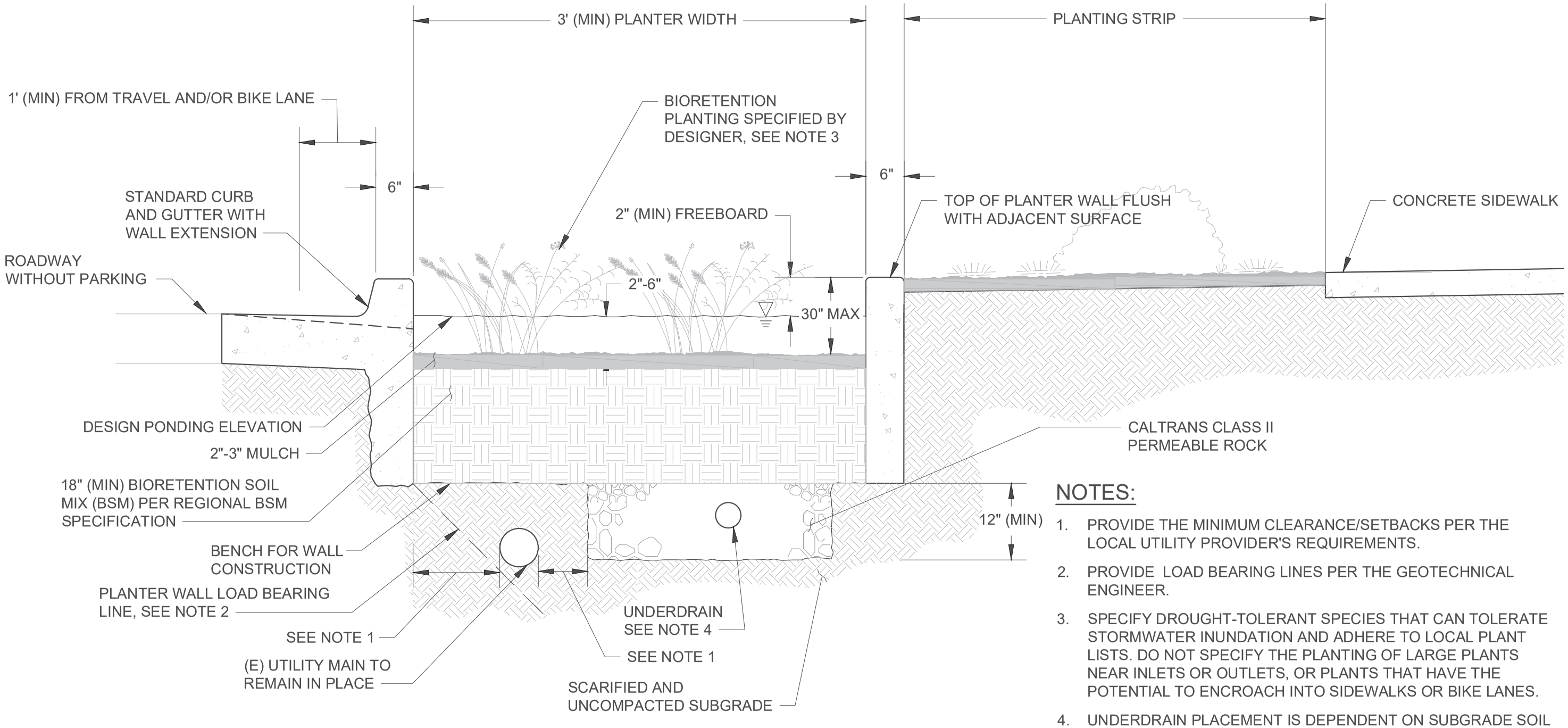
NOTES:

1. SPECIFY DROUGHT-TOLERANT SPECIES THAT CAN TOLERATE STORMWATER INUNDATION AND ADHERE TO LOCAL PLANT LISTS. DO NOT SPECIFY THE PLANTING OF LARGE PLANTS NEAR INLETS OR OUTLETS, OR PLANTS THAT HAVE THE POTENTIAL TO ENCROACH INTO SIDEWALKS OR BIKE LANES.
2. UNDERDRAIN PLACEMENT IS DEPENDENT ON SUBGRADE SOIL CONDITIONS. FOR TYPE B/C SOILS, THE UNDERDRAIN MAY BE ELEVATED TOWARDS THE TOP OF THE AGGREGATE STORAGE LAYER, APPROXIMATELY 3" BELOW BOTTOM OF BIORETENTION SOIL. FOR TYPE D SOILS, THE UNDERDRAIN SHALL BE PLACED 2" ABOVE THE SUBGRADE.

BIORETENTION BULBOUT SECTION A

BASMAA URBAN GREENING TYPICAL GI DETAILS
SECTION A-A
SLOPED SIDES / NO CURB WALLS

SCALE: 3/4"=1'
DRAWN BY: BF
CHECKED BY: SD
DATE : APRIL 14, 2017
SHEET NUMBER S-A-A



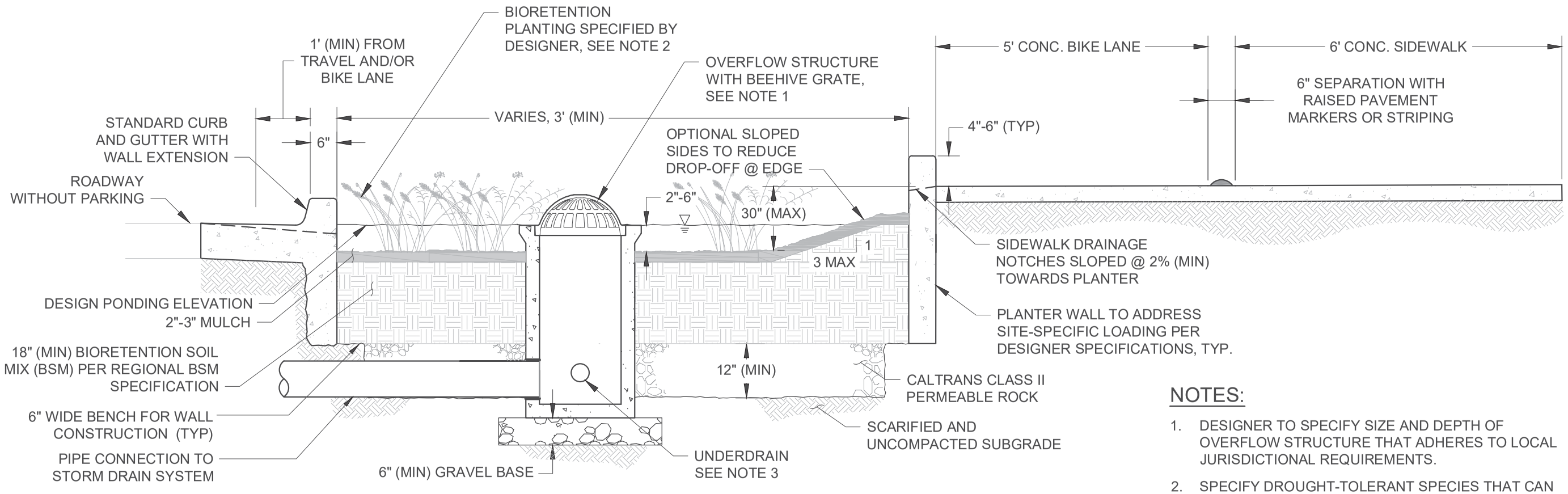
BIORETENTION BULBOUT SECTION B

NOTES:

1. PROVIDE THE MINIMUM CLEARANCE/SETBACKS PER THE LOCAL UTILITY PROVIDER'S REQUIREMENTS.
2. PROVIDE LOAD BEARING LINES PER THE GEOTECHNICAL ENGINEER.
3. SPECIFY DROUGHT-TOLERANT SPECIES THAT CAN TOLERATE STORMWATER INUNDATION AND ADHERE TO LOCAL PLANT LISTS. DO NOT SPECIFY THE PLANTING OF LARGE PLANTS NEAR INLETS OR OUTLETS, OR PLANTS THAT HAVE THE POTENTIAL TO ENCROACH INTO SIDEWALKS OR BIKE LANES.
4. UNDERDRAIN PLACEMENT IS DEPENDENT ON SUBGRADE SOIL CONDITIONS. FOR TYPE B/C SOILS, THE UNDERDRAIN MAY BE ELEVATED TOWARDS THE TOP OF THE AGGREGATE STORAGE LAYER, APPROXIMATELY 3" BELOW BOTTOM OF BIORETENTION SOIL. FOR TYPE D SOILS, THE UNDERDRAIN SHALL BE PLACED 2" ABOVE THE SUBGRADE.

BASMAA URBAN GREENING TYPICAL GI DETAILS
SECTION B-B
WALLS ON BOTH SIDES, UTILITY MAIN PROTECTION

SCALE: 3/4"=1'
DRAWN BY: BF
CHECKED BY: SD
DATE : April 14, 2017
SHEET NUMBER S-B-B



MIDBLOCK BULBOUT SECTION C

NOTES:

1. DESIGNER TO SPECIFY SIZE AND DEPTH OF OVERFLOW STRUCTURE THAT ADHERES TO LOCAL JURISDICTIONAL REQUIREMENTS.
2. SPECIFY DROUGHT-TOLERANT SPECIES THAT CAN TOLERATE STORMWATER INUNDATION AND ADHERE TO LOCAL PLANT LISTS. DO NOT SPECIFY THE PLANTING OF LARGE PLANTS NEAR INLETS OR OUTLETS, OR PLANTS THAT HAVE THE POTENTIAL TO ENCROACH INTO SIDEWALKS OR BIKE LANES.
3. UNDERDRAIN PLACEMENT IS DEPENDENT ON SUBGRADE SOIL CONDITIONS. FOR TYPE B/C SOILS, THE UNDERDRAIN MAY BE ELEVATED TOWARDS THE TOP OF THE AGGREGATE STORAGE LAYER, APPROXIMATELY 3" BELOW BOTTOM OF BIORETENTION SOIL. FOR TYPE D SOILS, THE UNDERDRAIN SHALL BE PLACED 2" ABOVE THE SUBGRADE.

BASMAA URBAN GREENING TYPICAL GI DETAILS
SECTION C-C
RAISED BIKE LANE, OVERFLOW STRUCTURE

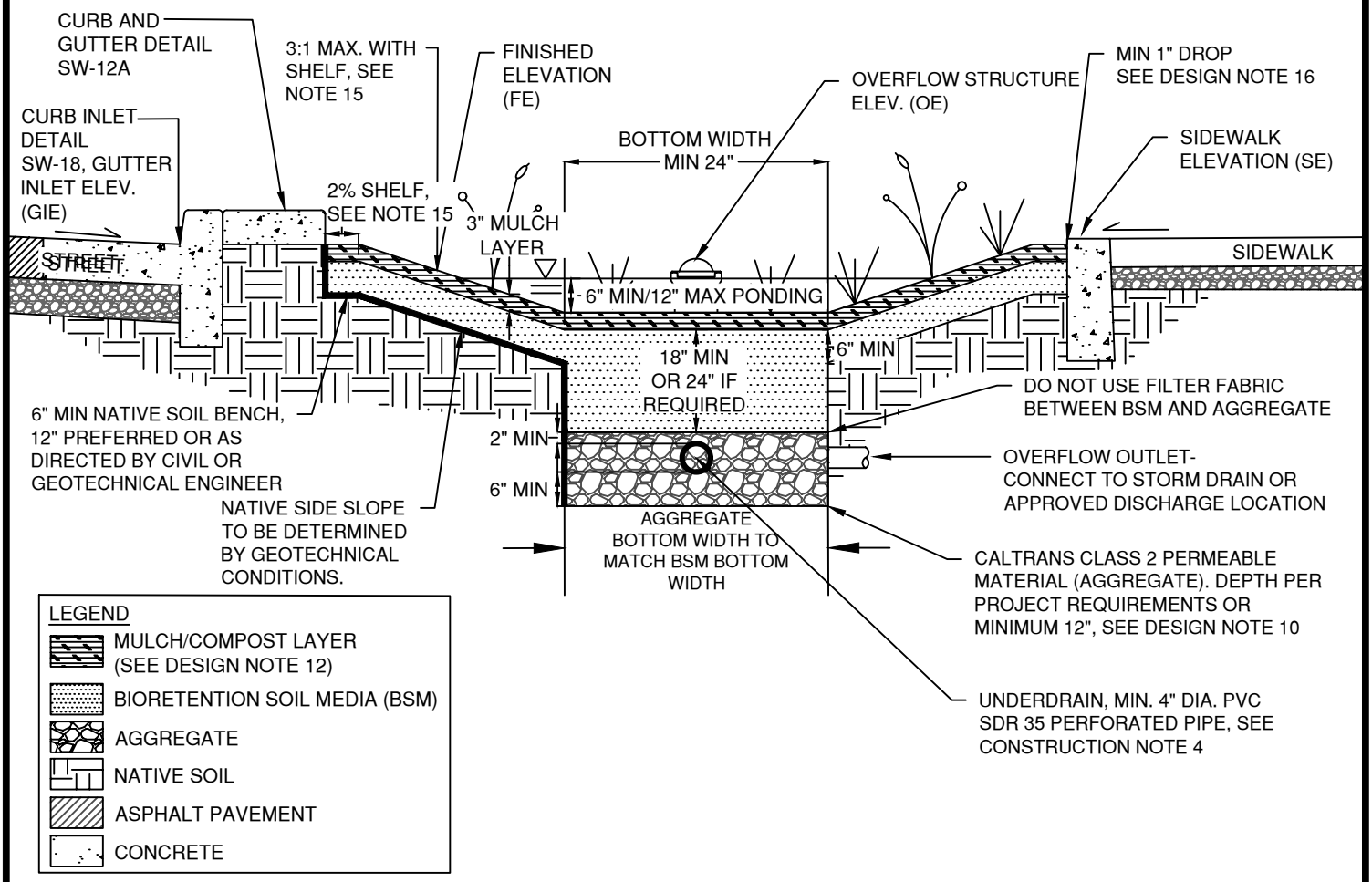
SCALE: 1"=2'
DRAWN BY: BF
CHECKED BY: SD
DATE : April 14, 2017
SHEET NUMBER S-C-C

CASQA-LIDI BIORETENTION DETAILS

TABLE OF CONTENTS

CASQA-LIDI BIORETENTION DETAILS

TABLE OF CONTENTS

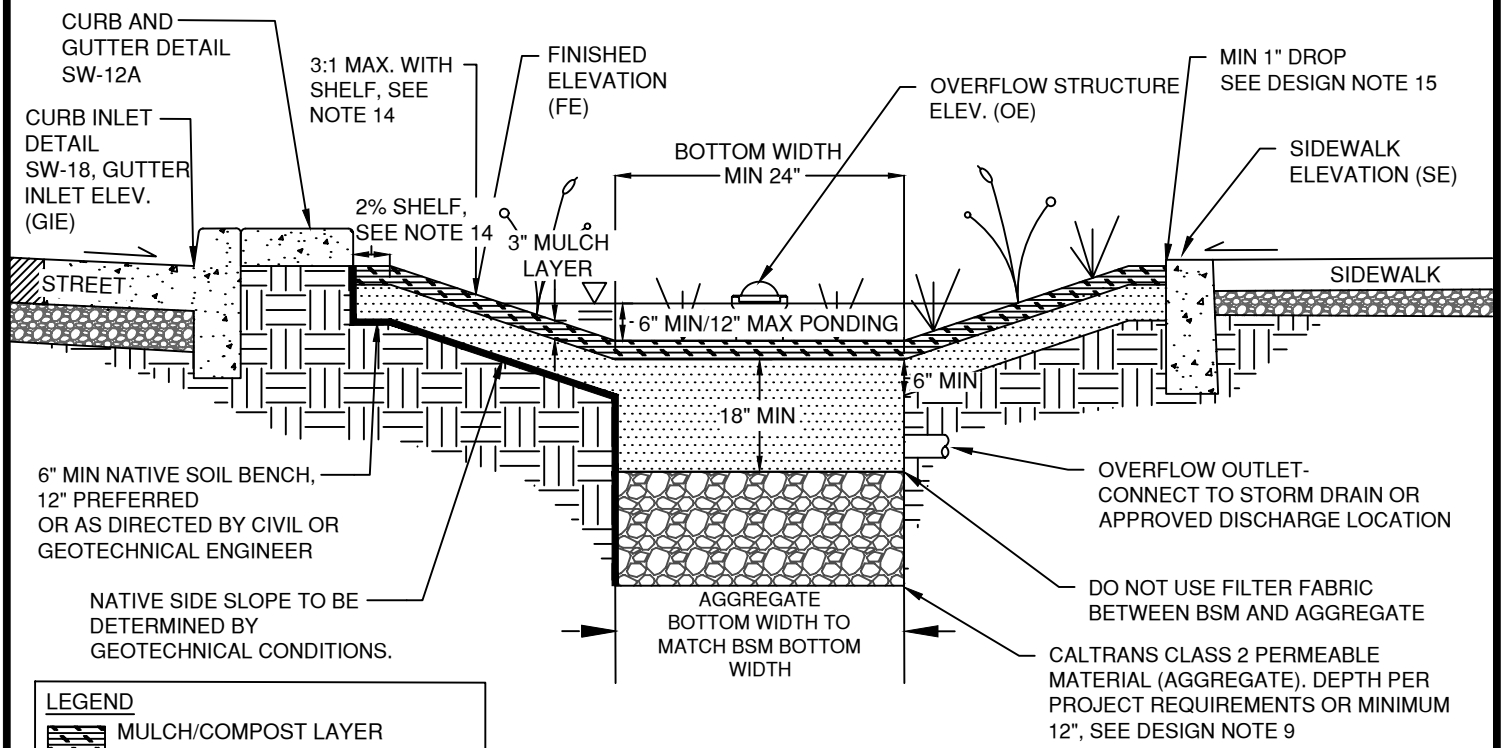


CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN 6" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.
5. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).
3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.
4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.
5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.
6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.
7. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.
8. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
9. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)
10. DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO.4) OPEN-GRADED AGGREGATE.
11. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
12. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.
13. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.
14. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.
15. NATIVE SIDE SLOPE 4:1 (H:V) PREFERRED, 3:1 WITH SHELF. 6" MINIMUM SHELF WITH 2% SLOPE TOWARDS FACILITY ADJACENT TO PEDESTRIAN USE OR CURB UNLESS 4:1 SLOPE PROVIDED.
16. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE MULCH LAYER.
17. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
5. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
6. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
7. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.

4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.

5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.

6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.

7. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

8. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)

9. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.

10. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

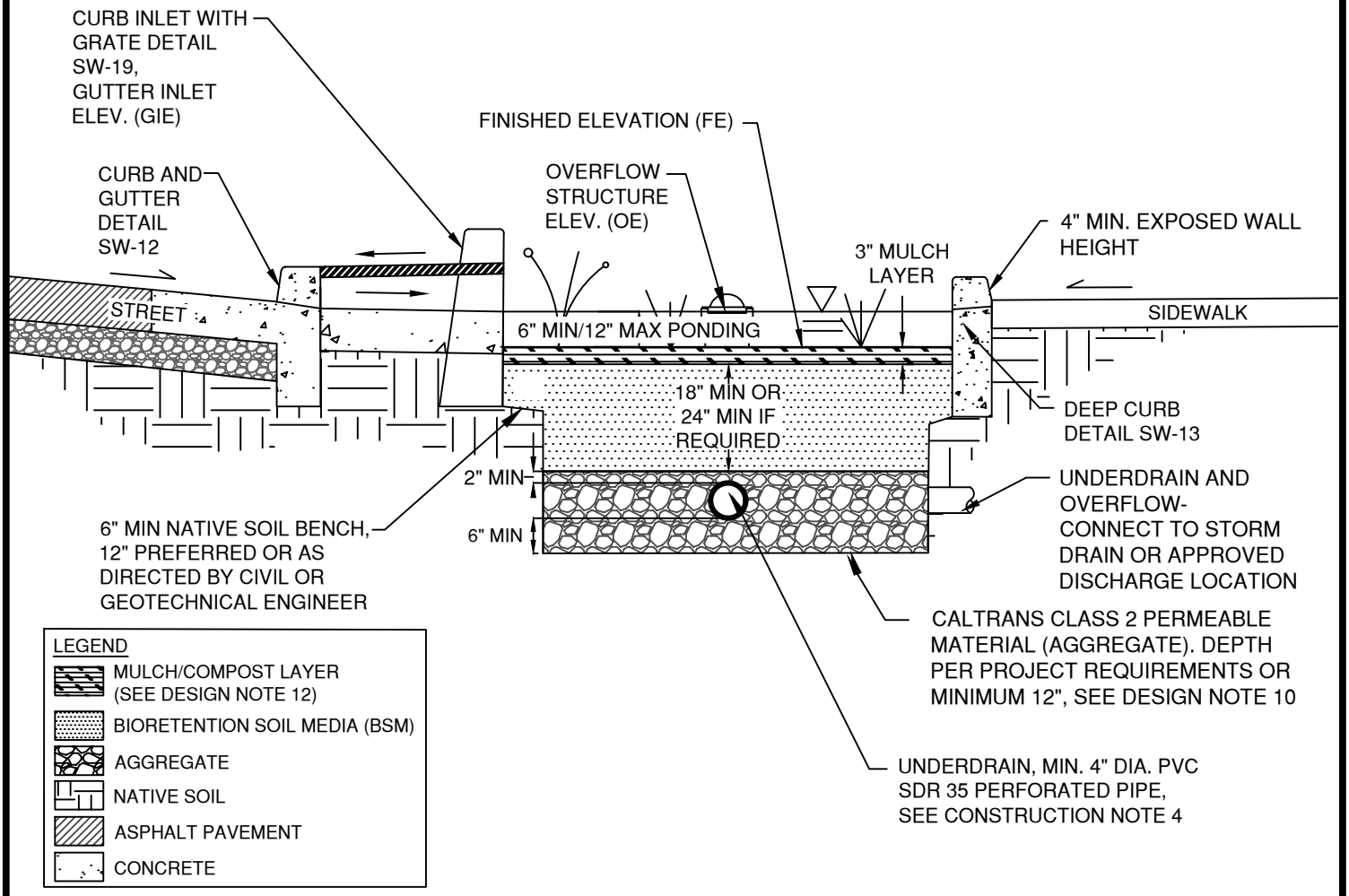
12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

14. NATIVE SIDE SLOPE 4:1 (H:V) PREFERRED, 3:1 WITH SHELF. 6" MINIMUM SHELF WITH 2% SLOPE TOWARDS FACILITY ADJACENT TO PEDESTRIAN USE OR CURB UNLESS 4:1 SLOPE PROVIDED.

15. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE MULCH LAYER.

16. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.

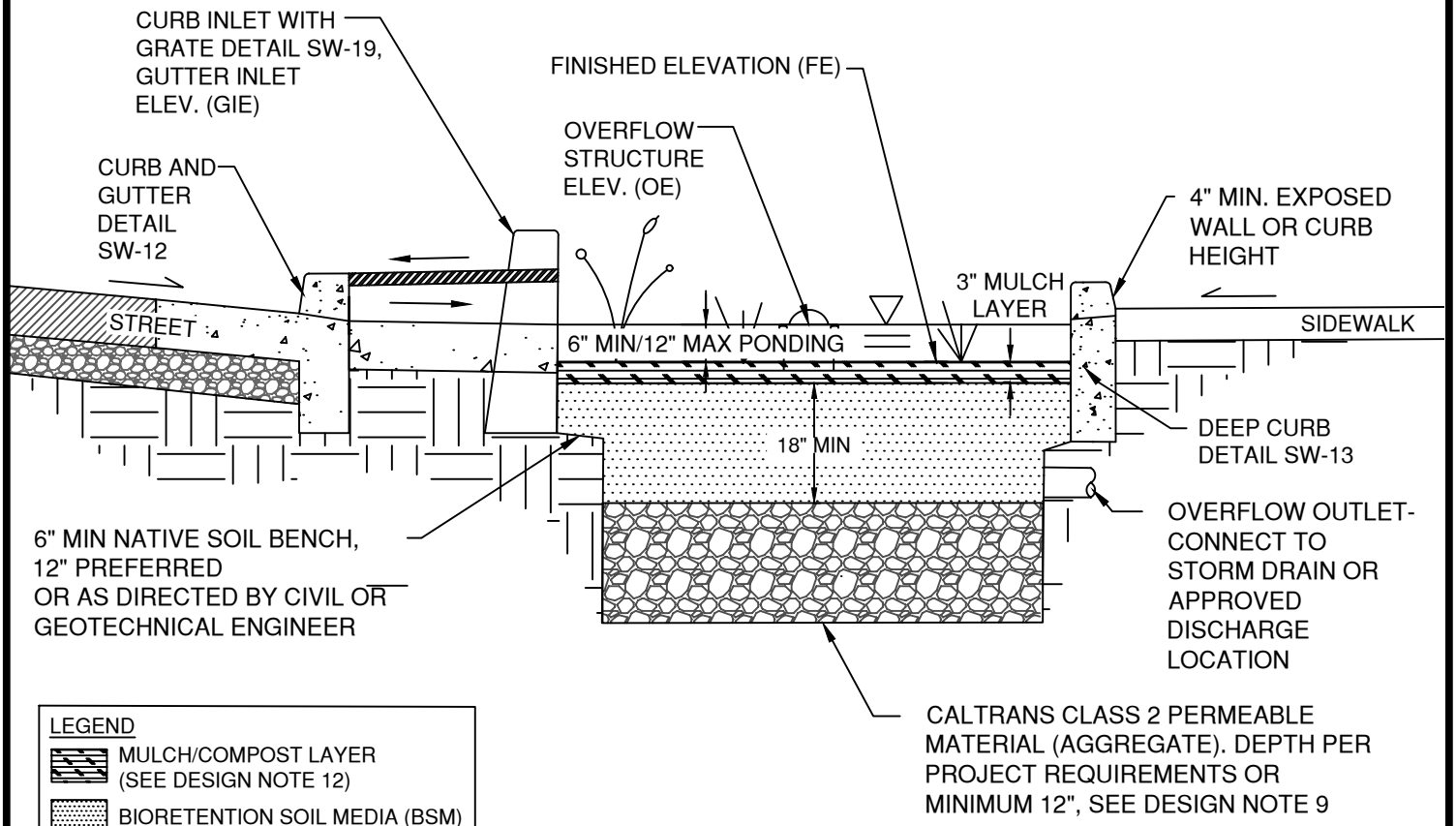


CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN 6" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.
5. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTIONFACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).
3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-18.
4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.
5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.
6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.
7. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.
8. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
9. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)
10. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.
11. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
12. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.
13. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.
14. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.
15. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



LEGEND

- MULCH/COMPOST LAYER (SEE DESIGN NOTE 12)
- BIORETENTION SOIL MEDIA (BSM)
- AGGREGATE
- NATIVE SOIL
- ASPHALT PAVEMENT
- CONCRETE

CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
5. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
6. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
7. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.

4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.

5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.

6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.

7. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

8. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)

9. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.

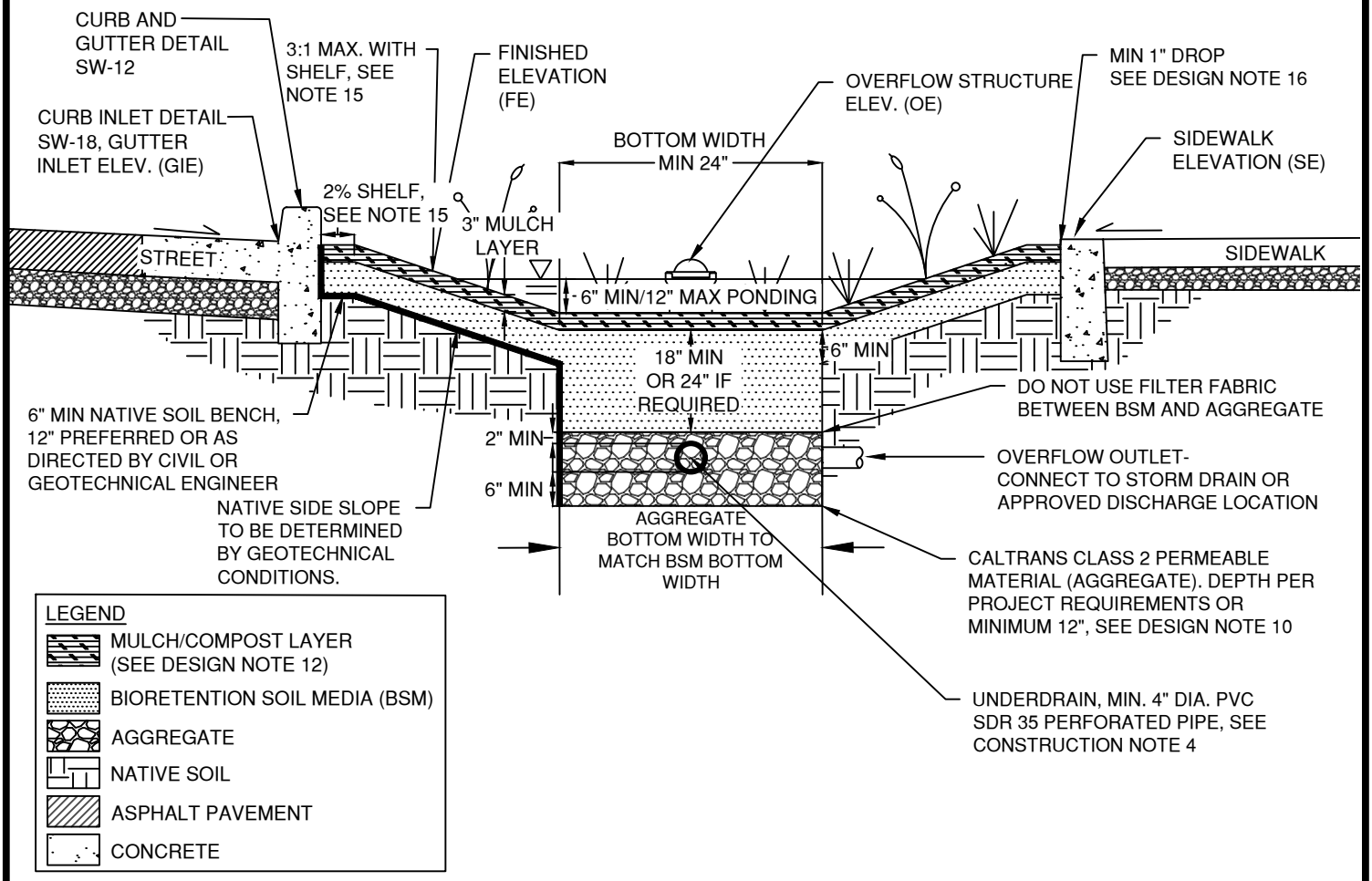
10. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

14. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN 6" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.
5. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.

4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.

5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.

6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.

7. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.

8. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

9. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)

10. DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO.4) OPEN-GRADED AGGREGATE.

11. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

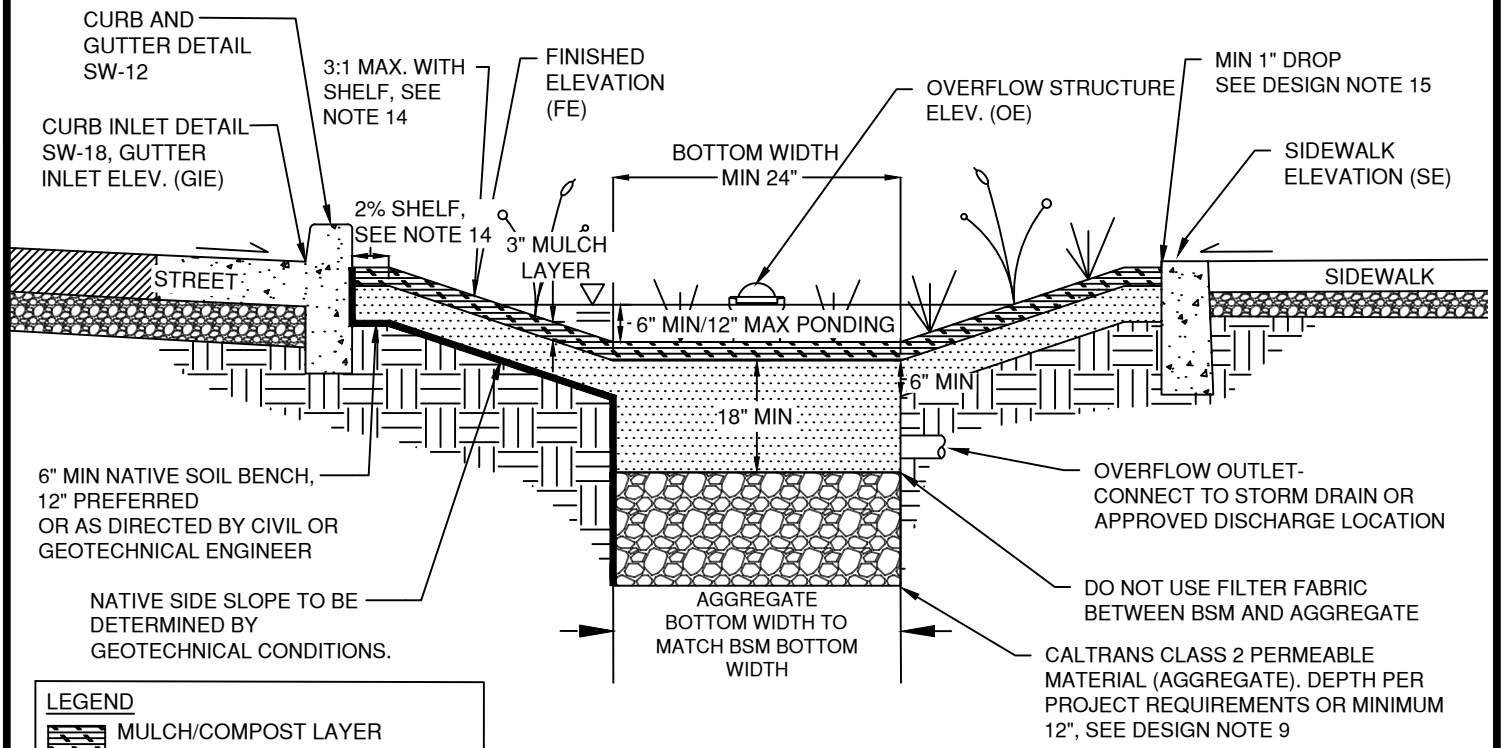
13. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

14. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

15. NATIVE SIDE SLOPE 4:1 (H:V) PREFERRED, 3:1 WITH SHELF. 6" MINIMUM SHELF WITH 2% SLOPE TOWARDS FACILITY ADJACENT TO PEDESTRIAN USE OR CURB UNLESS 4:1 SLOPE PROVIDED.

16. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE MULCH LAYER.

17. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
5. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
6. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
7. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.

4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.

5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.

6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.

7. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

8. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)

9. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.

10. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

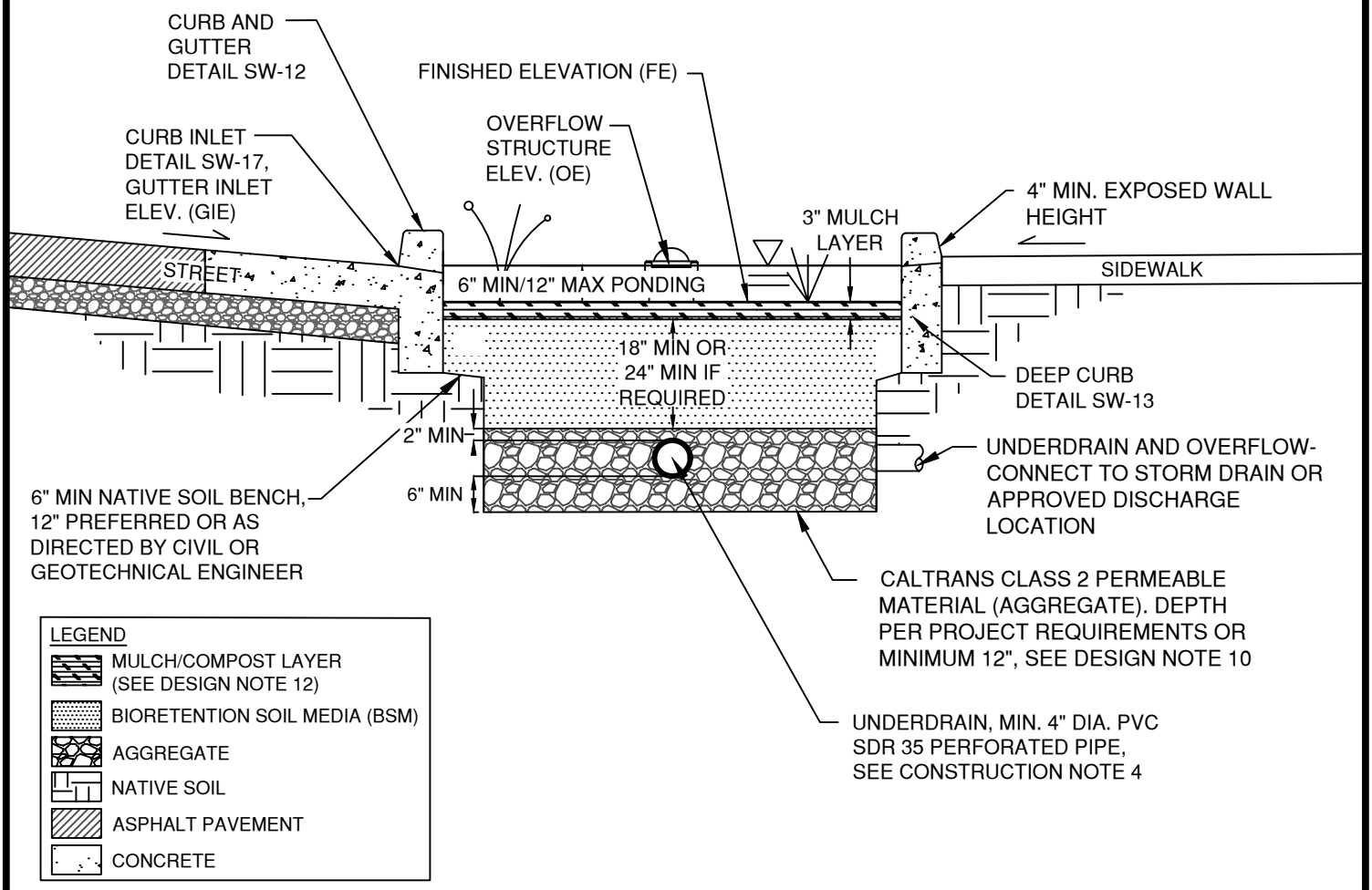
12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

14. NATIVE SIDE SLOPE 4:1 (H:V) PREFERRED, 3:1 WITH SHELF. 6" MINIMUM SHELF WITH 2% SLOPE TOWARDS FACILITY ADJACENT TO PEDESTRIAN USE OR CURB UNLESS 4:1 SLOPE PROVIDED.

15. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE MULCH LAYER.

16. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.

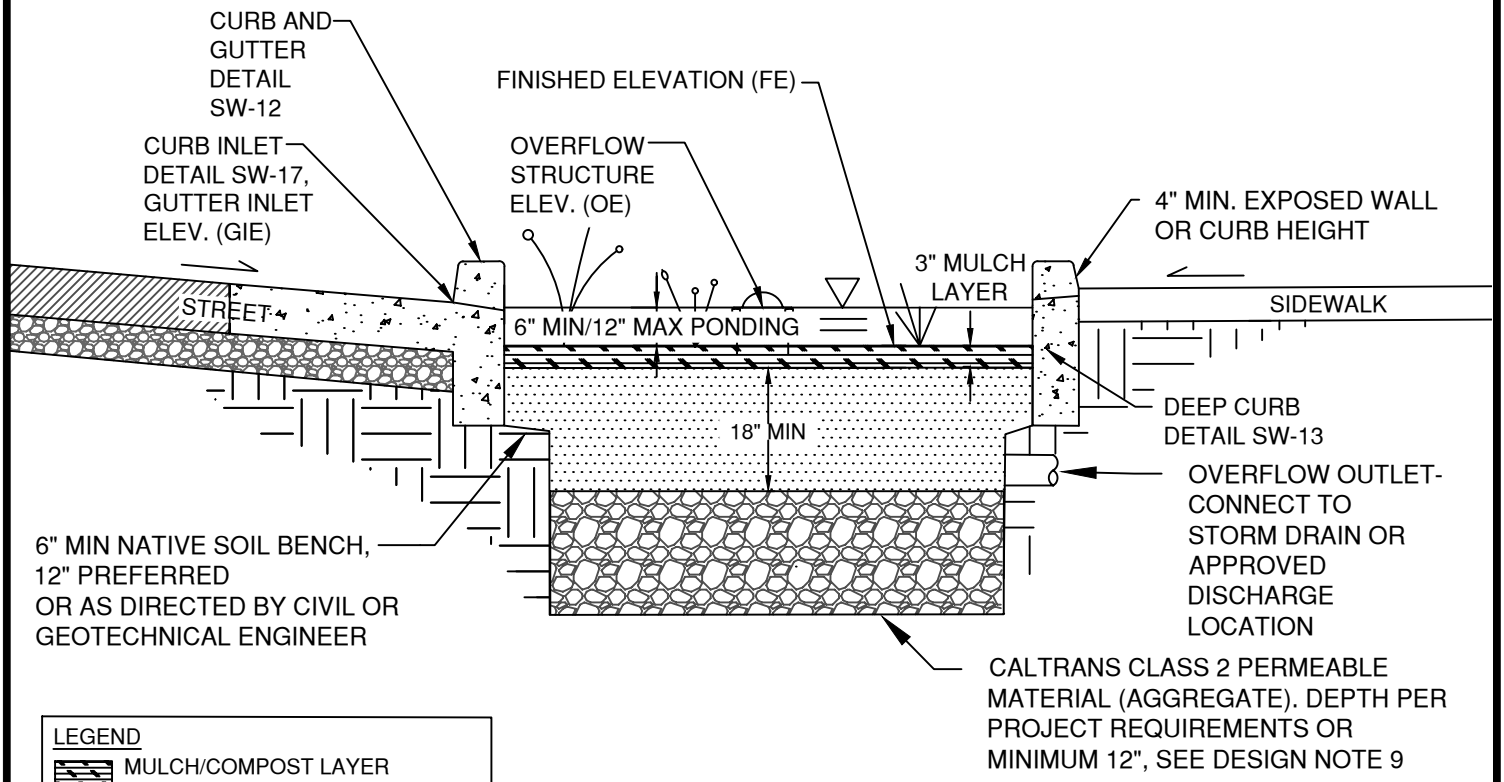


CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN 6" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.
5. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTIONFACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).
3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-18.
4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.
5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.
6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.
7. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.
8. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
9. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)
10. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.
11. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
12. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.
13. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.
14. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.
15. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



LEGEND

- MULCH/COMPOST LAYER (SEE DESIGN NOTE 12)
- BIORETENTION SOIL MEDIA (BSM)
- AGGREGATE
- NATIVE SOIL
- ASPHALT PAVEMENT
- CONCRETE

CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
5. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
6. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
7. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.

4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.

5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.

6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.

7. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

8. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)

9. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.

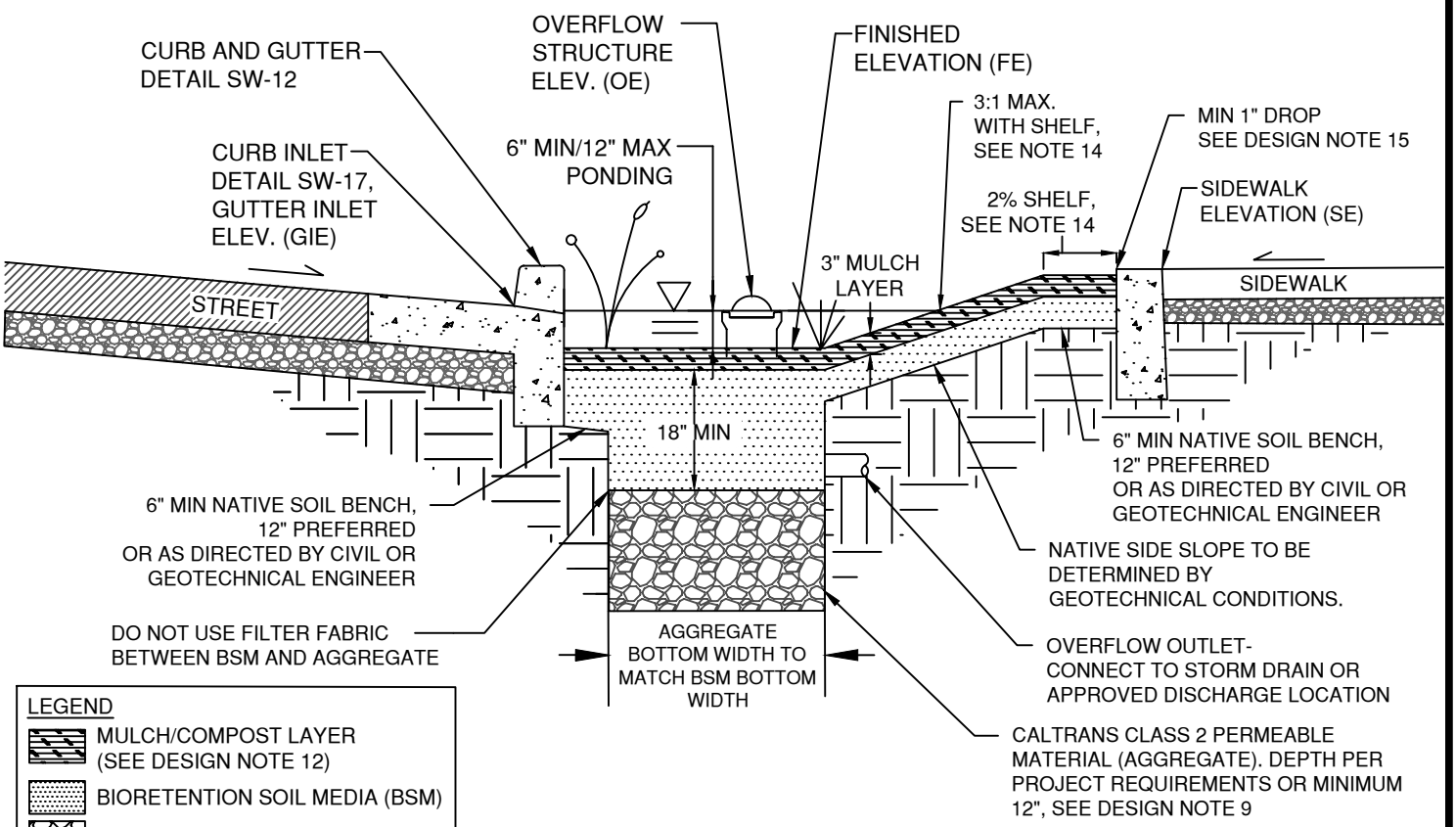
10. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

14. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.

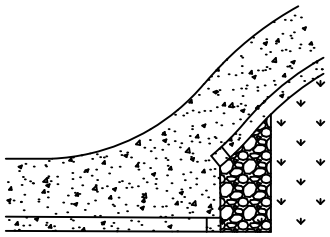


CONSTRUCTION NOTES

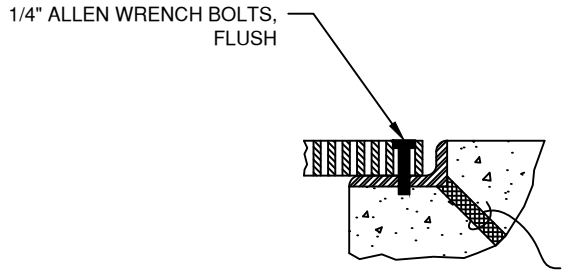
1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
5. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
6. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
7. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

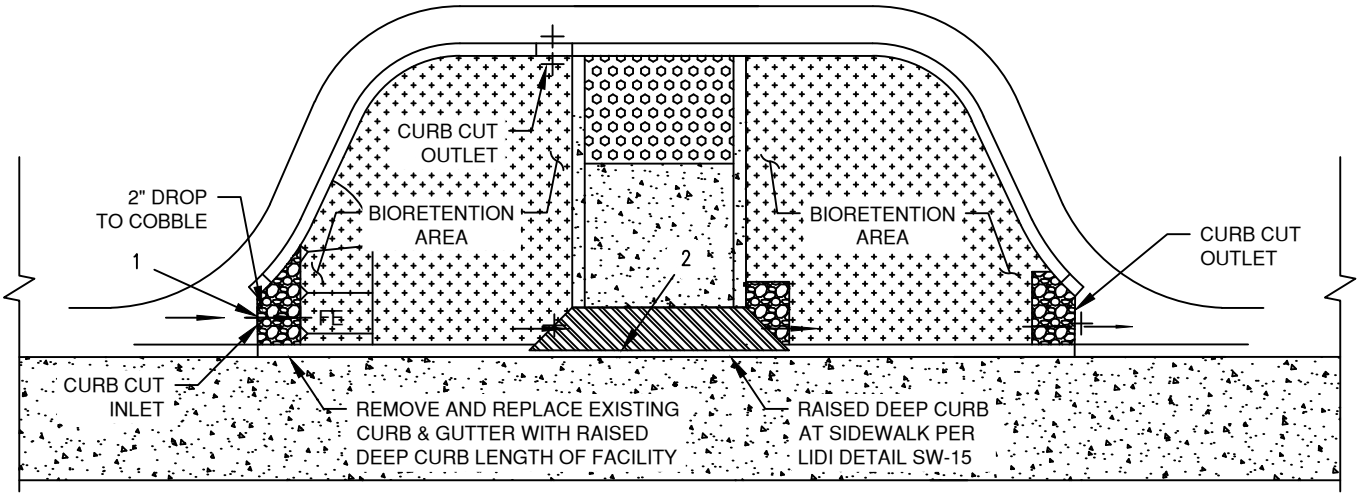
1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).
3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.
4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.
5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.
6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.
7. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
8. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)
9. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.
10. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.
12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.
13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.
14. NATIVE SIDE SLOPE 4:1 (H:V) PREFERRED, 3:1 WITH SHELF. 6" MINIMUM SHELF WITH 2% SLOPE TOWARDS FACILITY ADJACENT TO PEDESTRIAN USE OR CURB UNLESS 4:1 SLOPE PROVIDED.
15. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE MULCH LAYER.
16. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



CURB CUT INLET 1



GRATE & FRAME 2



CONSTRUCTION NOTES:

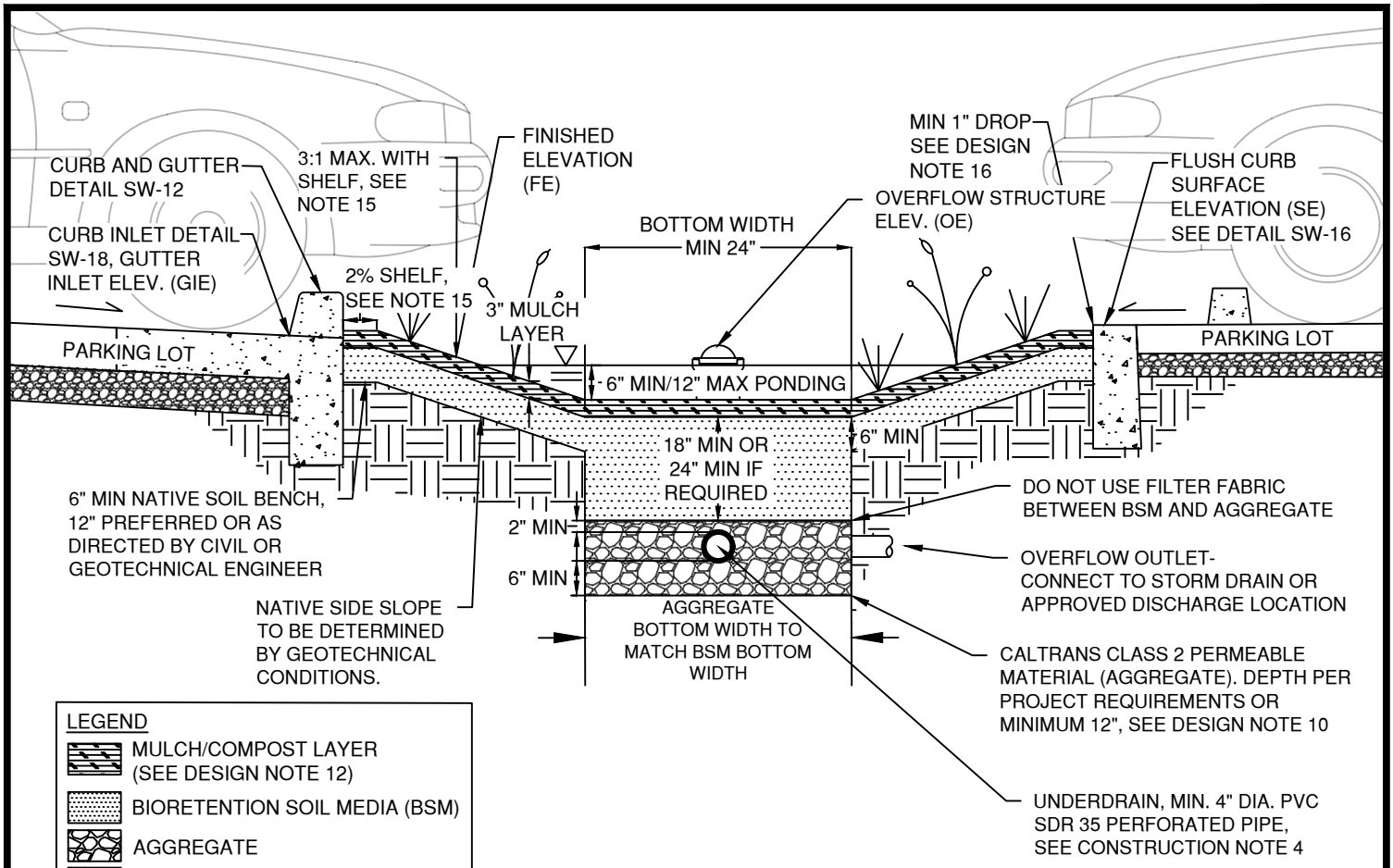
1. INSTALL GRAVEL BAGS AT CURB CUTS TO BLOCK FLOW FROM ENTERING BIORETENTION AREA. CITY TO REMOVE GRAVEL BAGS AT A TIME FOLLOWING CONSTRUCTION COMPLETION.

DESIGN NOTE:

1. THIS STANDARD DETAIL ASSUMES GRADUAL LONGITUDINAL AND CROSS SLOPES OF THE ROADWAY. STEEPER SLOPES IN EITHER DIRECTION WILL IMPACT CONVEYANCE AND ELEVATION DIFFERENCES BETWEEN THE FACILITY AND ADJACENT ROADWAY, CURB, AND SIDEWALK SURFACES. RETROFIT PROJECTS WILL FACE GREATER CONSTRAINTS THAN NEW CONSTRUCTION. SITE SPECIFIC DESIGN IS CRITICAL TO AVOID GRADE CONFLICTS AND MAXIMIZING PONDING AREA. GRADING PLANS THAT PROVIDE SPOT ELEVATIONS ACROSS THE ENTIRE FACILITY AND ALONG ADJACENT SURFACES ARE NECESSARY.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY: VERSION: 08/31/2017	STREET BIORETENTION BULB OUT, MID BLOCK CROSSING USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-5.1 SHEET 1 OF 1



LEGEND

- MULCH/COMPOST LAYER (SEE DESIGN NOTE 12)
- BIORETENTION SOIL MEDIA (BSM)
- AGGREGATE
- NATIVE SOIL
- ASPHALT PAVEMENT
- CONCRETE

CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN 6" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.
5. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.

4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.

5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.

6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.

7. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.

8. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

9. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)

10. DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO.4) OPEN-GRADED AGGREGATE.

11. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

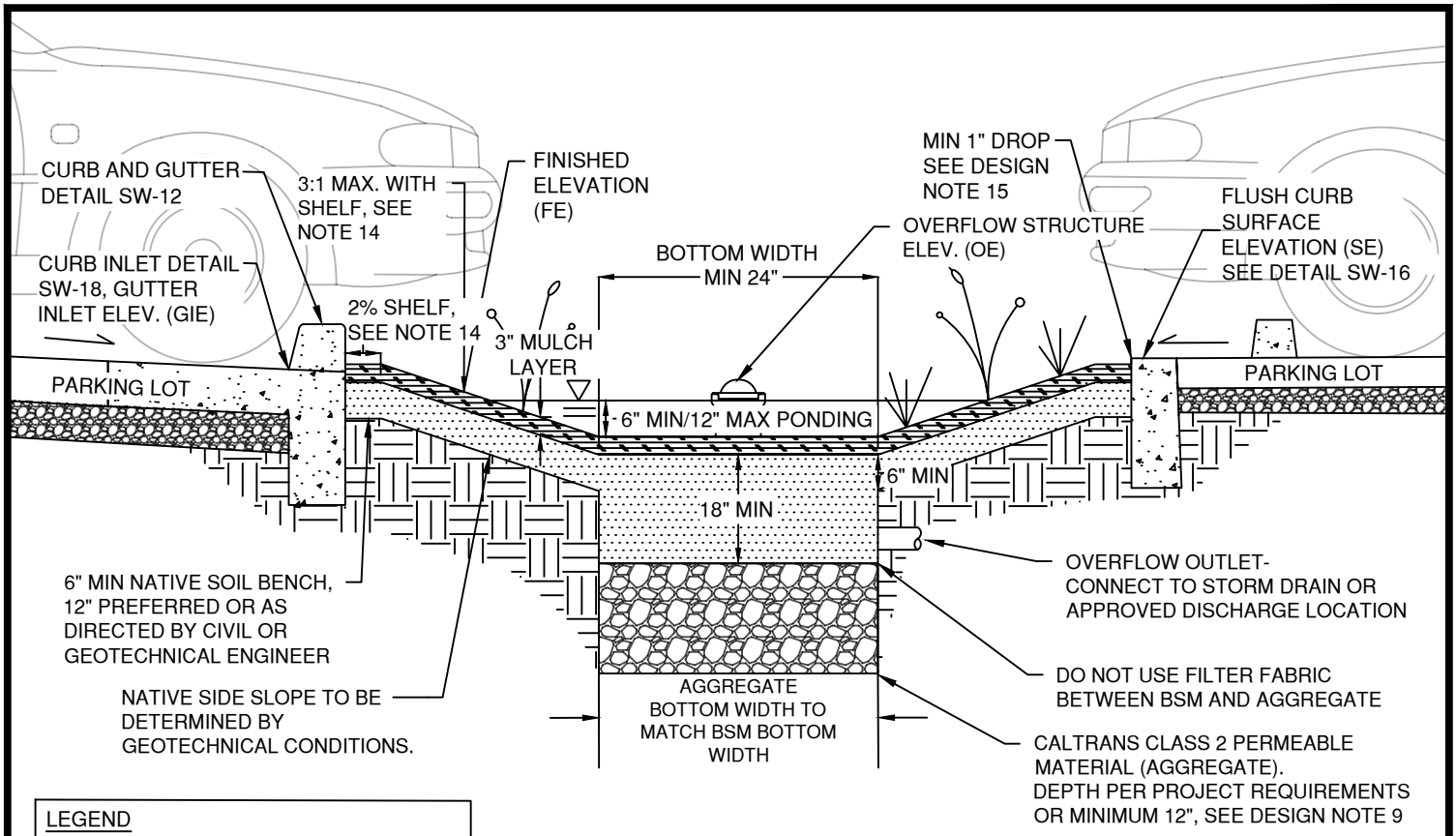
13. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

14. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

15. NATIVE SIDE SLOPE 4:1 (H:V) PREFERRED, 3:1 WITH BENCH. 6" MINIMUM SHELF WITH 2% SLOPE TOWARDS FACILITY ADJACENT TO PEDESTRIAN USE OR CURB UNLESS 4:1 SLOPE PROVIDED.

16. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE MULCH LAYER.

17. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



LEGEND

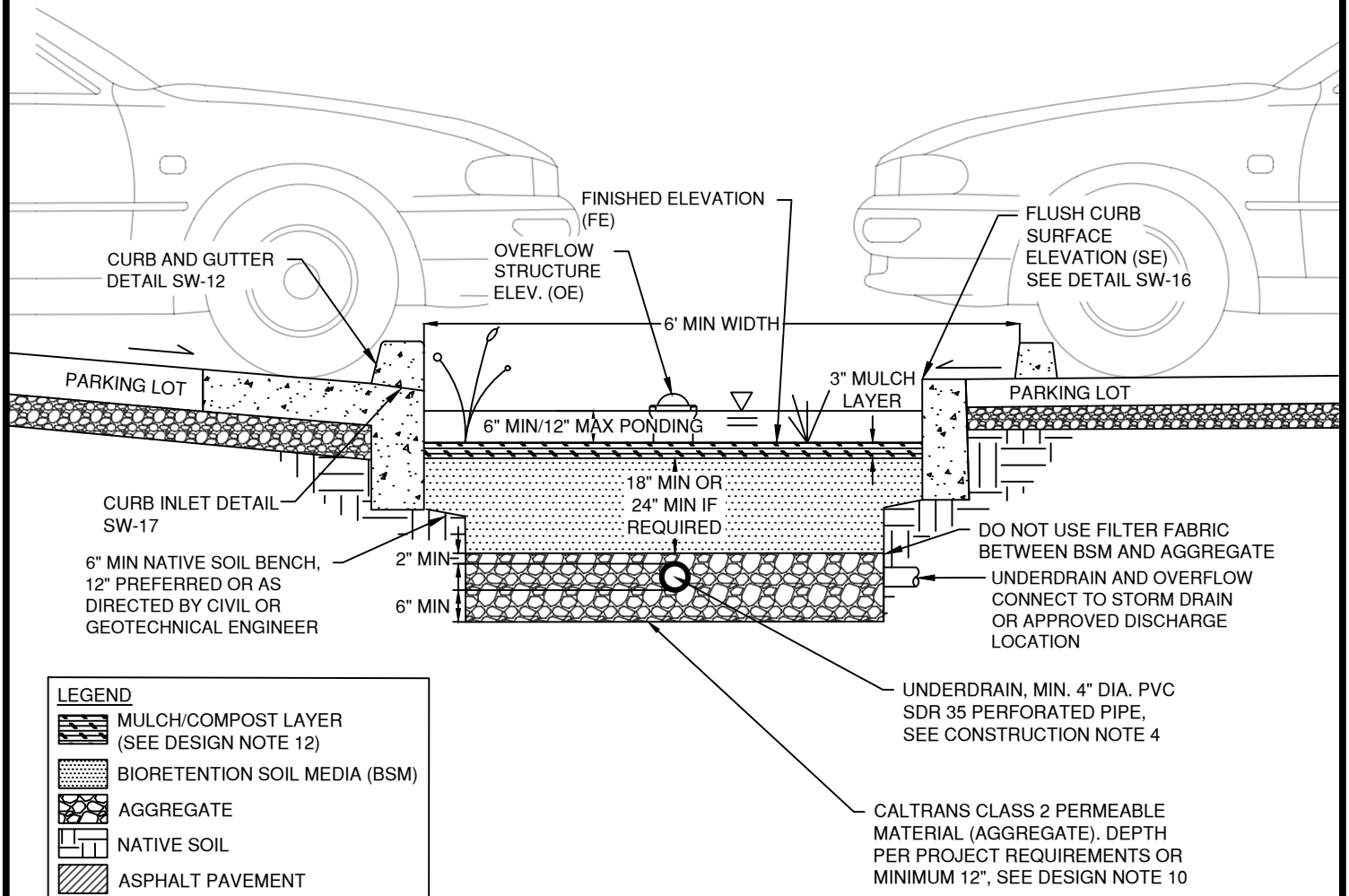
- MULCH/COMPOST LAYER (SEE DESIGN NOTE 12)
- BIORETENTION SOIL MEDIA (BSM)
- AGGREGATE
- NATIVE SOIL
- ASPHALT PAVEMENT
- CONCRETE

CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
5. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
6. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
7. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).
3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURE ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-18.
4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.
5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.
6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.
7. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
8. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)
9. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.
10. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.
12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.
13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.
14. NATIVE SIDE SLOPE 4:1 (H:V) PREFERRED, 3:1 WITH SHELF. 6" MINIMUM SHELF WITH 2% SLOPE TOWARDS FACILITY ADJACENT TO PEDESTRIAN USE OR CURB UNLESS 4:1 SLOPE PROVIDED.
15. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE MULCH LAYER.
16. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.

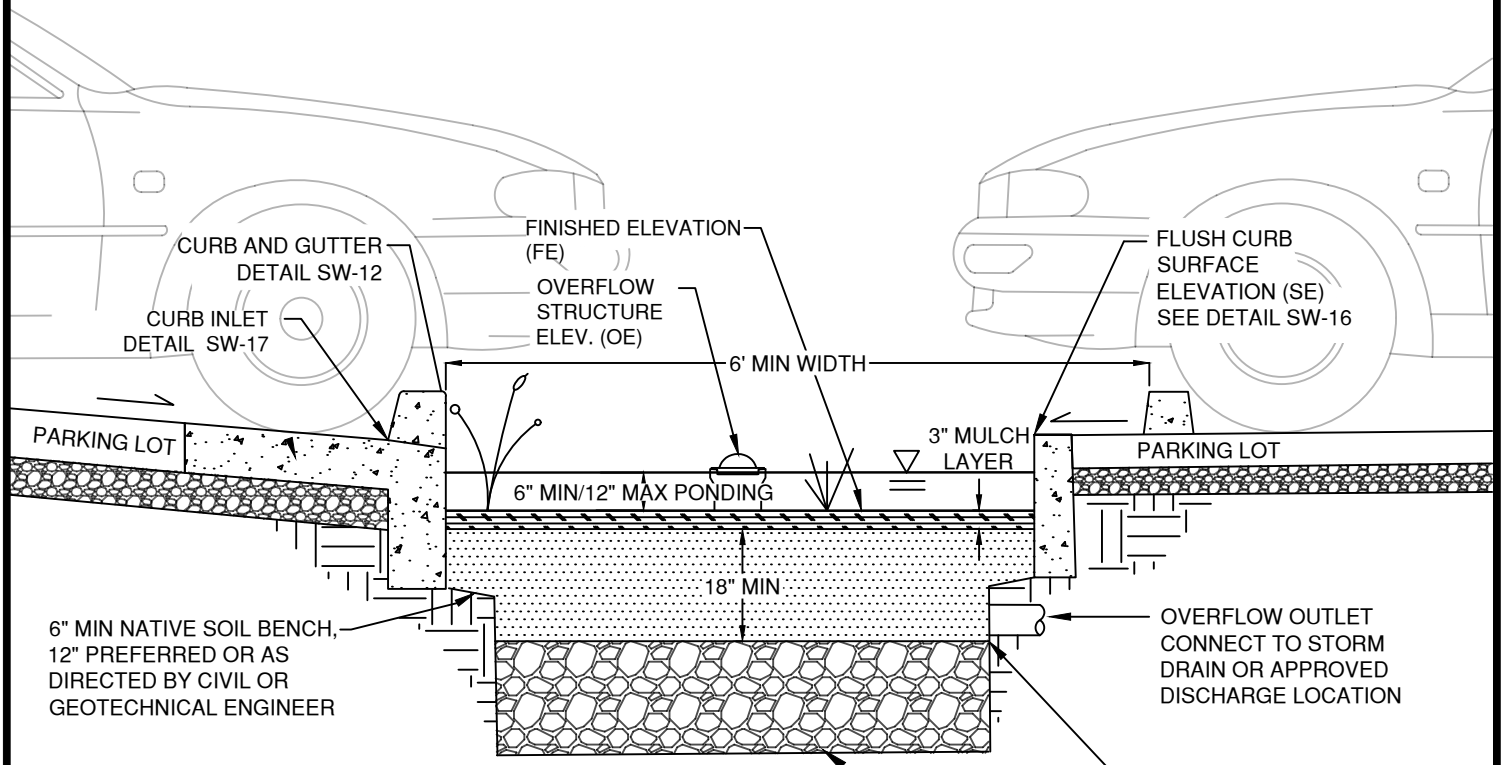


CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN 6" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.
5. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).
3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.
4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.
5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.
6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.
7. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.
8. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
9. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)
10. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.
11. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
12. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.
13. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.
14. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.
15. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



LEGEND

- MULCH/COMPOST LAYER (SEE DESIGN NOTE 12)
- BIORETENTION SOIL MEDIA (BSM)
- AGGREGATE
- NATIVE SOIL
- ASPHALT PAVEMENT
- CONCRETE

CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND SOIL.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
5. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
6. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
7. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-18.

4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIORETENTION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.

5. A VERTICAL LINER MAY BE USED FOR BIORETENTION FACILITIES TO PREVENT LATERAL FLOW AND TO SEPARATE THE NATIVE SOIL FROM THE BSM AND THE AGGREGATE, HOWEVER A HORIZONTAL LINER SHALL NOT BE USED.

6. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.

7. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

8. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)

9. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.

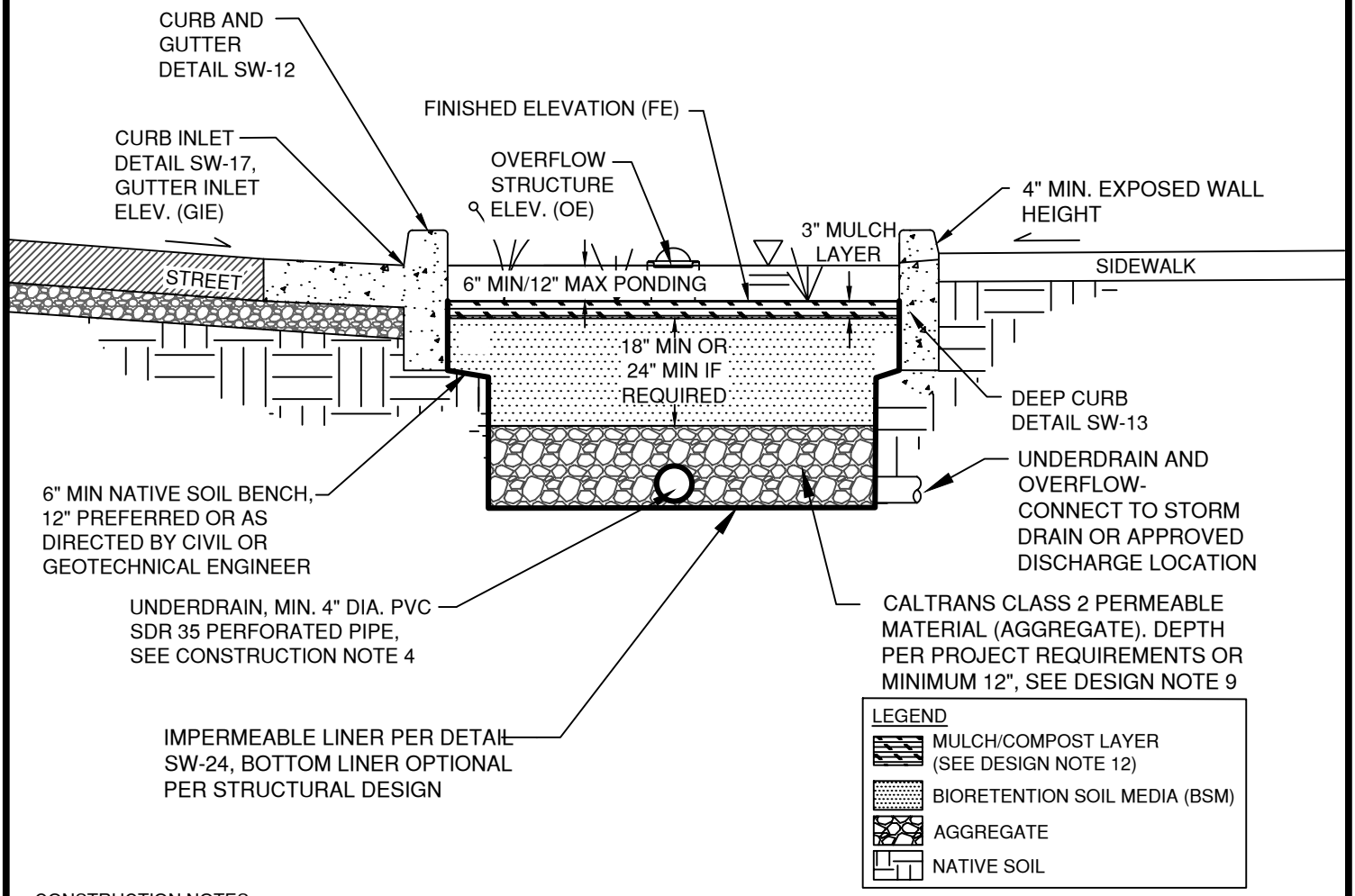
10. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

14. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIOFILTRATION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
4. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
5. DO NOT WORK WITHIN BIOFILTRATION AREA DURING RAIN OR UNDER WET CONDITIONS.
6. KEEP HEAVY MACHINERY OUTSIDE BIOFILTRATION AREA LIMITS.
7. STORMWATER SHOULD BE DIRECTED AWAY FROM BIOFILTRATION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

1. BIOFILTRATION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-18.

4. DUE TO SITE VARIABILITY, TO ENSURE THE LONG-TERM STRUCTURAL STABILITY OF THE BIOFILTRATION FACILITY AND ANY ADJACENT INFRASTRUCTURE CONSULT WITH A GEOTECHNICAL ENGINEER.

5. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.

6. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.

7. PROVIDE A CLEAN-OUT/OBSERVATION PORT IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

8. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-20, SW-21)

9. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.

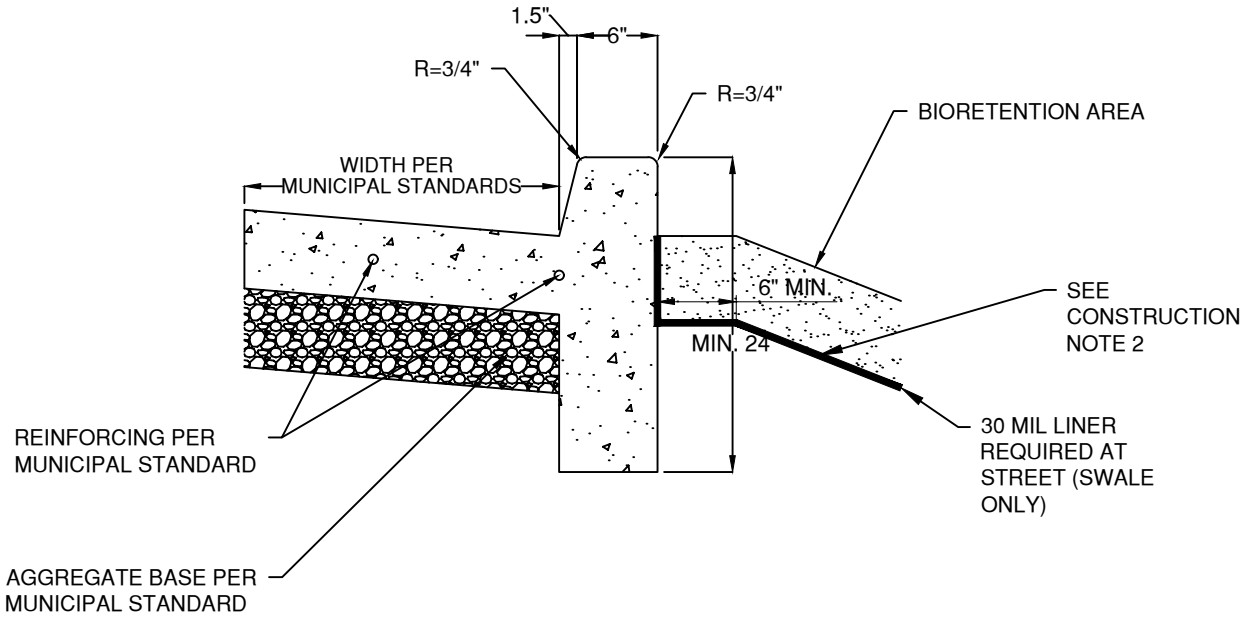
10. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

14. AVOID DECORATIVE USE OF COBBLE THAT CAN INTERFERE WITH WITH INFILTRATION.



DESIGN NOTES

1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER PLANTER WALL SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.

2. EDGE CONDITION WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.

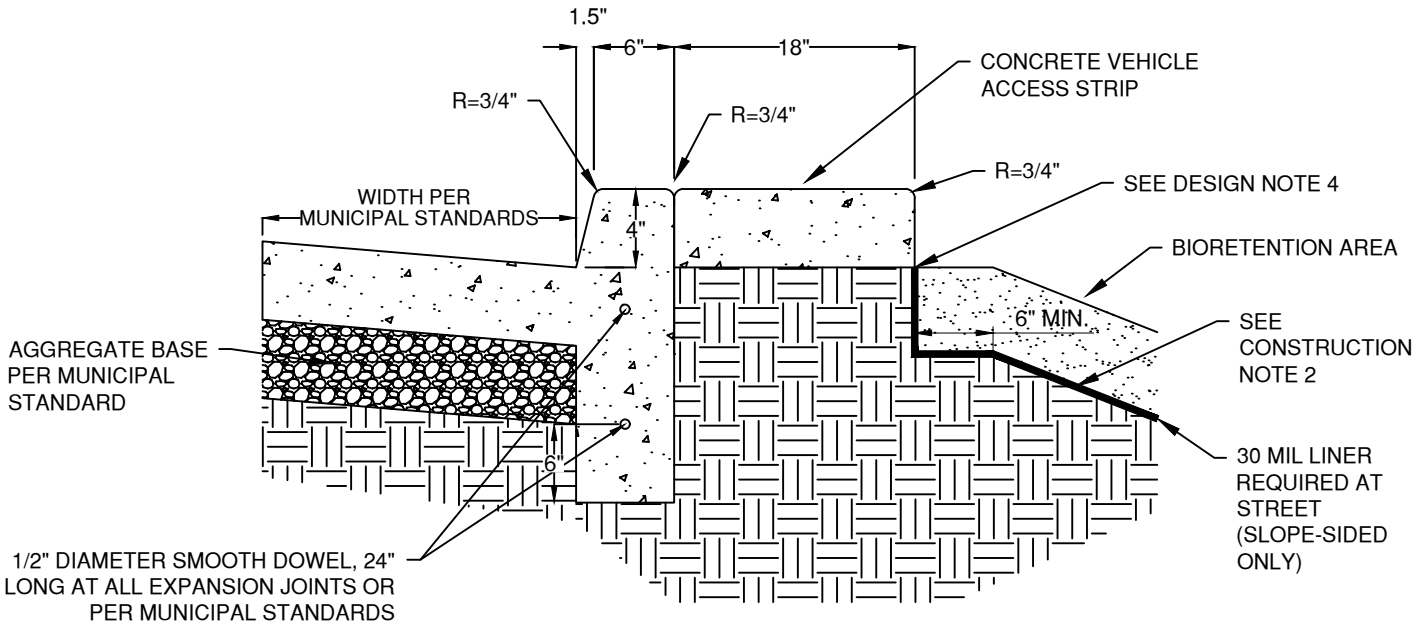
3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.

4. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

2. LAYBACK SLOPE AS FLAT AS POSSIBLE UNTIL TOP WIDTH PRODUCES 1:1 SLOPE & 24" BOTTOM WIDTH. AS PLANTER GETS WIDER MAINTAIN 1:1 SLOPE AND INCREASE BOTTOM WIDTH WIDER THAN 24". ALTERNATIVE TRENCH WALL CONFIGURATIONS MAY BE PROPOSED BY THE PROJECT GEOTECHNICAL ENGINEER (I.E. VERTICAL SHORING, REINFORCED TRENCH SIDEWALL) THAT DO NOT REQUIRE SIDEWALK SUPPORT FROM THE LIGHTLY COMPACTED BSM.

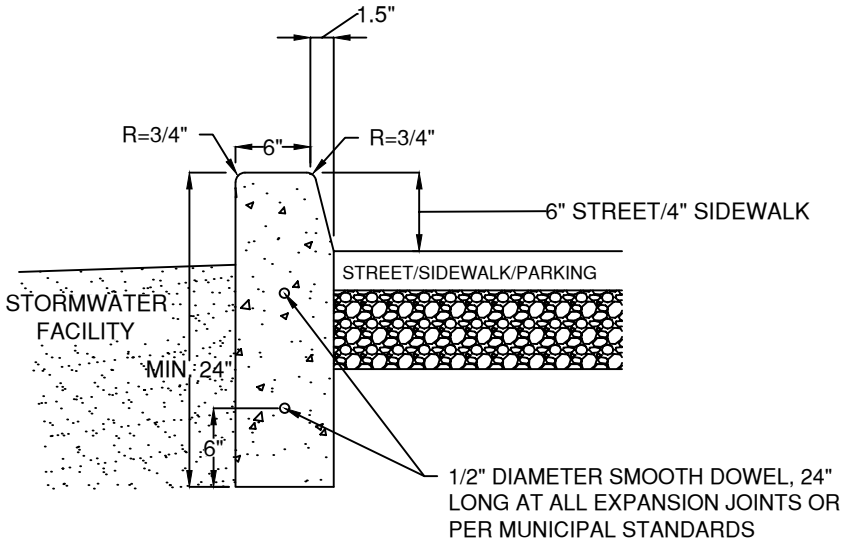


DESIGN NOTES

1. SPECIAL CONCRETE AND EXPANSION JOINS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.
2. PROVIDE OPENINGS IN CURB (12" WIDE) TO ALLOW FOR SURFACE DRAINAGE TO BIORETENTION AREAS IF DEDICATED INLET NOT USED. SPACING TO BE DETERMINED BY PROJECT ENGINEER BASED ON DESIGN STORM TO MINIMIZE PONDING AGAINST CURB FOR MEDIAN ISLAND APPLICATION.
3. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.
4. SEE REFERENCE DETAIL SW-24 FOR ATTACHMENT OF IMPERVIOUS LINER.

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.
2. LAYBACK SLOPE AS FLAT AS POSSIBLE UNTIL TOP WIDTH PRODUCES 1:1 SLOPE & 24" BOTTOM WIDTH. AS PLANTER GETS WIDER MAINTAIN 1:1 SLOPE AND INCREASE BOTTOM WIDTH WIDER THAN 24". ALTERNATIVE TRENCH WALL CONFIGURATIONS MAY BE PROPOSED BY THE PROJECT GEOTECHNICAL ENGINEER (I.E. VERTICAL SHORING, REINFORCED TRENCH SIDEWALL) THAT DO NOT REQUIRE SIDEWALK SUPPORT FROM THE LIGHTLY COMPACTED BSM.



DESIGN NOTES

1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER SWALE EDGE SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.

2. WHEN SIDEWALK DRAINS TO PLANTER, PROVIDE 4" - 6" WIDE NOTCH OPENINGS, 1" BELOW SIDEWALK, SLOPED TO FACILITY, PER BIORETENTION PLANTER DETAILS. SPACE OPENINGS TO CONVEY FLOWS. PROVIDE MINIMUM 2" COVER BETWEEN DRAINAGE NOTCH OPENING AND DOWELS.

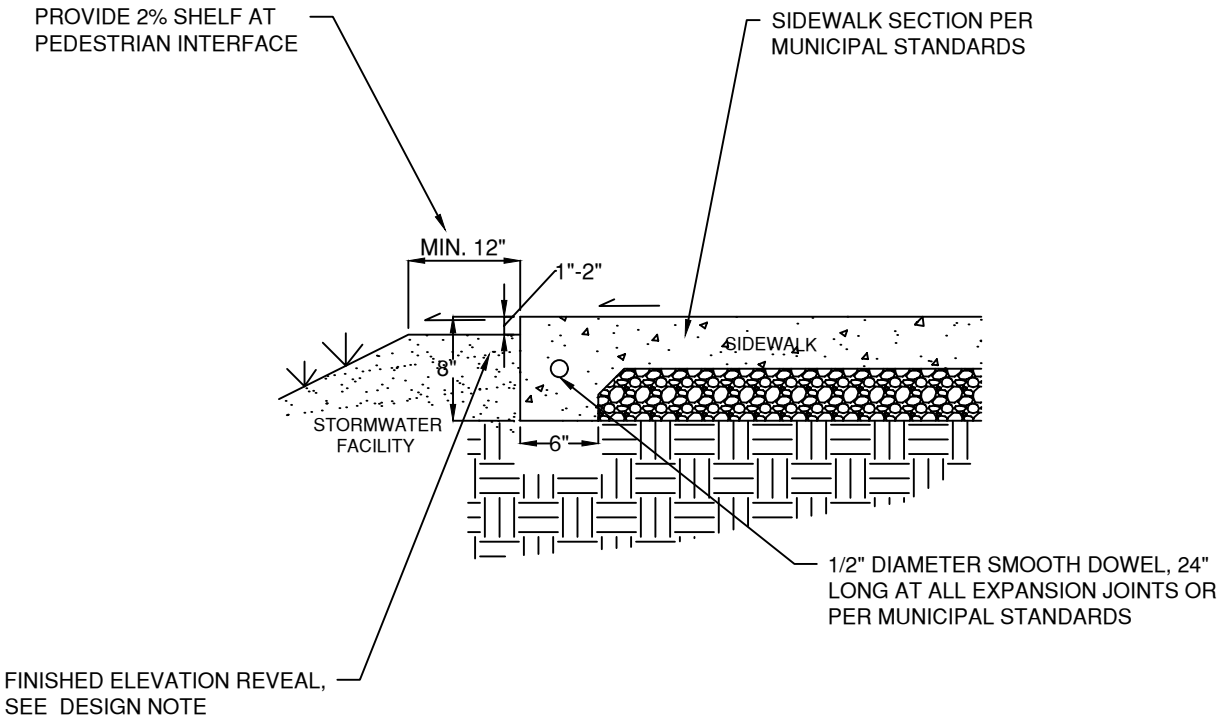
3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.

4. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

2. LAYBACK SLOPE AS FLAT AS POSSIBLE UNTIL TOP WIDTH PRODUCES 1:1 SLOPE & 24" BOTTOM WIDTH. AS PLANTER GETS WIDER MAINTAIN 1:1 SLOPE AND INCREASE BOTTOM WIDTH WIDER THAN 24". ALTERNATIVE TRENCH WALL CONFIGURATIONS MAY BE PROPOSED BY THE PROJECT GEOTECHNICAL ENGINEER (I.E. VERTICAL SHORING, REINFORCED TRENCH SIDEWALL) THAT DO NOT REQUIRE SIDEWALK SUPPORT FROM THE LIGHTLY COMPACTED BSM.



DESIGN NOTES

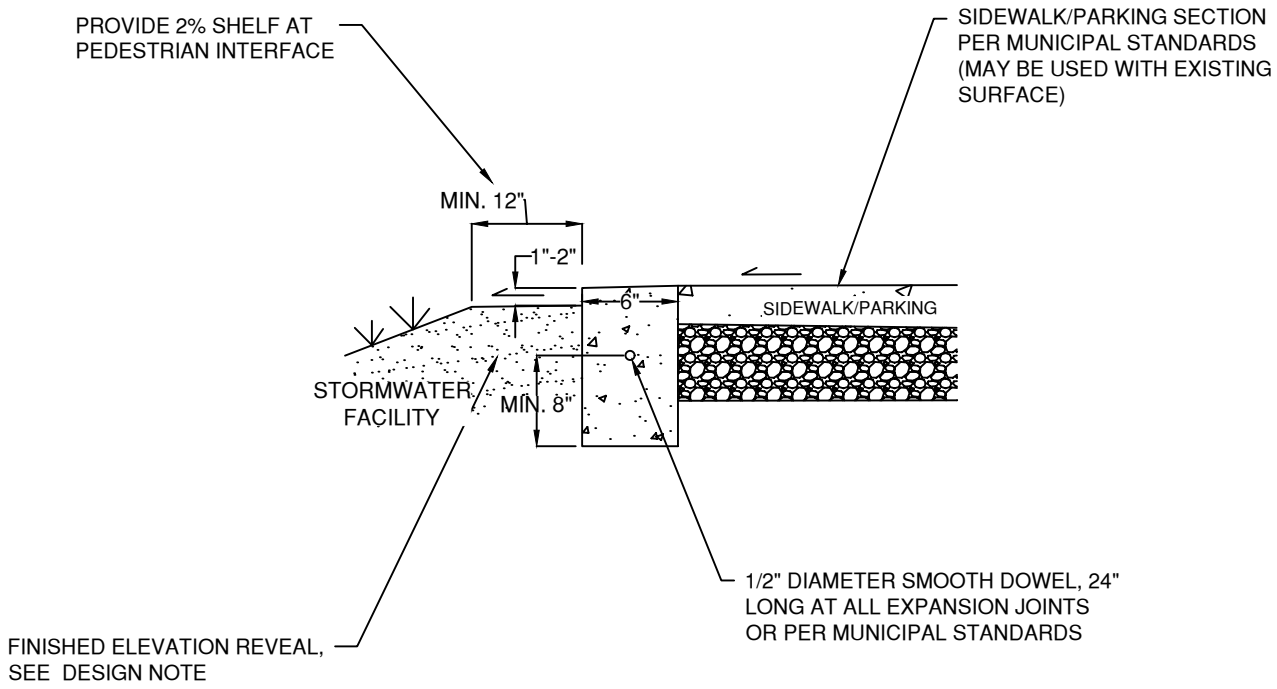
1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER FACILITY EDGE SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.

2. FINISHED ELEVATION REVEAL - WHERE SIDEWALK CONVEYS SHEET FLOW TO FACILITY, A 1"-2" REVEAL SHOULD BE MAINTAINED BETWEEN SIDEWALK AND FACILITY FINISHED GRADE TO AVOID MULCH OR PLANT BUILDUP FROM BLOCKING FLOWS.

3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

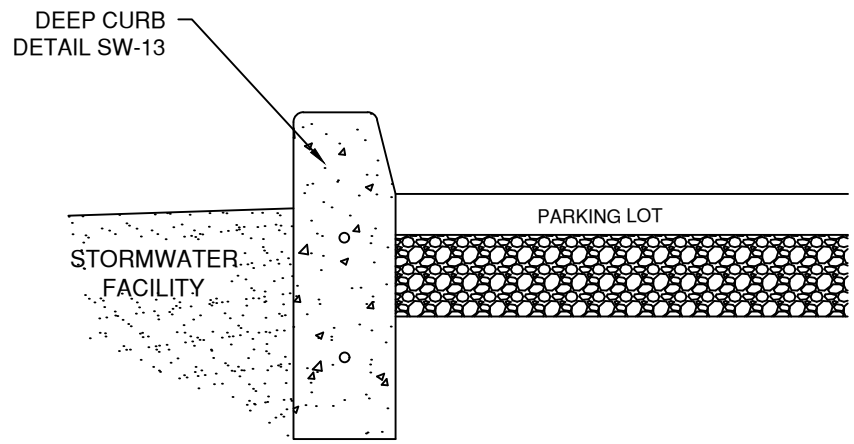


DESIGN NOTES

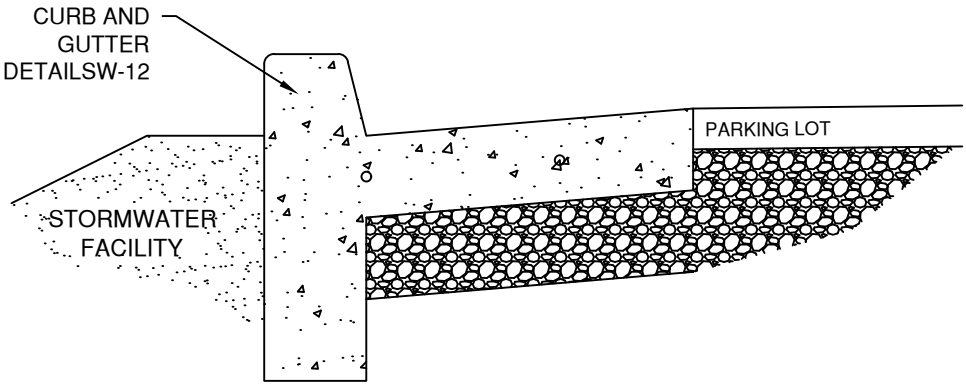
1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER FACILITY EDGE SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.
2. EDGE CONDITION WILL VARY FOR PROJECTS. CURB DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.
3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.
4. FINISHED ELEVATION REVEAL AT SIDEWALK - WHERE SIDEWALK CONVEYS SHEET FLOW TO FACILITY, A 1"-2" REVEAL SHOULD BE MAINTAINED BETWEEN SIDEWALK AND FACILITY FINISHED GRADE TO AVOID MULCH OR PLANT BUILDUP FROM BLOCKING FLOWS AND REDUCE DROP AT PEDESTRIAN INTERFACE.

CONSTRUCTION NOTES

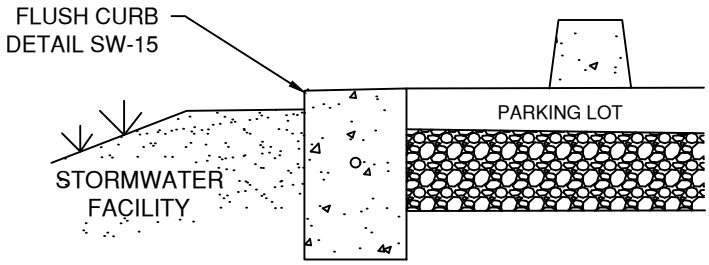
1. FINISH ALL EXPOSED CONCRETE SURFACES.



DEEP CURB



CURB AND GUTTER



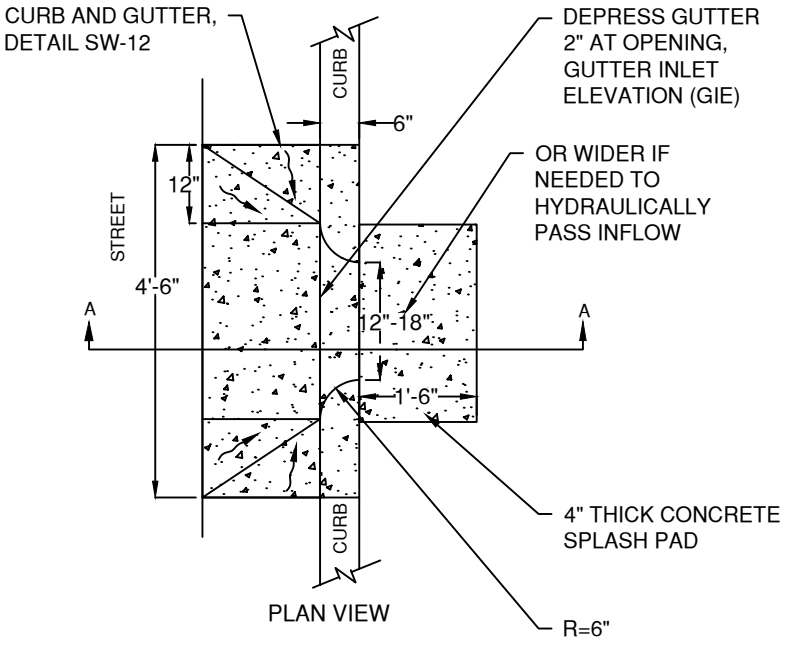
FLUSH EDGE/WHEEL STOPS

DESIGN NOTES

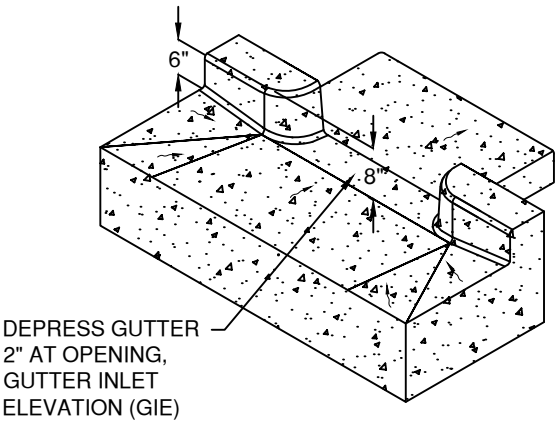
1. WHEEL STOPS MAY BE USED ON NON-FLUSH DESIGNS TO KEEP CARS FROM OVERHANGING BIORETENTION FACILITY.
2. VEHICLE OVERHANG CAN BE USED TO REDUCE IMPERVIOUS PAVEMENT AREA.
3. WHERE VEHICLE OVERHANG IS UTILIZED SELECT LOW GROWING PLANTS THAT WILL TOLERATE SHADING.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

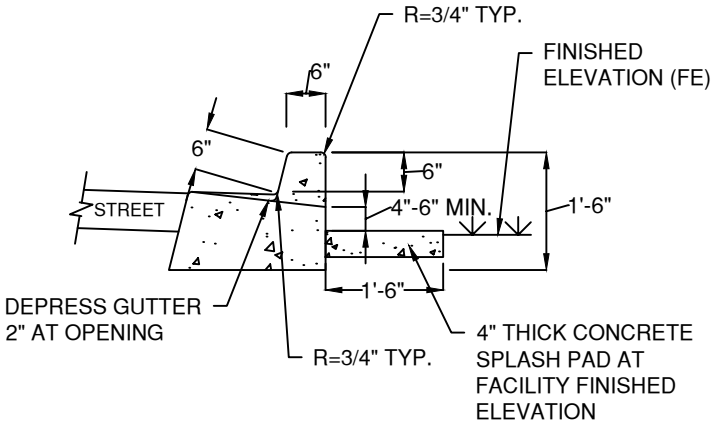
CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY: VERSION: 08/31/2017	PARKING LOT EDGE OPTIONS USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-16 SHEET 1 OF 1



PLAN VIEW



PERSPECTIVE VIEW



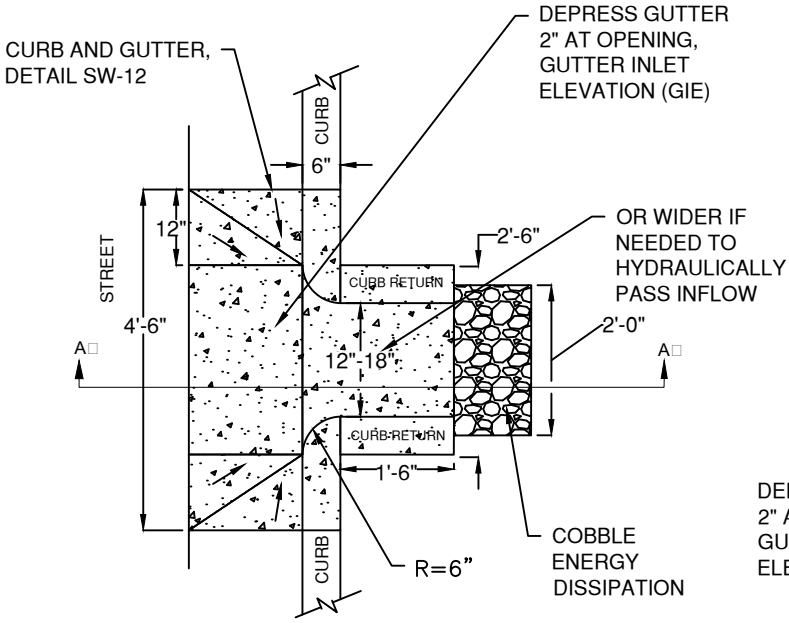
SECTION A-A

BIORETENTION DESIGN NOTES

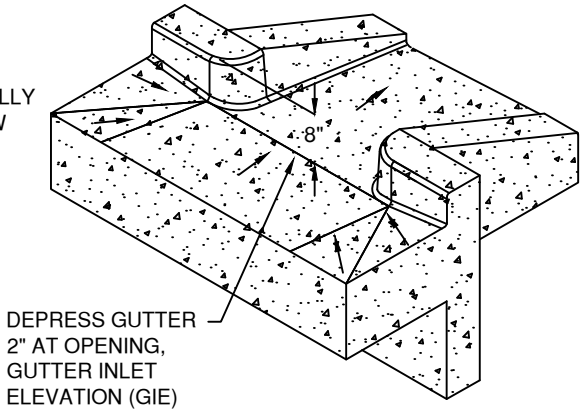
1. FOR USE WITH STORMWATER FACILITIES WITH FLAT BOTTOMS.
2. PROVIDE SPOT ELEVATIONS ON PLANS (FE, OE, GIE, IE). SEE DETAIL SW-2, SW-2A, SW-4 OR SW-4A.
3. CURB AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.
4. CURB HEIGHT MAY BE REDUCED TO 4-INCHES WHERE ADJACENT TO A SIDEWALK. SEE DETAILS SW-12 & SW-13.

CONSTRUCTION NOTES

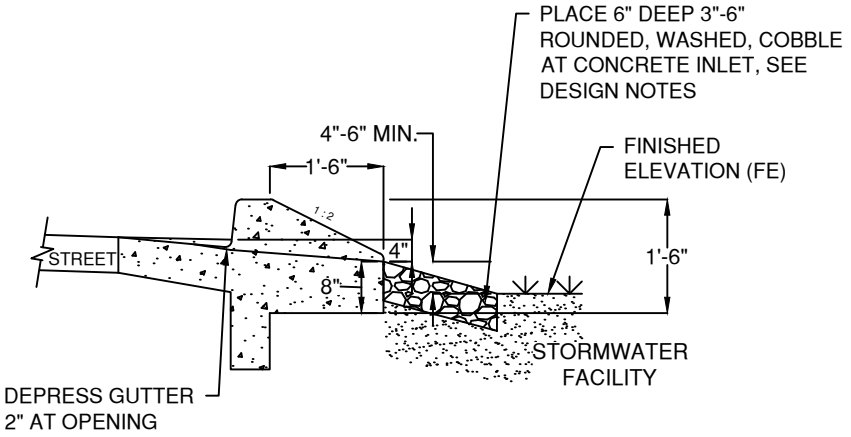
1. AFTER CONSTRUCTION PLACE SAND BAGS AT GUTTER OPENINGS TO KEEP STORM FLOWS FROM ENTERING FACILITY UNTIL VEGETATION IS ESTABLISHED.



PLAN VIEW



PERSPECTIVE VIEW



SECTION A-A

BIORETENTION DESIGN NOTES

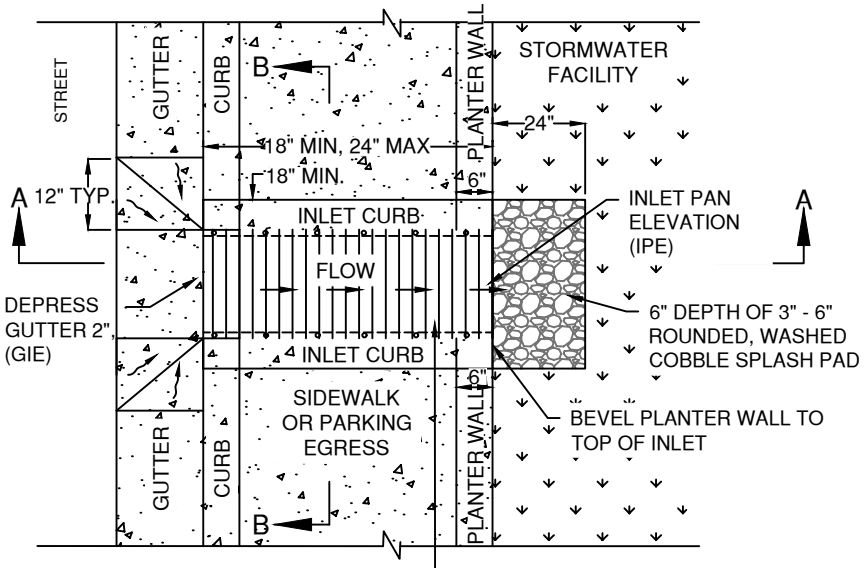
1. FOR USE WITH STORMWATER FACILITIES WITH SIDE SLOPES.
2. PROVIDE SPOT ELEVATIONS ON PLANS (FE, OE, GIE, IE). SEE DETAIL SW-1, SW-1A, SW-3 OR SW-3A.
3. CURB AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.
4. WHERE INLET FLOW VELOCITY IS HIGH, EXTEND COBBLE INTO FACILITY, BUT AVOID EXCESSIVE USE.
5. CURB HEIGHT MAY BE REDUCED TO 4-INCHES WHERE ADJACENT TO A SIDEWALK. SEE DETAILS SW-12 & SW-13.

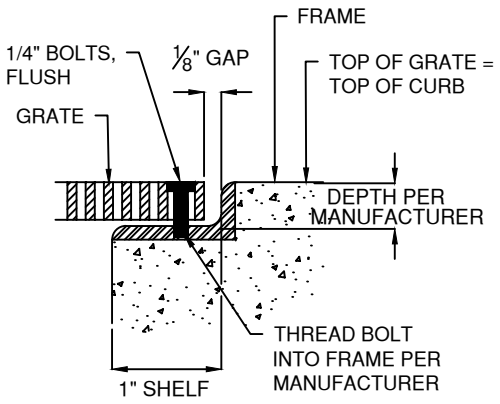
CONSTRUCTION NOTES

1. AFTER CONSTRUCTION PLACE SAND BAGS AT GUTTER OPENINGS TO KEEP STORM FLOWS FROM ENTERING FACILITY UNTIL VEGETATION IS ESTABLISHED.

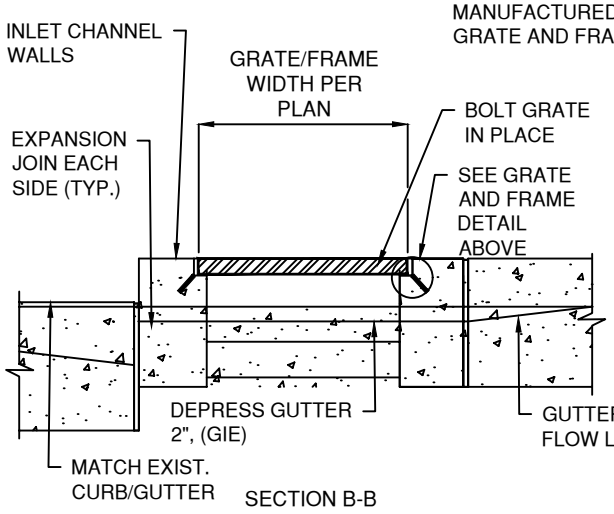
LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY: VERSION: 08/31/2017	CURB CUT INLET FOR SLOPE SIDED BIORETENTION SWALE	STANDARD PLAN NO. SW-18
		USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	SHEET 1 OF 1

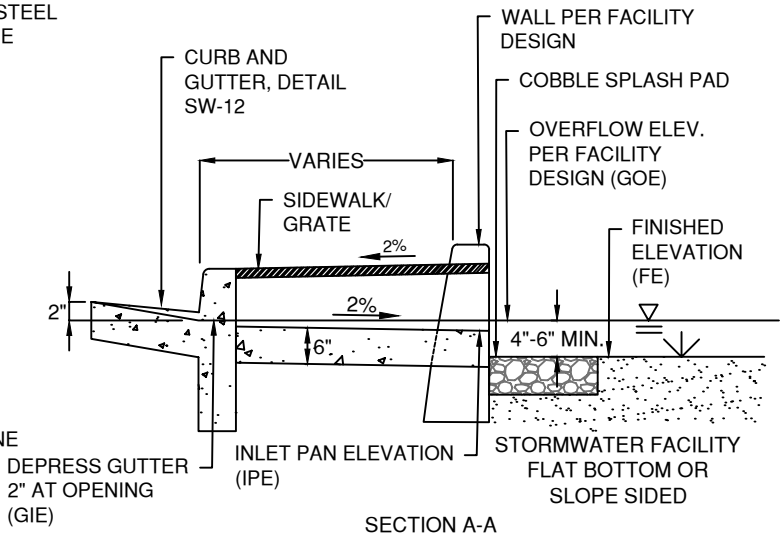




GRATE AND FRAME



SECTION B-B



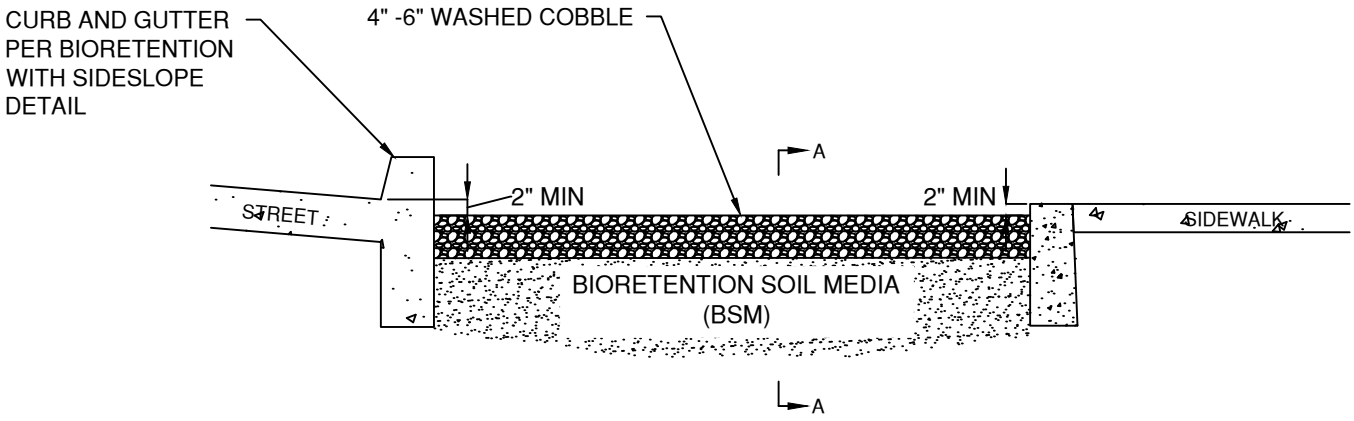
SECTION A-A

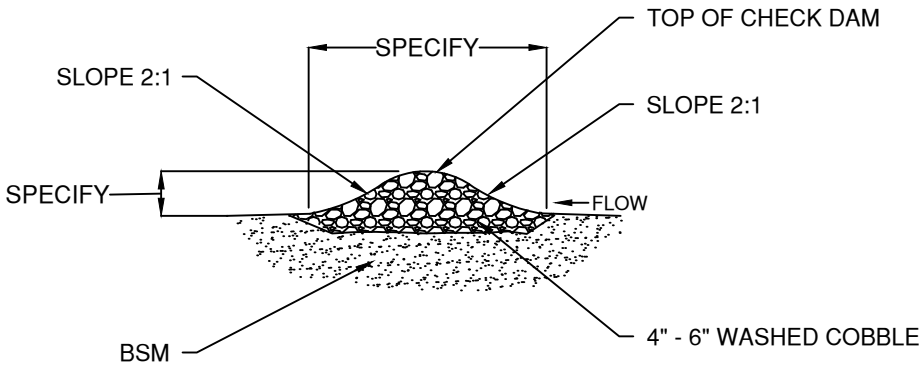
BIORETENTION DESIGN NOTES

1. FOR USE WITH STORMWATER FACILITIES WITH SLOPED SIDES OR FLAT BOTTOMS.
2. PROVIDE SPOT ELEVATIONS ON PLANS (FE, OE, GIE, IPE). SEE DETAIL SW-2, SW-2A, SW-4 OR SW-4A.
3. REFER TO MUNICIPAL STANDARD DRAWINGS AND MATCH GUTTER PAN OF ADJACENT CURB AND GUTTER.
4. IF SLOPED SIDES, WHERE INLET FLOW VELOCITY IS HIGH, EXTEND COBBLE INTO FACILITY, BUT AVOID EXCESSIVE USE.
5. BASE MATERIAL FOR CURB, GUTTER, AND SIDEWALK PER MUNICIPAL STANDARDS.
6. GRATE AND FRAME SHALL SUPPORT H-20 LOADING (ALHAMBRA FOUNDRY A-1540/A-1551 OR EQUIVALENT).
7. SOLID COVER AND FRAME (ALHAMBRA FOUNDRY A-1430/A-1433 OR EQUIVALENT) MAY BE USED IN PLACE OF GRATE AND FRAME.

CONSTRUCTION NOTES

1. AFTER CONSTRUCTION PLACE SAND BAGS AT GUTTER OPENINGS TO KEEP STORM FLOWS FROM ENTERING FACILITY UNTIL VEGETATION IS ESTABLISHED.





SECTION A-A

BIORETENTION DESIGN NOTES

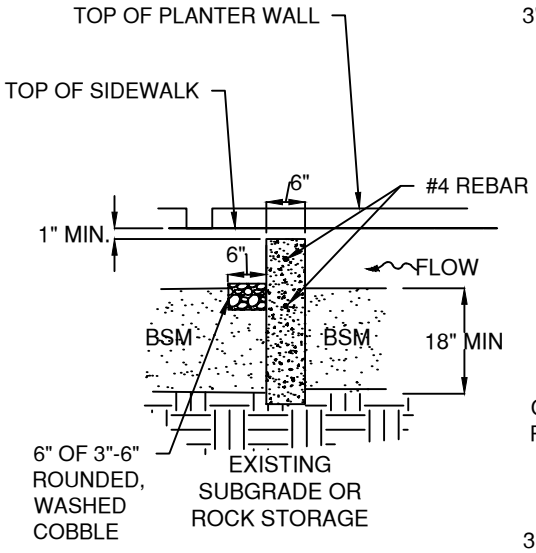
1. FOR USE WITH STORMWATER FACILITIES WITH SLOPED SIDES.
2. BEST SUITED FOR FACILITIES WITH <= 2% LONGITUDINAL SLOPE.
3. PROVIDE ELEVATIONS AND STATIONING AND/OR DIMENSIONING FOR CHECK DAMS.
4. SPACE CHECK DAMS TO MAXIMIZE PONDING ACROSS ENTIRE CELL.
5. ENSURE THAT CHECK DAM ELEVATIONS DO NOT CAUSE STORMWATER TO OVERFLOW TO SIDEWALK.

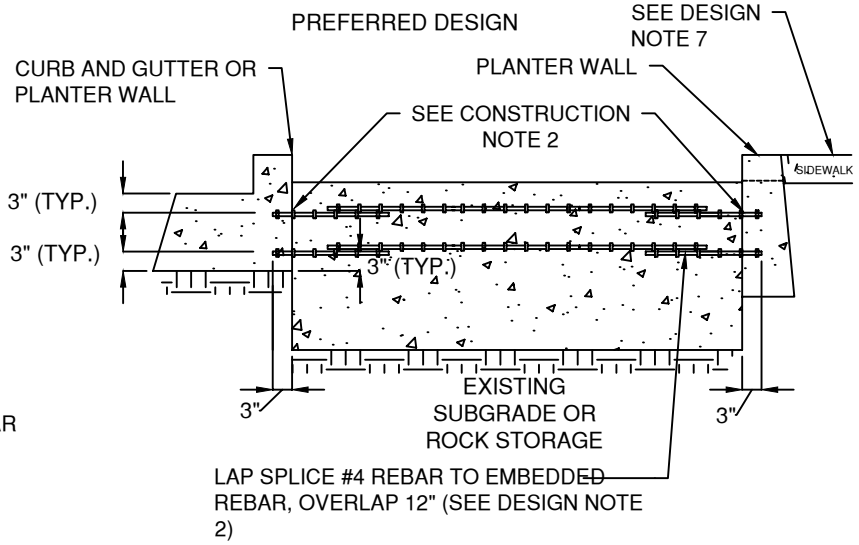
CONSTRUCTION NOTES

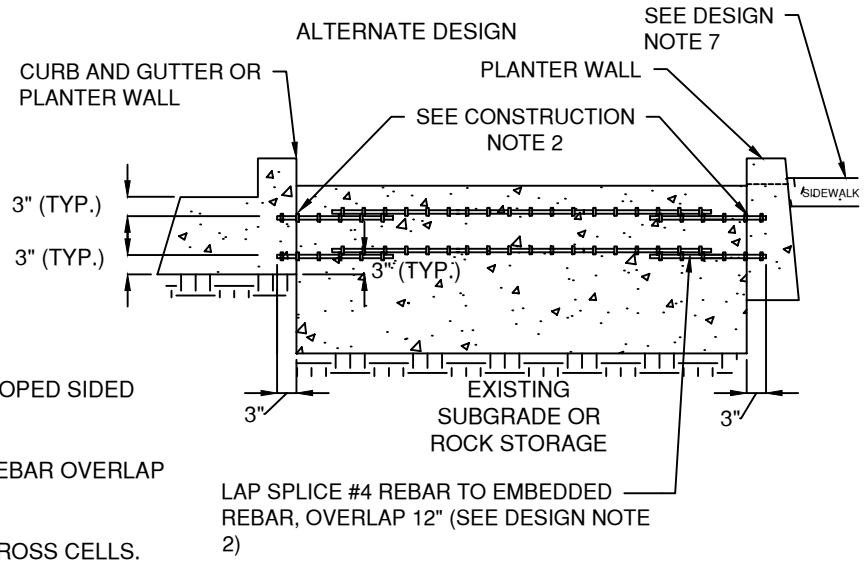
1. DO NOT WORK DURING RAIN OR UNDER WET CONDITIONS.
2. KEEP ALL HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY: VERSION: 08/31/2017	GRAVEL CHECK DAM USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-20 SHEET 1 OF 1





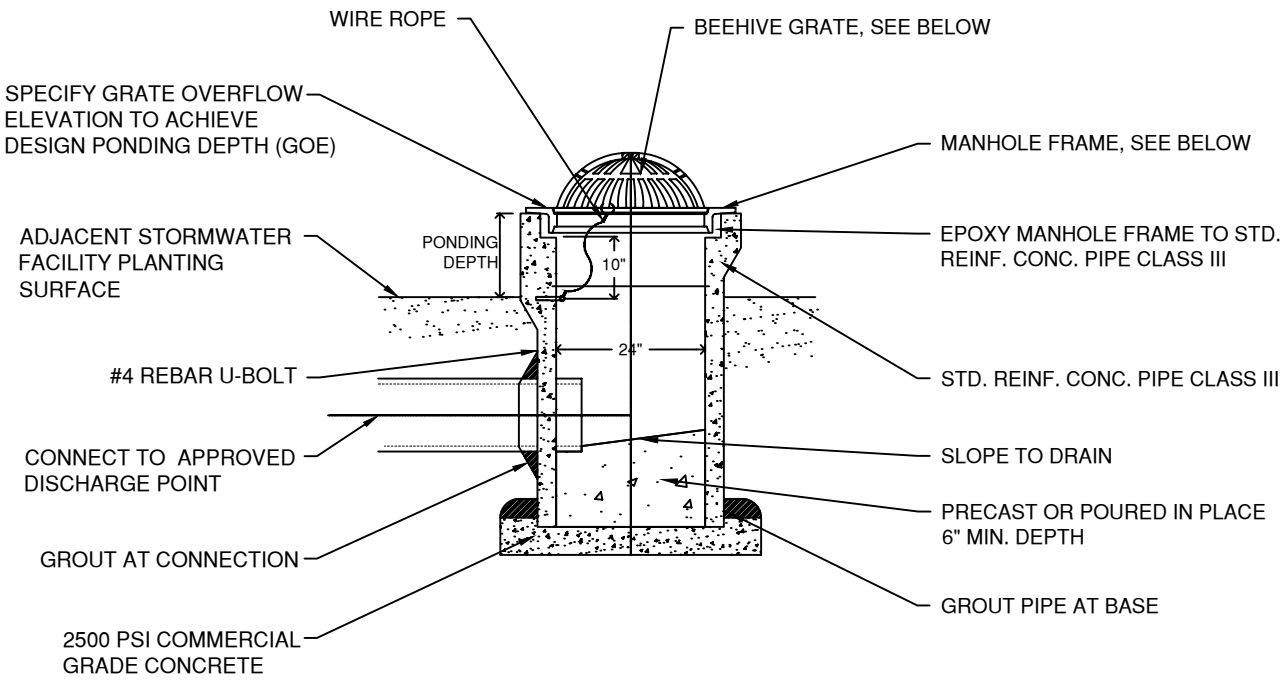


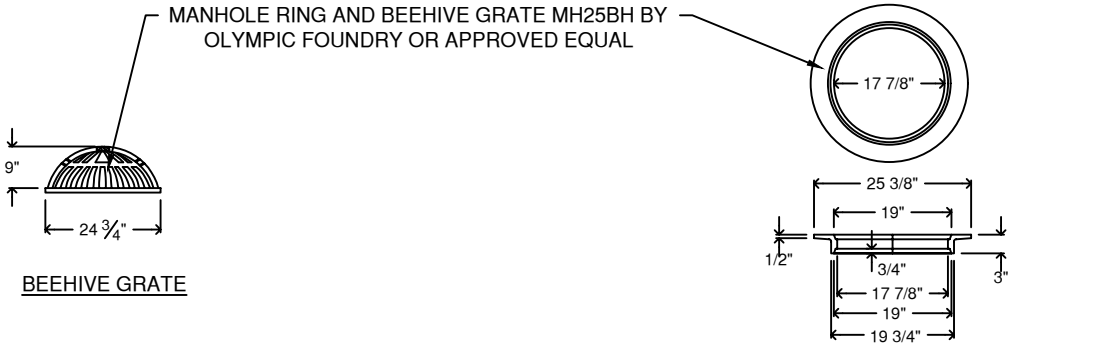
BIORETENTION DESIGN NOTES

1. FOR USE WITH BIORETENTION PLANTERS OR SLOPED SIDED SWALES/RAIN GARDENS.
2. FOR CHECK DAMS LONGER THAN 12' SPECIFY REBAR OVERLAP LENGTH.
3. SPACE CHECK DAMS TO MAXIMIZE PONDING ACROSS CELLS.
4. PROVIDE ELEVATIONS AND STATIONING AND/OR DIMENSIONING FOR CHECK DAMS.
5. ENSURE THAT CHECK DAM ELEVATIONS DO NOT CAUSE STORMWATER TO OVERFLOW TO SIDEWALK.
6. SHOW PLANTER WALL EMBEDDED IN EXISTING SUBGRADE OR DRAINROCK.
7. PREFERRED DESIGN IS TO CONSTRUCT TOP OF SIDEWALK AT GRADE WITH TOP OF PLANTER WALL TO ALLOW RUNOFF TO SHEETFLOW INTO BIORETENTION PLANTER. IF CURB IS NEEDED, USE ALTERNATE DESIGN AND ENSURE TOP OF CONCRETE CHECK DAM IS A MINIMUM OF 1" BELOW BOTTOM OF CURB NOTCH.

CONSTRUCTION NOTES

1. EMBED #3 REBAR 3" INTO CURB AND PLANTER WALL.
2. DO NOT WORK DURING RAIN OR UNDER WET CONDITIONS.
3. KEEP ALL HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.





BEEHIVE GRATE

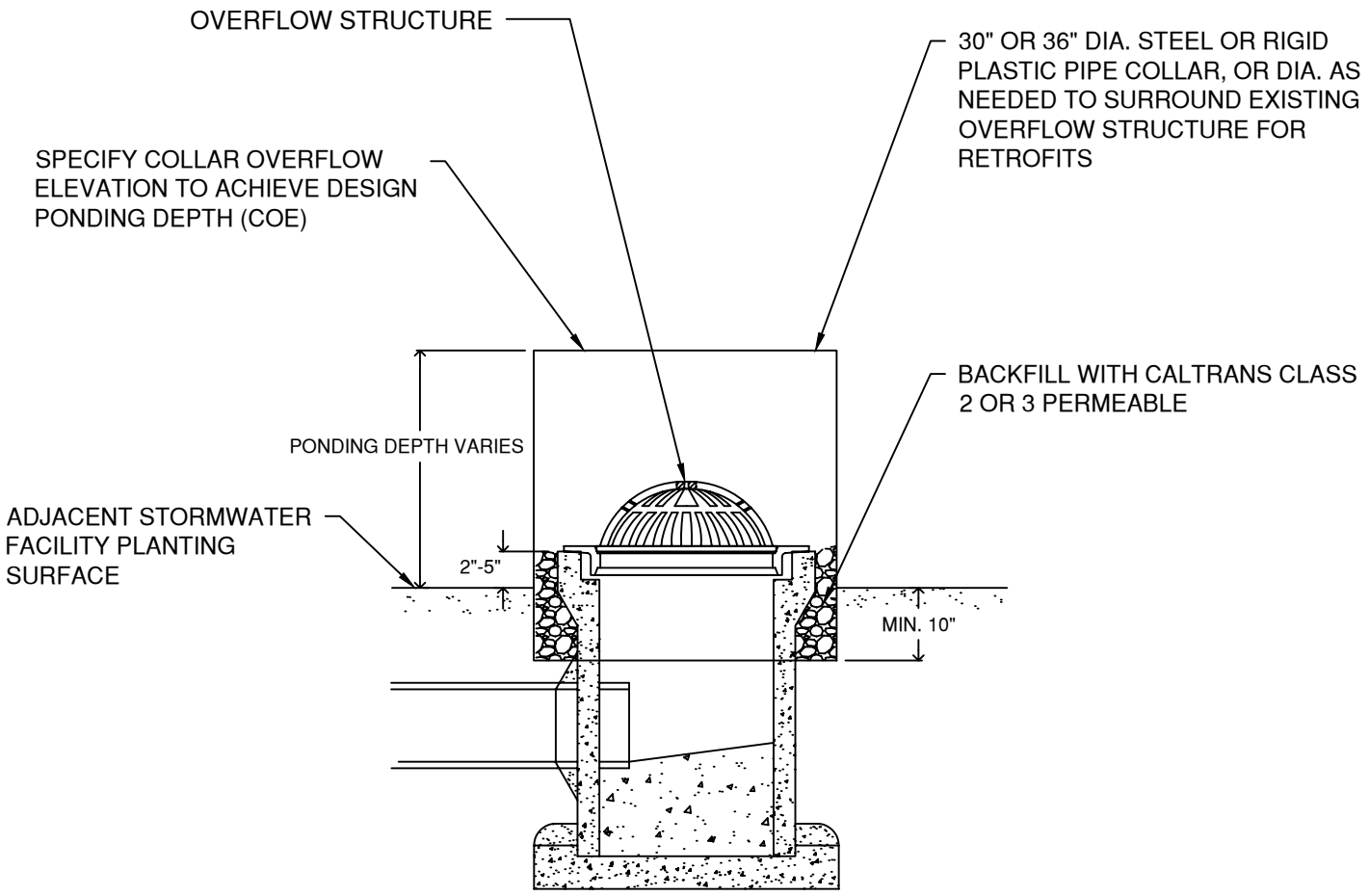
24"x4" REVERSIBLE MANHOLE FRAME

DESIGN NOTES

1. PROVIDE GRATE OVERFLOW ELEVATION ON PLANS.
2. TO INCORPORATE FLEXIBILITY INTO DESIGN OVERFLOW ELEVATION OR CORRECT ELEVATION OF AN EXISTING STRUCTURE, INSTALL OVERFLOW COLLAR, PER DETAIL SW-22A.
3. IN PRIVATE SITES NOT IN CITY R/W THE PROJECT CIVIL ENGINEER MAY PROPOSE ALTERNATIVES FOR GRATE INSTALLATIONS USING ALTERNATIVE MANUFACTURER'S PRODUCT/CONFIGURATION.

CONSTRUCTION NOTES

1. DO NOT ADJUST OVERFLOW GRATE ELEVATION, CONSTRUCT AS SHOWN ON PLANS.



DESIGN NOTES

1. MAY BE USED IN CONJUNCTION WITH OVERFLOW STRUCTURES TO ALLOW FOR FIELD ADJUSTMENT OF OVERFLOW ELEVATION, OR AS RETROFIT TO CORRECT EXISTING STRUCTURE THAT DOES NOT ALLOW PONDING TO OCCUR.

2. PROVIDE COLLAR OVERFLOW ELEVATION (COE) ON PLANS.

3. PCC PIPE RISER EXTENSIONS MAY BE UTILIZED IN LIEU OF OVER FLOW STRUCTURE COLLAR.

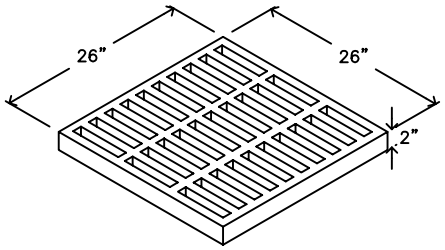
CONSTRUCTION NOTES

1. CENTER COLLAR ON OVERFLOW GRATE.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

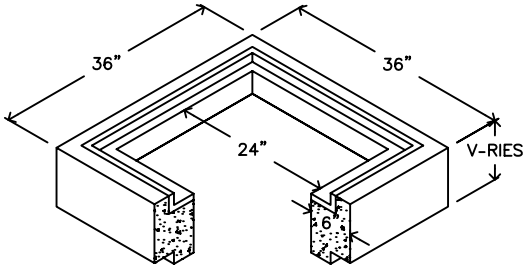
CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY: VERSION: 08/31/2017	OVERFLOW STRUCTURE COLLAR USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-22A SHEET 1 OF 1

C.I. GRATE

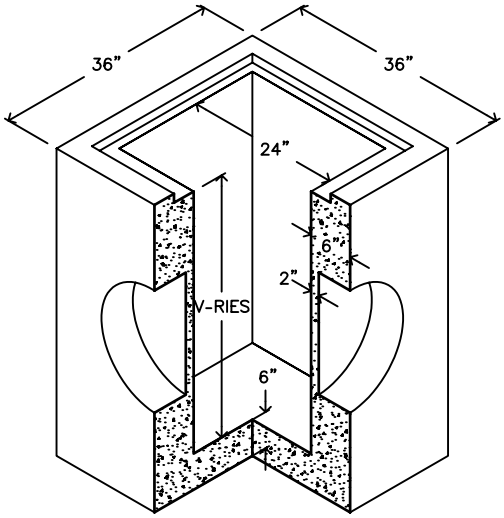


C.I. FRAME

EXTENSION



BOTTOM



DESIGN NOTES

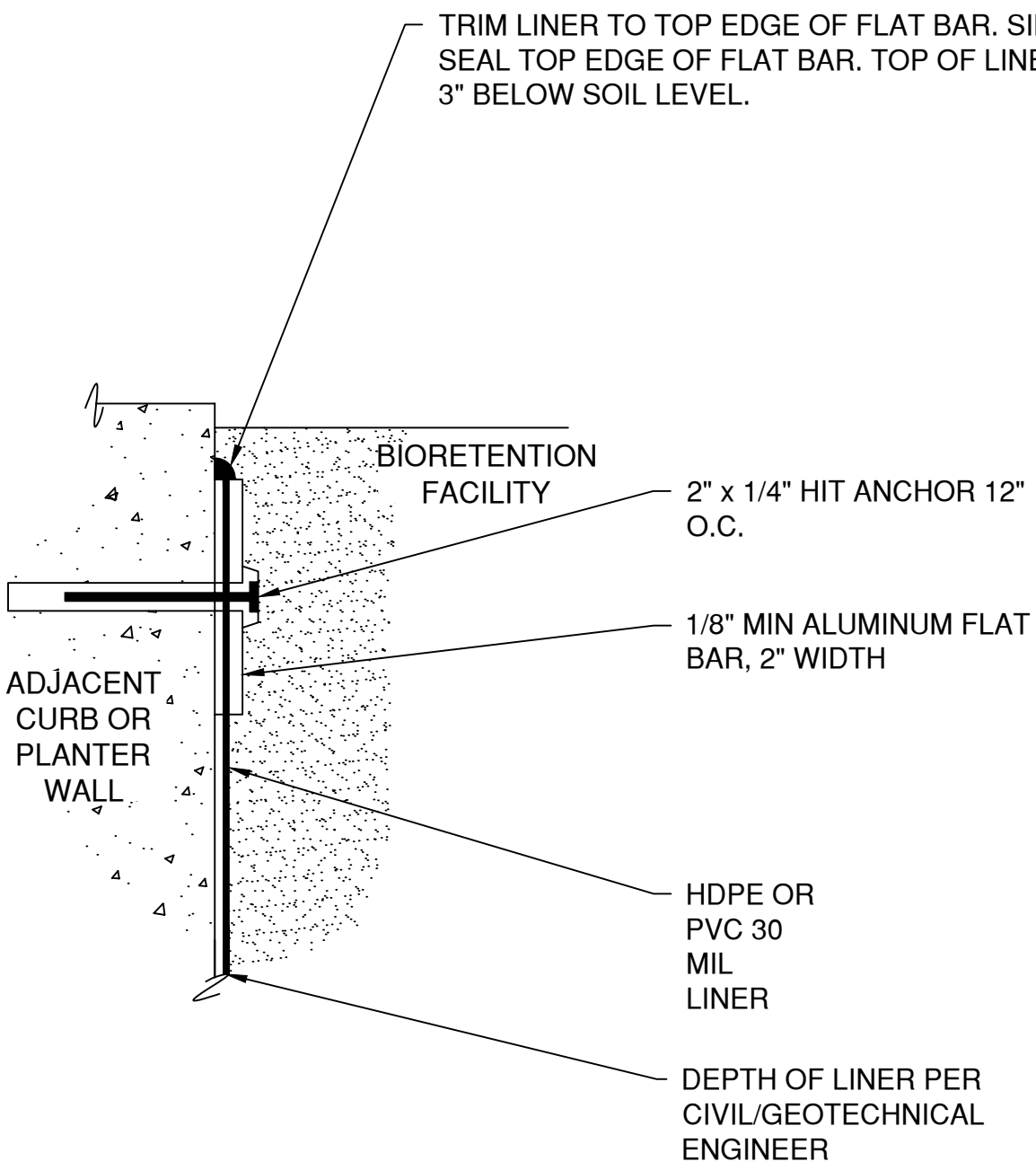
1. PROVIDE GRATE OVERFLOW ELEVATION ON PLANS.
2. PROVIDE EXTENSION OVERFLOW ELEVATION (COE) ON PLANS.
3. ON PRIVATE SITES NOT IN CITY RIGHT-OF-WAY THE PROJECT CIVIL ENGINEER MAY PROPOSE ALTERNATIVES FOR GRATE INSTALLATIONS USING ALTERNATIVE MANUFACTURER'S PRODUCTION/CONFIGURATION.

CONSTRUCTION NOTES

1. DO NOT ADJUST OVERFLOW GRATE ELEVATION, CONSTRUCT AS SHOWN ON PLANS.

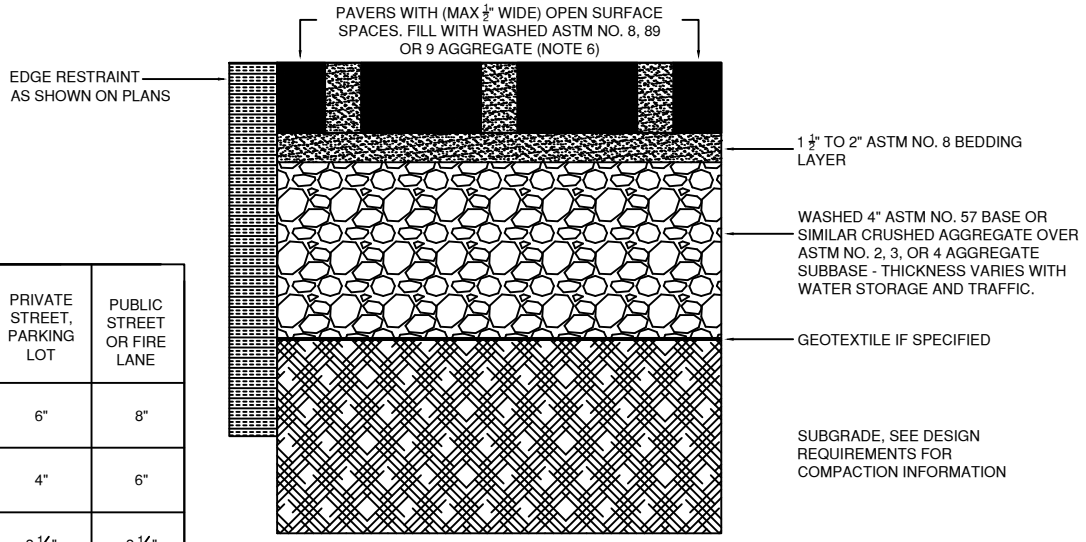
LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

CASQA central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY: VERSION: 08/31/2017	OVERFLOW STRUCTURE WITH SQUARE GRATE USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-23 SHEET 1 OF 1

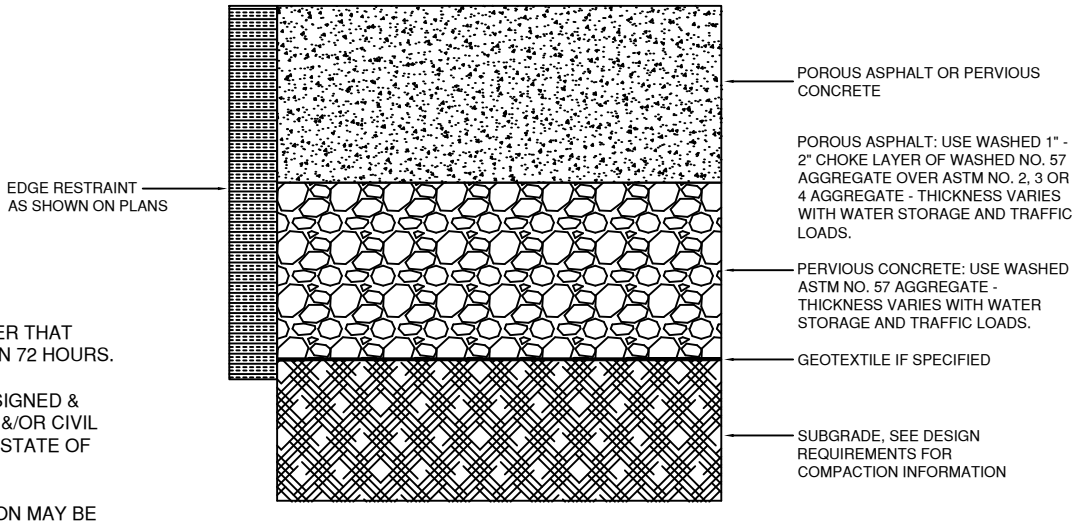


LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY:	IMPERMEABLE LINER CONNECTION	STANDARD PLAN NO. SW-24
	VERSION: 08/31/2017	USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	SHEET 1 OF 1



	RESIDENTIAL DRIVEWAY OR PEDESTRIAN ONLY	PRIVATE STREET, PARKING LOT	PUBLIC STREET OR FIRE LANE
PERVIOUS CONCRETE	4"	6"	8"
POROUS ASPHALT	3"	4"	6"
PERMEABLE INTERLOCKING PAVERS	2 ⅜"	3 ⅛"	3 ⅛"
ENGINEERING REQ'D	NO	YES	YES
COMPACTION REQ'D	NO	YES	95%



NOTES:

1. UNDERDRAIN TO REMOVE WATER THAT CANNOT BE INFILTRATED WITHIN 72 HOURS.
2. DESIGNS PROVIDED SHALL BE SIGNED & STAMPED BY A GEOTECHNICAL &/OR CIVIL ENGINEER REGISTERED IN THE STATE OF CALIFORNIA.
3. GEOTEXTILE USE AND SELECTION MAY BE DETERMINED BY A GEOTECHNICAL ENGINEER PER AASHTO M-288.
4. UNDERDRAIN AND ORIFICE CONFIGURATION SHALL BE BASED ON ENGINEERED DESIGN.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

CASQA central coast LIDI

DEVELOPED UNDER PROP. 84 GRANT

APPROVED BY:

VERSION: 08/31/2017

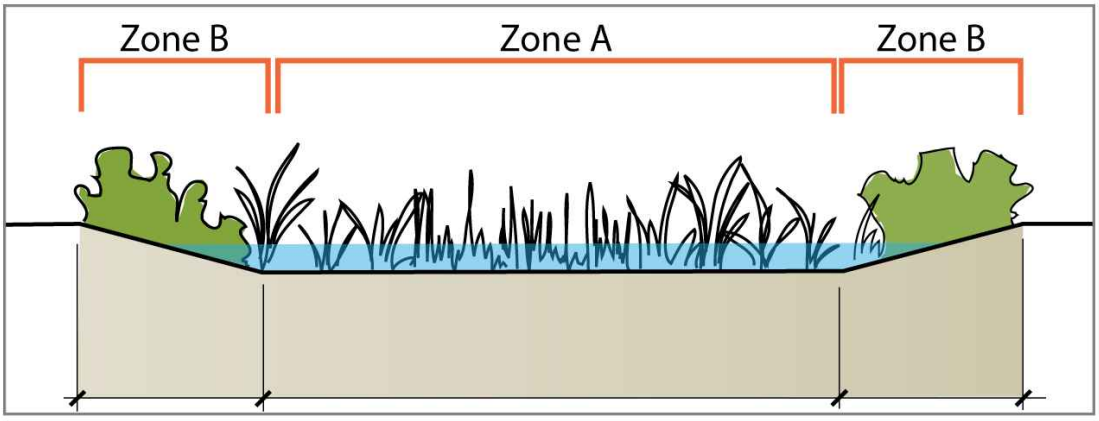
PERVIOUS PAVEMENT

STANDARD PLAN NO. SW-25

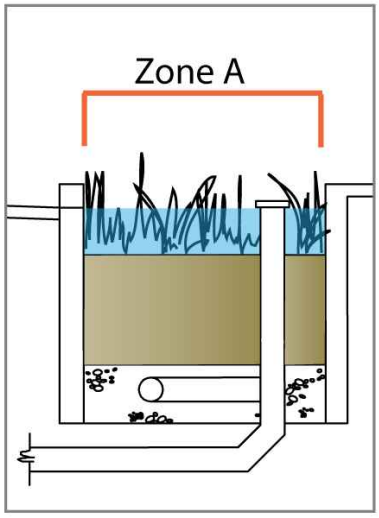
USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION

SHEET 1 OF 1

Varying slope and ponding levels: Varying slope and ponding levels: This bioretention planting area has sloped edges. Plants in the bottom area will be inundated during storms (**Zone A**). Those planted on the sideslopes are above the level of ponding, but will experience seasonally wet conditions (**Zone B**).



Uniform surface grade: This stormwater planter has a flat bottom with consistent depth of ponding across the structure. All of the plants selected for this design must be tolerant of periodic inundation (**Zone A**).



Trees		San Diego Co. Native - SD California Native - CA Non-Native - X	Landscape Position: 1 - Low1, 2 - Mid2, 3 - High3	Mature Size (height x width)	Irrigation Demands: High - H ▪ Moderate - M Low - L ▪ Rainfall Only - N	Light Requirements Sun - SU ▪ Shade - SH Part Shade - PS	Season Evergreen - E, Deciduous – D Semi-Evergreen - SE	Coastal Exposure? Yes - Y	City of Imperial Beach Sunset Zone: 24
Acer negundo californicum 4,5	**California Box Elder**5	**SD**	**1**	**60'x60'**	**M-H**	**SU, PS**	**D**		**A2-3; 1-10, 12-24**
Cercis occidentalis 4	**Western Redbud**	**SD**	**1**	**10-18' x 10-18'**	**M**	**SU, PS**	**D**		**2-24**
Ilex vomitoria	Yaupon Holly	X	**1**	15-20' x 10-15'	H	SU, PS	E		4-9, 11-24
Juglans californica	Southern California Black Walnut	SD	1	15-30' x 15-30'	N-L	SU	D		18-24
Liquidambar styraciflua 5	Sweet Gums5	X	**1**	60' x 20-25'	M-H	SU	D		3-9, 14-24
Magnolia grandiflora 5	Southern Magnolia5	X	**1**	80' x 60'	H	SU, PS	E	Y	4-12, 14-24, H1-2
Metasequoia glyptostroboides 5	**Dawn Redwood**5	**X**	**1**	**90' x 20'**	**H**	**SU**	**D**		**A3, 3-10, 14-24**
Myrica californica	Pacific Wax Myrtle	CA	**1**	10-30 x 10-30'	M	SU	E	Y	4-9, 14-24
Platanus acerifolia	London Plane Tree	X	1	**40-80' x 30-40'**	M-H	SU	D		2-24
Platanus racemosa 4,5	**California Sycamore**5	**SD**	**1**	**30-80' x 20-50'**	**M-H**	**SU**	**D**	**Y**	**4-24**
Quercus agrifolia 4,5	**Coast Live Oak**5	**SD**	**1**	**20-70' x 20-70'**	**N-L**	**SU**	**E**	**Y**	**7-9, 14-24**
Salix gooddingii 4,5	**Western Black Willow**5	**SD**	**1**	**20-40'x20-30'**	**H**	**SU**	**D**		**-**
Sambucus mexicana 4,5	**Mexican Elderberry**5	**SD**	**1**	**10-30' x 8-20'**	**M-H**	**SU, PS**	**SE**		**2-24, H1**
Taxodium spp. 5	Cypress5	X	**1**	50-70' x 15-30'	L-H	SU	D		2-10, 12-24
Umbellularia californica 5	California Bay5	CA	**1**	20-25' x 20-25'	L-H	SU, PS, SH	E	Y	4-9, 14-24
Washingtonia filifera 4,5	**California Fan Palm**5	**SD**	**1**	**60' x 20'**	**L-M**	**SU**	**E**		**8,9,10,11-24,H1-2**

DEPARTMENT OF PUBLIC WORKS
IMPE`RIAL BEACH

TITLE: ZONE A LID RECOMMENDED PLANT LIST

STANDARD PLAN

SW-26

SHEET 2 OF 6

DESIGNED BY:

DRAWN BY:

CHECKED BY:

APPROVED:

DATE:

CITY ENGINEER: ____________________

Perennials		San Diego Co. Native - SD California Native - CA Non-Native - X	Landscape Position: 1 - Low1, 2 - Mid2, 3 - High3	Mature Size (height x width)	Irrigation Demands: High - H ▪ Moderate - M Low - L ▪ Rainfall Only - N	Light Requirements Sun - SU ▪ Shade - SH Part Shade - PS	Season Evergreen - E, Deciduous – D Semi-Evergreen - SE	Coastal Exposure? Yes - Y	City of Imperial Beach Sunset Zone: 24
Achillea millefolium [4]	**Common Yarrow**	**SD**	**1**	**3' x 2'**	**L-M**	**SU**	**SE**	**Y**	**A1-A3, 1-24**
Anemopsis californica [4]	**Yerba Mansa**	**SD**	**1**	**1'x2-4'**	**H**	**SU, PS, SH**	**D**		**-**
Aquilegia formosa	Western Columbine	SD	2	1-3' x 1.5'	H	SU, PS	SE		A1-3, 1-11, 14-24
Artemisia palmeri [4]	**San Diego Sagewort**	**SD**	**2**	**2-3'x3'**	**H**	**SU, PS**	**SE**	**Y**	**-**
Asarum caudatum	Wild Ginger	CA	2	1' x 3'	H	SH	E		4-6, 14-24
Epilobium californica [4]	**California Fuscia**	**CA**	**1**	**1-2'x3-5'**	**L-M**	**SU**	**SE**		**2-11, 14-24**
Fragaria chiloensis [4]	**Beach Strawberry**	**CA**	**1**	**4-8" x spreading**	**H**	**SU, PS**	**E**	**Y**	**4-24**
Iris douglasiana	Pacific Coast Iris	CA	1	2' x 2'	M	SU, PS	E	Y	4-9, 14-24
Iris missouriensis	Western Blue Flag Iris	SD	1	2' x 2'	M-H	SU, PS	D		1-10, 14-24
Iva hayesiana [4]	**San Diego Marsh Elder**	**SD**	2	**1' x 5'**	**N**	**SU, PS**	**SE**	**Y**	**17, 23-24**
Jaumea carnosa	Jaumea	SD	1	<1' x spreading	H	SU	E		-
Limonium californicum	California Sea Lavender	SD	1	1-1.5' x < 3' spreading	M-H	SU, PS	SE	Y	-
Lobelia dunnii	Dunn's Lobelia	SD	2	1-1.5' x 1.5-3'	M-H	SU, PS	E	Y	-
Mimulus cardinalis	Scarlet Monkey Flower	SD	1	2.5' x 2.5'	M-H	SU, PS, SH	D		2-24
Polystichum munitum	Western Sword Fern	CA	2	2-4' x 2-4'	H	SH	E	Y	A3, 2-9, 14-24
Potentilla glandulosa	Sticky Cinquefoil	SD	1	2' x 3'	M-H	SU, PS, SH	E	Y	-
Ribes viburnifolium	Evergreen Currant	SD	3	3-6' x 12'	N-M	SU, PS	E	Y	5,7-9,14-17, 19-24
Salicornia pacifica (or virginica) [4]	Pickleweed	SD	1	1-2' x spreading	H	SU	SE	Y	-
Salvia uliginosa	Bog Sage	X	2	4-6' x 3-4'	M-H	SU	E		6-9, 14-24
Satureja douglasii	Yerba Buena	CA	2	<1' x 3'	H	PS	E		4-9, 14-24
Satureja mimuloides	Monkeyflower Savory	CA	1	1-3' x 1-3'	M-H	SU, PS	D		-

DEPARTMENT OF PUBLIC WORKS
IMPE`RIAL BEACH

TITLE: ZONE A LID RECOMMENDED PLANT LIST

STANDARD PLAN

SW-26

SHEET 3 OF 6

DESIGNED BY:

DRAWN BY:

CHECKED BY:

APPROVED: DATE:

CITY ENGINEER: ____________

Perennials		San Diego Co. Native - SD California Native - CA Non-Native - X	Landscape Position: 1 - Low1, 2 - Mid2, 3 - High3	Mature Size (height x width)	Irrigation Demands: High - H ▪ Moderate - M Low - L ▪ Rainfall Only - N	Light Requirements Sun - SU ▪ Shade - SH Part Shade - PS	Season Evergreen - E, Deciduous – D Semi-Evergreen - SE	Coastal Exposure? Yes - Y	City of Imperial Beach Sunset Zone: 24
Sisyrinchium bellum 4	Blue-eyed Grass	SD	2	6-18” x 6-18”	M-H	SU, PS	E	Y	2-9, 14-24
Trifolium wormskioldii	Coast Clover	SD	1	2' x spreading	H	SU	D		-
Salicornia pacifica (or virginica) **4**	**Pickleweed**	**SD**	**1**	**1-2' x spreading**	**H**	**SU**	**SE**	**Y**	**-**
Salvia uliginosa	Bog Sage	X	2	4-6' x 3-4'	M-H	SU	E		6-9, 14-24
Satureja douglasii	Yerba Buena	CA	2	<1' x 3'	H	PS	E		4-9, 14-24
Satureja mimuloides	Monkeyflower Savory	CA	1	1-3' x 1-3'	M-H	SU, PS	D		-
Sisyrinchium bellum **4**	**Blue-eyed Grass**	**SD**	**2**	**6-18” x 6-18”**	**M-H**	**SU, PS**	**E**	**Y**	**2-9, 14-24**
Trifolium wormskioldii	Coast Clover	SD	1	2' x spreading	H	SU	D		-

DEPARTMENT OF PUBLIC WORKS
IMPE`RIAL BEACH

TITLE: ZONE A LID RECOMMENDED PLANT LIST

STANDARD PLAN

SW-26

SHEET 4 OF 6

DESIGNED BY:

DRAWN BY:

CHECKED BY:

APPROVED: DATE:

CITY ENGINEER: ______

Grasses & Grass-Like Plants		San Diego Co. Native - SD California Native - CA Non-Native - X	Landscape Position: 1 - Low1, 2 - Mid2, 3 - High3	Mature Size (height x width)	Irrigation Demands: High - H ▪ Moderate - M Low - L ▪ Rainfall Only - N	Light Requirements Sun - SU ▪ Shade - SH Part Shade - PS	Season Evergreen - E, Deciduous – D Semi-Evergreen - SE	Coastal Exposure? Yes - Y	City of Imperial Beach Sunset Zone: 24
Buchloe dactyloides 'UC Verde'	'UC Verde' Buffalograss	X	1	6-8" x spreading	L-H	SU	D		-
Carex praegracilis	California Field Sedge	SD	1	1'-2' x spreading	M-H	SU, PS	E	Y	-
Carex pansa	California Meadow Sedge	CA	1	6-8" x spreading	M-H	SU, PS	SE	Y	7-9, 11-24
Carex spissa [4]	**San Diego Sedge**	**SD**	**1**	**5' x 5'**	**H**	**SU, PS**	**SE**	**Y**	**7-9, 14-17, 19-24**
Carex subfusca	Rusty Sedge	SD	1	6-8" x spreading	M	SU, PS, SH	SE		**7-9, 11-24**
Chondropetalum tectorum	Small Cape Rush	X	1	3-4' x 3-4'	M-H	SU, PS	E	Y	8-9, 14-24
Distichlis spicata [4]	**Salt Grass**	**SD**	**1**	**1' x 3'**	**M-H**	**SU, PS**	**D**	**Y**	**-**
Eleocharis macrostachya [4]	**Common Spike Rush**	**SD**	**1**	**1-3' x 2'**	**H**	**SU, PS**	**E**	**Y**	**-**
Equisetum hyemale ssp. affine	Horsetail Reed	SD	1	4' x spreading	H	SU, PS	E		1-24
Festuca californica	California Fescue	CA	1	2-3' x 1-2'	M-H	SU, PS	E	Y	4-9, 14-24
Festuca rubra 'Molate'	Molate Red Fescue	CA	1	1-2' x spreading	H	SU, PS	E		A2-3, 1-10, 14-24
Juncus effusus	Soft Rush	SD	1	2.5' x 2.5	M-H	SU, PS	E		1-24, H1
Juncus mexicanus [4]	**Mexican Rush**	**SD**	**1**	**2' x 2'**	**M-H**	**SU, PS**	**E**		**-**
Juncus patens [4]	**California Gray Rush**	**CA**	**1**	**2' x 2'**	**L-H**	**SU, PS**	**E**		**4-9, 14-24**
Leymus triticoides	Creeping Wildrye	CA	1	1.5'-4.5'	L-M	SU, PS	E	Y	-
Muhlenbergia rigens [4]	**Deer Grass**	**SD**	**1**	**2-4' x 3-4'**	**L**	**SU**	**E**		**4-24**
Nassella pulchra	Purple Needlegrass	CA	2	3' x 2'	N-L	SU	D		5-9, 11, 14-24
Schoenoplectus californicus [4]	**California Bulrush**	**SD**	**1**	**10' x spreading**	**H**	**SU, PS, SH**	**E**		**-**
Sporobolus airoides	Alkali Dropseed	CA	1	3' x 3'	L-M	SU	D		1-24
Zephyranthes candida	Rain Lily	X	1	12"x12"	H	SU, PS	E		4-9, 12-24, H1, H2

DEPARTMENT OF PUBLIC WORKS
IMPE`RIAL BEACH

TITLE: ZONE A LID RECOMMENDED PLANT LIST

DESIGNED BY:
DRAWN BY:
CHECKED BY:

APPROVED: DATE:

CITY ENGINEER: ______________________

STANDARD PLAN

SW-26

SHEET 5 OF 6

Annuals and Short-Lived Perennials		San Diego Co. Native - SD California Native - CA Non-Native - X	Landscape Position: 1 - Low1, 2 - Mid2, 3 - High3	Mature Size (height x width)	Irrigation Demands: High - H ▪ Moderate - M Low - L ▪ Rainfall Only - N	Light Requirements Sun - SU ▪ Shade - SH Part Shade - PS	Season Evergreen - E, Deciduous – D Semi-Evergreen - SE	Coastal Exposure? Yes - Y	City of Imperial Beach Sunset Zone: 24
Limnanthes douglasii	Meadowfoam	CA	1	6-12" x 6-12"	H	SU	-		1-9, 14-24
Limnanthes gracilis ssp. Parishii	Parish Meadowfoam	SD	2	6-12" x 6-12"	H	SU	-		-
Lupinus succulentus [4]	**Arroyo Lupine**	**SD**	**2**	**3'x3'**	**M-H**	**SU**	**-**		**7-24**
Oenothera elata [4]	**Yellow Evening Primrose**	**SD**	**1**	**2-3' x 2-3'**	**L-H**	**SU, PS**	**E**		**5-7, 14-24**
Pluchea odorata [4]	**Salt Marsh Fleabane**	**SD**	**1**	**2-3' x 1-2'**	**H**	**SU, PS**	**SE**		**-**

Vines		San Diego Co. Native - SD California Native - CA Non-Native - X	Landscape Position: 1 - Low1, 2 - Mid2, 3 - High3	Mature Size (height x width)	Irrigation Demands: High - H ▪ Moderate - M Low - L ▪ Rainfall Only - N	Light Requirements Sun - SU ▪ Shade - SH Part Shade - PS	Season Evergreen - E, Deciduous – D Semi-Evergreen - SE	Coastal Exposure? Yes - Y	City of Imperial Beach Sunset Zone: 24
Vitis californica	**California Grape**	**SD**	**1**	**30'**	**N-L**	**SU, PS**	**D**		**4-24**

DEPARTMENT OF PUBLIC WORKS
IMPE`RIAL BEACH

TITLE: ZONE A LID RECOMMENDED PLANT LIST

STANDARD PLAN

SW-26

SHEET 6 OF 6

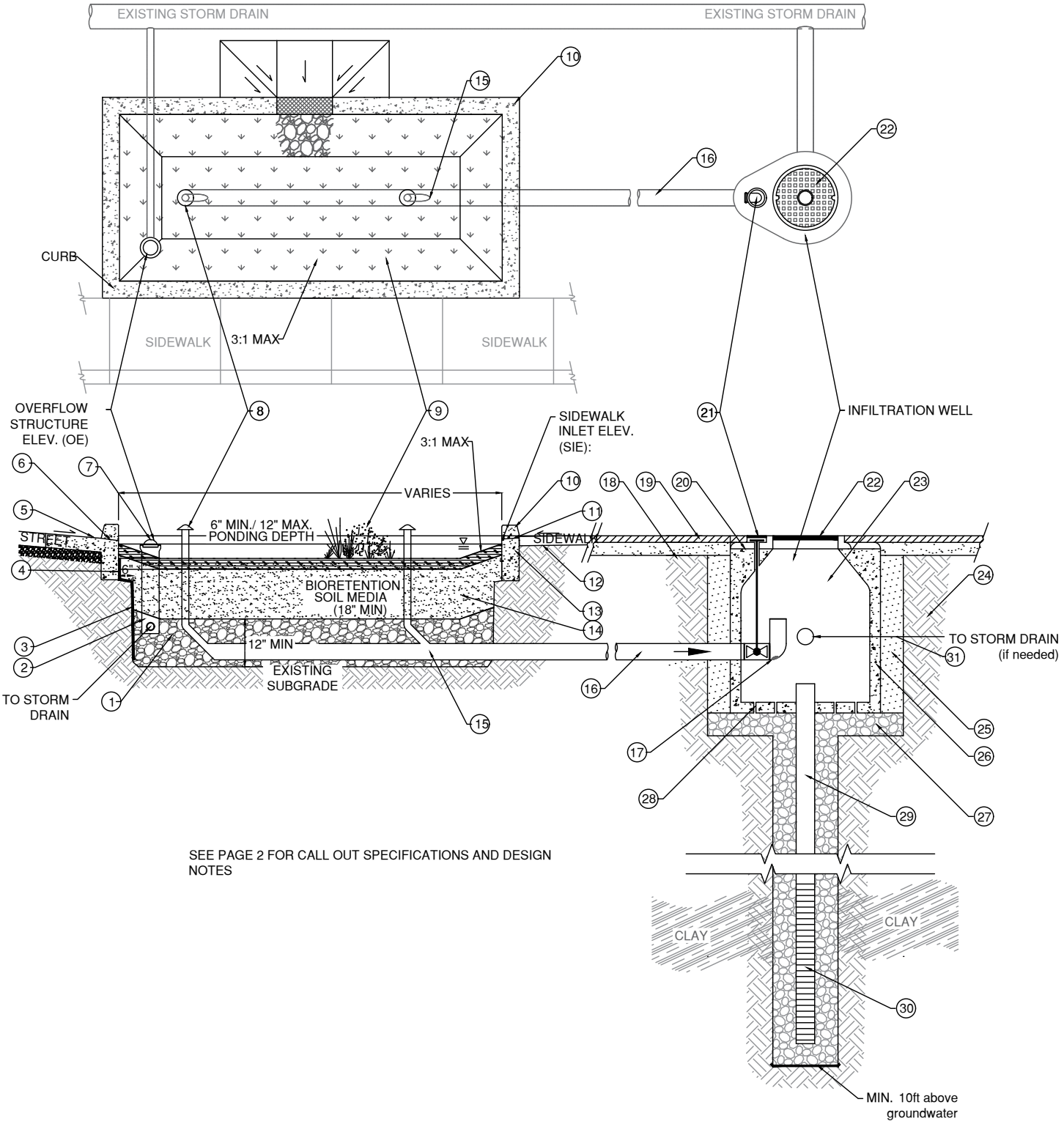
DESIGNED BY:

DRAWN BY:

CHECKED BY:

APPROVED: DATE:

CITY ENGINEER: ______________________



SEE PAGE 2 FOR CALL OUT SPECIFICATIONS AND DESIGN NOTES

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

DEVELOPED UNDER PROP. 84 GRANT

APPROVED BY:

VERSION: 08/31/2017

DRYWELL STORMWATER BMP

STANDARD PLAN NO. SW-27

USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION

SPECIFICATIONS

1. 12” DEEP OPEN GRADED WASHED STONE (TYPICALLY 3/4” TO 1-1/2” (ASTM #4 STONE) OR 1” TO 2” (ASTM #3 STONE).
2. BRIDGING LAYER(S) PER LIDI BIORETENTION TECHNICAL SPECIFICATIONS (BTS). DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE. DO NOT USE FILTER FABRIC BETWEEN BIOFILTER SOIL MATERIAL (BSM) AND AGGREGATE.
3. 30 ML LINER MAY BE REQUIRED TO AVOID LATERAL INFILTRATION BELOW STREET; SUBJECT TO GEOTECHNICAL RECOMMENDATIONS.
4. MAINTAIN 6” MINIMUM BENCH OF NATIVE SOIL FOR SUPPORT OF ADJACENT SIDEWALK/ROAD (TYPICAL).
5. CURB AND GUTTER DETAIL SW-12.
6. CURB INLET DETAIL SW-17, GUTTER INLET ELEV (GIE). LOCATE ENERGY DISSIPATION COBBLE PADS AS SPECIFIED IN INLET DETAILS.
7. OVERFLOW STRUCTURE REQUIRED FOR IN-LINE SYSTEMS WITHOUT OVERFLOW BYPASS, DETAIL SW-22, SW-22A, and SW-23.
8. MAINTENANCE PIPES - 4” MIN. DIA. VERTICAL PVC PIPES CONNECTED TO UNDERDRAIN. PLACED AT START AND 3 FEET BEFORE END OF UNDERDRAIN. REQUIRES DIRECTIONAL SWEEP BEND. THREADED AND CAPPED
9. VEGETATION - PLANT SELECTION AND MULCH (OPTIONAL) PER BIORETENTION TECHNICAL SPECIFICATIONS.
10. 4” MIN. EXPOSED WALL HEIGHT
11. SIDEWALK DRAINAGE NOTCH 1” LOWER THAN SIDEWALK, SLOPED TO FACILITY
12. SEE PLANS FOR SIDEWALK RESTORATION
13. DEEP CURB DETAIL SW-13
14. BIORETENTION SOIL MEDIA (BSM). SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS (BTS). SPECIFICATION SHOULD AVOID COMPOST OR OTHER MATERIAL KNOWN TO LEACH NUTRIENTS.
15. UNDERDRAIN, MIN. 4” DIA. PVC SDR 35 PERFORATED PIPE OR LARGER AS NEEDED TO CONVEY PEAK TREATED FLOWRATE WITH MINIMAL HEAD LOSS, SEE CONSTRUCTION NOTES.
16. 8” INLET PIPE OR OTHER.
17. LOW FLOW ORIFICE. (SEE DESIGN NOTE 11).
18. STABILIZED BACKFILL - TWO-SACK SLURRY MIX.
19. SIDEWALK PER MUNICIPAL STANDARDS.
20. COMPACTED BASE MATERIAL.
21. ACCESS HATCH WITH SHUT OF VALVE SWITCH. CONNECTED TO SHUT OF VALVE IN INLET PIPE.
22. MAINTENANCE HOLE COS TYPE 204-204 MH A OR B. ¾” I.D. MIN OBSERVATION PORT.
23. MANHOLE CONE - MODIFIED FLAT BOTTOM.
24. EXISTING SOILS. (SEE CONSTRUCTION NOTE 4, 8).
25. COMPACTED BACKFILL
26. PRE-CAST OR INSITU CAST CONTROL VAULT (SEE DESIGN NOTE 8)
27. ROCK - WASHED, SIZED BETWEEN 3/8” AND 1-1/2"
28. PERFORATED BASE OF CONTROL VAULT
29. DRILLED SHAFT WITH 6” WELDED STEEL OR THREADED PVC CASING (SEE DESIGN NOTE 13 & CONSTRUCTION NOTE 7,8)
30. 6 - 8” O.D. WELDED WIRE STAINLESS STEEL WELL SCREEN OR THREADED PVC SLOTTED SCREEN. SCREEN LENGTH + LENGTH + SLOT WIDTH TO BE DETERMINED IN ACCORDANCE WITH LOCAL CONSTRAINTS .I.E. DISTANCE BETWEEN CLAY LAYER AND MIN. 10FT ABOVE SEASONAL HIGH GROUNDWATER LEVEL
31. PVC STORMDRAIN CONNECTOR PIPE. SAME DIAMETER AS INFLOW PIPE TO CONTROL VAULT.

DESIGN NOTES

1. ADDITIONAL DESIGN GUIDANCE FOR BIOFILTRATION SYSTEM PROVIDED IN LIDI BIORETENTION TECHNICAL SPECIFICATIONS (BTS) DOCUMENT.
2. BOTTOM WIDTH - PROVIDE 2 FT MINIMUM FLAT BREGENALL
3. BOTTOM WITH A MAX 3:1 SLOPE FOR SURFACE FINISHING WITHIN BIOFILTRATION SYSTEM
4. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3” DEEP LAYER OF ¾” (NO. 4) OPEN-GRADED AGGREGATE.
5. PROVIDE SPOT ELEVATIONS AT INLETS ON CIVIL PLANS (FE, OE, GIE, SIE). SEE DETAIL SW-17.
6. EDGE CONDITION WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, WALL, AND SIDEWALK DETAILS MAY BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.
7. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
8. LONGITUDINAL SLOPE 6% WITH CHECK DAMS.
9. IF CHECK DAMS ARE NEEDED, SEE CONCRETE CHECK DAM DETAIL SW-18.
10. VARIATIONS IN DRY WELL DESIGN SHOULD BE MADE TO ACCOMMODATE STORAGE VOLUME DESIGN AND TO SUIT LOCAL CONDITIONS AND CONSTRAINTS.
11. IN AREAS WITHOUT A STORMDRAIN, THE SYSTEM SHOULD ONLY BE CONSTRUCTED WHERE THE MAINTENANCE HOLE SURFACE INVERT IS ABOVE THE BIOFILTER OVERFLOW ELEVATION.
12. ALTERNATIVE VAULT LOCATIONS POSSIBLE INCLUDING WITHIN THE BIOFILTER FOOTPRINT.
13. VALVE CAN BE MOVED TO THE BIOFILTER IF DESIRED. REQUIRES STRUCTURAL SUPPORT.
14. ALTERNATIVE PRODUCTS SUCH AS VENDOR-SUPPLIED DRY WELL PRODUCTS MAY BE USED AS A SUBSTITUTE PROVIDED THAT THE ALTERNATIVE PRODUCT IS EQUAL.
15. THIS DESIGN IS LIKELY TO QUALIFY AS A CLASS V WELL SUBJECT TO REGISTRATION WITH THE USEPA.

Low Impact Development Initiative (LIDI)
Bioretention Technical Specifications

The following technical information is for use in conjunction with the complete set of bioretention area standard details developed by the LIDI for use in the Central Coast region and throughout California. Central Coast region-specific requirements are noted where applicable.

Facility Design/Dimensions

- Bioretention facilities should be sized to retain and/or treat the water quality design flow and/or volume in accordance with the stormwater permit requirements that apply to the local jurisdiction and appropriate local, countywide, and/or statewide (CASQA) guidance documents. Design parameters specified in stormwater permits will determine the surface area and storage volume required within the facility.
- Bottom width – facilities should have flat bottoms and sufficient width for ease of constructability and maintenance.
  - Provide 2' wide minimum for facilities with side slopes and planters (facilities with vertical side walls).
- Allowable standing water duration – generally 48 to 72 hours

  Allowable ponding time is typically associated with mosquito vector control or perceived nuisance flooding and varies by location.
- Ponding depth - Min. 6", max. 12". The depth is measured from the surface of the bioretention soil media and not adjusted for application of mulch.
- Planter depth – (from adjacent pedestrian walking surface to facility finished elevation/planting surface) is based on desired ponding plus freeboard, but also relates to planter width. Planters can be deeper if they are wider, and need to be shallower as they narrow. This is a pedestrian perception and safety issue. Some recommended width to depth guidelines are as follows (allowable depths and appropriate edge treatments may be specified by the local jurisdiction and may be determined by ADA requirements):

PLANTER WIDTH	MAX. PLANTER DEPTH
> 5'	16"
4' – 5'	12"
3' – 4'	10"
2' – 3'	8"

- Slope/grades
  - Side slope - 4:1 preferred
    - Max. 3:1 allowed with min. 12" wide shoulder (2% slope toward facility) adjacent to pedestrian use or curb.
  - Longitudinal slope – Facility should be relatively flat (i.e., maximum of 2% longitudinal slope of bottom) so that water ponds and infiltrates evenly across the facility surface.
    - If installed on a slope, facilities should be terraced and separated by check dams and weir overflows to provide flat-bottomed cells with proper storage and infiltration.
    - Installation not recommended on slopes > 8%.
  - Grades on opposite sides within a facility should be similar to optimize ponding across the entire basin/cell.

Hard Infrastructure

- Inlet curb cut design selection should be based on application considerations:
  - Sloped sided or planter facility
  - Curb and gutter adjacent to facility or separated by pedestrian sidewalk
- Curb cut width – 12”-18” minimum, with rounded edges, depress gutter 2” at opening (see SW-14, SW-15, SW-16)
- Sidewalk edge type selection should be based on application considerations:
  - New or retrofit
  - Sloped sided or planter box
- Sidewalk wall - planter box requires 4” min. height wall adjacent to sidewalk for pedestrian safety.
- Sidewalk wall drainage notch – when sidewalk drains to planter, provide 4”-6” wide notch openings in wall, opening 1” below sidewalk, slope to facility. Space openings to convey flows.
  - Provide minimum 2” cover between notch and structural dowels in curbs/walls.
- Energy dissipation – provide aggregate or concrete splash pads at inlets per inlet details.
  - For aggregate: 6” depth, 3" – 6" rounded, washed cobble
  - For sloped sided facilities where inlet flow velocity is high, extend cobble into facility, but avoid excessive or decorative use.
- Where impermeable liner is included between facility and adjacent

infrastructure (street, parking lot), use 30 ML HDPE or PVC material, see Impermeable Liner detail.

- Check dams – provide for facilities installed on slope
  - Per check dam details SW-17 and SW-18
  - Check dams should be placed for every 4-6" of elevation change and so that the top of each dam is at least as high as the toe of the next upstream dam.
- Overflow structure – required for on-line systems without an overflow bypass
  - Per overflow structure details SW-19, SW-20
  - Connect to approved discharge point or another downstream bioretention area.
- Provide observation well in facility if required
  - Upright 6 inch rigid PVC (SDR 40 or equivalent) pipe, perforated for the section extending through the depth of the bioretention soil media (and aggregate layer if included), extending 6 inches above the top of soil elevation, with a threaded cap.
  - Locate to avoid damage from maintenance activities.

Facility Media (soil, aggregate, mulch)

- Aggregate layer – where an aggregate layer is included in the design (underdrain design or optional use based on project requirements, depth based on sizing calculations), specify "CalTrans Class 2 Permeable."
  - CalTrans Class 2 Permeable does not require an aggregate filter course between the aggregate storage layer and the bioretention soil media above.
  - When CalTrans Class 2 Permeable is not available, substitute CalTrans Class 3 Permeable.
    - Class 3 Permeable requires an overlying 3" deep layer of ¾" (No. 4) open graded aggregate (between Class 3 and bioretention soil media above).
  - Filter fabric - do NOT use fabric between bioretention soil media and aggregate layer
- Bioretention soil media (BSM) - use local jurisdiction approved/recommended BSM (e.g. Bay Area Stormwater Management Agencies Association (BASMAA) Regional Biotreatment Soil Specification (revised January 29, 2016)[1].

[1] http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/MRP/provisionC.3/Revised_%20Biotreatment%

  - Using a performance specification for alternative bioretention soil mix is not recommended (but may be allowed by the local jurisdiction).
  - A pre-mixed bioretention soil media is preferable to mixing soil on-site.
- BSM depth – 18" minimum depth; 24" recommended, or as required by the local jurisdiction. 24" depth required in the Central Coast Region for facilities with underdrains.
  - Where trees are specified, increase BSM depth in tree planting locations, per arborist's or landscape architects direction, or allow trees access to sufficient volume of native soil.
    - Tree planting in bioretention - see BASMAA Literature Review - Bioretention Design for Tree Health (September 15, 2016)[2]
- Bioretention soil media placement and compaction – place BSM in 6" lifts. Compact each lift with a landscape roller or by lightly wetting. Allow BSM to dry overnight before planting.
- Mulch depth – 2" – 3" (3" recommended and required by State Model Water Efficiency Landscape Ordinance)
  - Do not apply mulch in ponding zone just prior to or during rainy season.
  - When mulch is used, excavation must allow for specified bioretention soil depth to achieve finished elevations as shown on civil plans
- Mulch type - when used in ponding zone, must be aged, stabilized, non-floating mulch, such as a specified composted wood mulch. Gravel mulch may also be used when high flow velocities through the system are expected.

<u>Landscape (planting and irrigation)</u>

- Irrigation - Provide irrigation for plant establishment (2-3 years), and supplemental irrigation during periods of prolonged drought.
  - Provide separate zone for connection to water supply
- Planting - see LIDI plant guidance for bioretention areas technical assistance memo (TAM) or use bioretention plant list in other local or countywide guidance document.
  - Landscape Architects who have not previously designed bioretention systems should use plants from the LIDI TAM or other approved plant list. Landscape Architects with experience designing for bioretention may use additional plant species consistent with the above lists and

20_Soil.pdf
[2] www.basmaa.org

appropriate for the facility design and local conditions.

- Do not locate plants at inlets. Consider mature growth to determine planting layout and avoid future blockage of inlets by plants.
- Trees located on slopes should be 5’ minimum from inlets to avoid erosion of soil at root ball.

Underdrain Design

- Aggregate layer depth – 12” minimum depth.
- Underdrain – use 4” diameter, PVC SDR 35 perforated pipe.
  - Install underdrain with holes facing down.
  - Underdrain discharge elevation should be near top of aggregate layer if facility is allowed to infiltrate into native soil.
  - Underdrain slope may be flat or have a slight slope.
  - Connect underdrain to approved discharge point.
  - Provide capped, threaded PVC cleanout for underdrain, 4" min. dia. with sweep bend.
  - Do NOT wrap underdrain with filter fabric.

SAN FRANCISCO
stormwatermanagementrequirements
and design guidelines

Access Appendix B via: https://www.sfwater.org/Modules/ShowDocument.aspx?documentID=9101

Appendix F. Sizing Requirements for Green Infrastructure Facilities

Appendix F. Sizing Requirements for Green Infrastructure Facilities

This appendix includes the following:

1. San Francisco Bay Regional Water Quality Control Board memorandum, "Conditional Acceptance of Guidelines for Sizing Green Infrastructure Facilities in Street Projects", dated June 21, 2019.
2. Bay Area Stormwater Management Agencies Association, *Guidance for Sizing Green Infrastructure Facilities in Street Projects with companion analysis: Green Infrastructure Facility Sizing for Non-Regulated Street Projects*, Prepared by Dan Cloak Environmental Consulting, EOA, Inc., and Dubin Environmental, 2019.

CALIFORNIA
Water Boards

GAVIN NEWSOM
GOVERNOR

JARED BLUMENFELD
SECRETARY FOR
ENVIRONMENTAL PROTECTION

San Francisco Bay Regional Water Quality Control Board

June 21, 2019
CIWQS Place ID 756972

Geoff Brosseau, BASMAA, geoff@brosseau.us
Jim Scanlin, ACCWP, jims@acpwa.org
Courtney Riddle, CCCWP, courtney.riddle@pw.cccounty.us
Adam Olivieri, SCVURPPP, awo@eoainc.com ; Jill Bicknell, SCVURPPP, jcbicknell@eoainc.com
Matt Fabry, SMCWPPP, mfabry@smcgov.org
Kevin Cullen, FSURMP, kcullen@fssd.com
Melissa Morton, VFWD MMorton@vallejowastewater.org ;
Jennifer Harrington, VFWD, jharrington@vallejowastewater.org

Subject: Conditional Acceptance of Guidance for Sizing Green Infrastructure Facilities in Street Projects

Dear MRP Stormwater Program Managers:

This letter provides the Water Board's conditional acceptance of BASMAA's "Guidance for Sizing Green Infrastructure Facilities in Street Projects" (Guidance) and the "Green Infrastructure Facility Sizing for Non-Regulated Street Projects Technical Report" (Report). The Water Board supports Permittee efforts to retrofit existing streets with low impact development/green stormwater infrastructure (LID) bioretention treatment controls and recognizes both the challenges inherent in retrofitting existing urban infrastructure and the substantial water quality and related benefits that can result from successful retrofits.

Municipal Regional Stormwater NPDES Permit (MRP) Permittee studies, including stormwater resource plans and work on reasonable assurance analyses for pollutants of concern, have identified the public right-of-way, and particularly streets, as a key location for retrofits to control urban runoff pollution from the Bay Area's already-built urban environment. The Water Board recognizes the importance of green street retrofits and supports Permittee efforts to implement them. At the same time, there is a potentially significant trade-off between reduced treatment control sizing relative to the tributary area and the likelihood a control will function effectively over its life. All else

being equal, controls that are relatively larger are more likely to provide water quality and related co-benefits with less attention over time.

MRP Provision C.3.j.i.(g) allows the Permittees to propose an approach for alternate sizing of LID treatment controls to achieve treatment control and hydromodification requirements in certain green streets projects where conventional design storm hydraulic sizing may be difficult:

> For street projects not subject to Provision C.3.b.ii (i.e., non-Regulated Projects), Permittees may collectively propose a single approach with their Green Infrastructure Plans for how to proceed should project constraints preclude fully meeting the C.3.d sizing requirements.

The Report, in support of the Guidance, sets forth a sizing approach for bioretention controls for treatment using the combined flow and volume modelling approach. The Report notes, appropriately, that Permittees will design treatment controls to be "as large as feasible." Where larger sizing is impracticable, this approach enables bioretention controls to be as small a percentage of the tributary area as possible, and as little as 1.5 – 3 percent, while treating at least 80 percent of the average annual runoff based on local precipitation gauge records. This conditional acceptance provides direction on how Permittees should design controls to be as large as practicable, within existing MRP requirements.

The Guidance includes general suggestions regarding an approach for treating less than 80 percent of the total runoff, which may be appropriate for voluntary green street retrofit projects, and could be considered for green infrastructure plan street retrofit projects, in combination with Permittee reasonable assurance analyses and a future, more-detailed proposal of how to implement such reduced sizing. We look forward to working with the Permittees on that.

One aspect of the approach is that it has minimized safety factors, which, as noted in the Guidance, is likely to result in the construction of controls that have a greater need for operation and maintenance work over their lifetime, a higher rate of failure, and may be more likely to have reduced effectiveness and a reduced effective life in the absence of that attention. This calls into question whether the approach meets the C.3.d sizing requirements for Regulated Projects, and whether it should be applied beyond non-Regulated Green Streets retrofit projects. In the absence of additional evaluation of this issue, the reduced sizing approach should not be applied to Regulated Projects.

In addition, BASMAA considered developing, but did not include in this effort, specific guidance regarding how Permittees could determine practicability for using the reduced sizing approach, and regional guidance for green street best management practice installation, such as recommended locations and designs based on typical tributary areas. Such work could be a useful future project. The Guidance does include examples of constraints that could lead to reduced sizing.

The Report and Guidance do not propose an alternative sizing approach for hydromodification. While noting the MRP's triggers for hydromodification controls, the Guidance states categorically that hydromodification controls "...do not apply to street projects that retrofit drainage systems that receive runoff from existing roofs and paving." It is likely that many projects would not trigger the MRP's hydromodification control requirements. However, where the retrofits are part of a project that meets or exceeds the triggers for the MRP's hydromodification requirements, then the requirements would apply. Permittees should continue to review that as part of project implementation.

To better address the question of practicability and to help develop information that can contribute to future guidance regarding green street retrofits, this conditional acceptance directs Permittees to use existing MRP Provision C.3.d regulated project sizing for green street bioretention treatment control initial sizing. The design approaches for that sizing are set forth in the Permittees' existing technical guidance documents. With cause (e.g., significantly constrained area for a BMP, substantially increased costs for that sizing relative to the C.3.j.i.(g) approach, significant amounts of run-on from adjacent areas, or other substantial constraints identified by Permittees), and with reporting in their Annual Reports, Permittees may use the proposed C.3.j.i.(g) sizing for "non-Regulated Project" green streets projects, including non-Regulated Project green streets projects in Permittees' Green Infrastructure Plans and purely voluntary green streets projects.

The intent of the reporting is for the Permittees and the Water Board to, over time, identify more categorically green street retrofit approaches and needs, allowing Permittees to more-easily implement an effective and robust green street retrofit program. We look forward to working with the Permittees to identify appropriate and useful sizing analysis practicability information that can be developed, reported, and/or retained by the Permittees, as appropriate.

This conditional approval categorizes green streets projects into three categories. Regulated Projects under MRP Provision C.3.b, including green street retrofit projects funded all or in part from alternate compliance; green street retrofit projects that are not otherwise Regulated Projects under C.3.b, which may include green street retrofit projects in Green Infrastructure Plans; and purely voluntary green street retrofit projects.

- **Regulated projects**: Should be designed to the sizing standard in C.3.d, using the approaches set forth in existing Permittee technical guidance manuals.[1]

- **Green street retrofit projects in Permittee green infrastructure plans, which are not Regulated Projects under C.3.b**: Should be designed to the sizing standard in C.3.d, using the approaches set forth in existing Permittee technical guidance manuals. If Permittee analysis determines there is substantial cause to

[1] The Water Board may consider changes to this approach for Regulated Projects in a future MRP reissuance, following additional discussion regarding safety factors, control performance, and more-specific guidance regarding implementation.

reduce the sizing to the proposed C.3.j.i.(g) approach, then reduce the sizing, with reporting in the Permittee's annual report as to why larger sizing was impracticable.

- **Voluntary green street retrofit projects outside of green infrastructure plans**: Permittees should determine whether controls can be designed to the C.3.d sizing standard, using the approaches set forth in existing Permittee technical guidance manuals. To the extent that is not possible, they should use the C.3.j.i.(g) approach.

The Guidance notes that even with site-specific constraints, it may still be desirable to design bioretention treatment controls to treat amounts of runoff below the 80 percent of average annual runoff standard. We agree. It notes, further, that "[p]ollutant reduction achieved by GI facilities in street projects will be estimated in accordance with the Interim accounting Methodology or the applicable Reasonable Assurance Analysis." We look forward to working with the Permittees to establish an agreed-upon approach for estimating pollutant load reductions associated with smaller-sized facilities. In addition, we are interested to work with the Permittees regarding guidance on bounds for control sizing, such as particular control designs to use or bounds below which the operation and maintenance burden may be unreasonably high relative to the benefits achieved.

We look forward to working with you to identify appropriate reporting regarding use of the Guidance and Report that can be completed prior to the MRP's reissuance, and which could inform the reissuance. Reporting is likely to include a narrative discussion of how Permittees implemented the alternative design guidance for projects using it, and consideration of how to track partial treatment with respect to crediting for Provisions C.11 and C.12.

If you have any questions or would like to discuss this matter further, please contact Dale Bowyer at (510) 622-2323 or dale.bowyer@waterboards.ca.gov.

Sincerely,

Digitally signed by Keith H. Lichten
Date: 2019.06.21 17:23:39 -07'00'

Keith H. Lichten, Chief
Watershed Management Division

Guidance for Sizing Green Infrastructure Facilities in Street Projects

with companion analysis:

Green Infrastructure Facility Sizing for Non-Regulated Street Projects

B A S M A A

Bay Area
Stormwater Management
Agencies Association

Prepared by
Dan Cloak Environmental Consulting
EOA, Inc.

June 2019

Introduction and Regulatory Background

Provision C.3.j. in the reissued Municipal Regional Stormwater Permit[1] (MRP) requires each Permittee to "complete and implement a Green Infrastructure (GI) Plan for the inclusion of low impact development drainage design into storm drain infrastructure on public and private lands, including streets, roads, storm drains, parking lots, building roofs, and other storm drain infrastructure elements."

Provision C.3.j.i.(g) further mandates that these plans include:

> *Requirements that projects be designed to meet the treatment and hydromodification sizing requirements in Provisions C.3.c. and C.3.d. For street projects not subject to Provision C.3.b.ii. (i.e., non-Regulated Projects) Permittees may collectively propose a single approach with their Green Infrastructure Plans for how to proceed should project constraints preclude fully meeting the C.3.d. sizing requirements. The single approach can include different options to address specific issues or scenarios. That is, the approach shall identify the specific constraints that would preclude meeting the sizing requirements and the design approach(es) to take in that situation. The approach should also consider whether a broad effort to incorporate hydromodification controls into green infrastructure, even where not otherwise required, could significantly improve creek health and whether such implementation may be appropriate, plus all other information as appropriate (e.g., how to account for load reduction for the PCBs or mercury TMDLs).*

This document represents the "single approach" collectively proposed by the Permittees for how to proceed when constraints on GI projects affect facility sizing in street projects. For other types of projects, information on hydraulic sizing is provided in the technical guidance manuals for Provision C.3 developed by each countywide stormwater program.

Hydraulic Sizing Requirements

MRP Provision C.3.d contains criteria for sizing stormwater treatment facilities. Facilities may be sized on the basis of flow, volume, or a combination of flow and volume. With adoption of the 2009 MRP, a third option for sizing stormwater treatment facilities was added to Provision C.3.d. This option states that "treatment systems that use a combination of flow and volume capacity shall be sized to treat at least 80 percent of the total runoff over the life of the project, using local rainfall data."

This option can also be used to develop sizing factors for facilities with a standard cross-section (i.e., where the volume available to detain runoff is proportional to facility surface area). To calculate sizing factors, inflows, storage, infiltration to groundwater, underdrain discharge, and overflows are tracked for each time-step during a long-term simulation. The continuous simulation is repeated, with variations in the treatment surface area, to determine the minimum area required for the facility to capture and treat 80% of the inflow during the simulation.

---

[1] Order R2-2015-0049

Such an analysis was conducted for BASMAA by Dubin Environmental Consulting and is described in the attached Technical Report. The analysis shows that bioretention facilities with the current-standard cross-section can capture and treat the Provision C.3.d amount of runoff when sized to 1.5% - 3% of tributary equivalent impervious area, depending on location.

Hydromodification Management

A principal objective of LID is to mimic natural hydrology in the post-development condition. This is accomplished by retaining and infiltrating runoff flows during small to medium events. Flows from larger events are detained and slowed.

MRP Provision C.3.g. includes requirements and criteria for implementing hydromodification management (HM). These HM requirements apply to Regulated Projects that create or replace an acre or more of impervious area, increase the amount of impervious area over the pre-project condition, and flow to creeks that are at risk of erosion. As such, the HM requirements do not apply to street projects that retrofit drainage systems that receive runoff from existing roofs and paving.

However, Provision C.3.j.i.(g) states that the Permittees' approach to sizing GI facilities "...should also consider whether a broad effort to incorporate hydromodification controls into green infrastructure, even where not otherwise required, could significantly improve creek health and whether such implementation may be appropriate..."

Various criteria for HM design have been used in California and throughout the U.S. These criteria have been based on one or more of the following principles:

- Maintaining watershed processes
- Maintaining a site-specific water balance
- Maintaining the value of the curve number used in the NRCS method of computing peak runoff
- Controlling increases in peak flows from a specified storm size
- Controlling increases in the duration of flows at each intensity within a specified range (flow duration control)
- Controlling the likelihood of downstream erosion in streams (erosion potential, or Ep)

Generally, for any HM criterion used, facilities with more storage and a larger infiltrative area will be more effective in meeting the criterion than facilities with less storage and a smaller infiltrative area.

In the statewide municipal stormwater NPDES permit for small MS4s, Provision E.12.f. includes the following HM standard applicable to Bay Area small MS4s: "Post-project runoff shall not exceed estimated pre-project flow rate for the 2-year, 24-hour storm..."

Dubin (2014) conducted modeling to evaluate whether this standard would be met in the San Francisco Phase II counties (Marin, Sonoma, Napa, and Solano) by a bioretention facility meeting the minimum requirements in that permit's Provision

E.12.f. Dubin's analysis found that a facility sized to 4% of tributary equivalent impervious area, and having a 6-inch deep reservoir with 2 inches of freeboard, 18 inches of treatment soil, and a 12-inch-deep "dead storage" gravel layer below the underdrain, would meet this standard, even in the wettest portions of the Bay Area.

Additional Considerations for Bioretention Sizing

In summary, bioretention facilities for street projects sized to 1.5% - 3% of tributary equivalent impervious area (depending on their location in the Bay Area) can meet the criteria in Provision C.3.d., according to the modeling study documented in the attached Technical Memo.

There are many reasons to design and build facilities larger than the Provision C.3.d. minimum. Building larger facilities helps ensure the facilities perform to the minimum hydraulic capacity intended, despite minor flaws in design, construction, and maintenance, providing an engineering safety factor for the project. Further, larger-sized facilities may more effectively address objectives to maximize the removal of pollutants (particularly pollutants in dissolved form), to operate as full trash capture devices, and to manage hydromodification effects.

However, municipalities often face considerable challenges in retrofitting existing streetscapes with GI facilities. Constraints and design challenges typically encountered in the public right-of-way include:

- The presence of existing underground utilities (known and unknown during the design phase);
- The presence of existing above-ground fixtures such as street lights, fire hydrants, utility boxes, etc.;
- The presence of existing mature trees and root systems;
- The elevation of or lack of existing storm drains in the area to which to connect underdrains or overflow structures;
- Challenges of defining and controlling any catchment areas on adjacent private parcels that drain to the roadway surface;
- Low soil permeability and strength, and the need to protect the adjacent roadway structure;
- Competition with other assets & uses for limited right-of-way area; and
- Presence of archeologic/cultural deposits.

Use of the sizing factors in the attached Technical Memo will provide municipalities flexibility in design of bioretention facilities for street projects where constraints are present.

Recommendations for Sizing Approaches for Green Infrastructure Retrofit Facilities in Street Projects

1. Bioretention facilities in street projects should be sized as large as feasible and meet the C.3.d criteria where possible. Constraints in the public right-of-way may affect the size of these facilities and warrant the use of smaller sizing factors.

Bioretention facilities in street projects may use the sizing curves in the attached memorandum to meet the C.3.d criteria. Local municipal staff involved with other assets in the public right of way should be consulted to provide further guidance to design teams as early in the process as possible.

2. Bioretention facilities in street projects smaller than what would be required to meet the Provision C.3.d criteria may be appropriate in some circumstances. As an example, it might be appropriate to construct a bioretention facility where a small proportion of runoff is diverted from a larger runoff stream. Where feasible, such facilities can be designed as "off-line" facilities, where the bypassed runoff is not treated or is treated in a different facility further downstream. In these cases, the proportion of total runoff captured and treated should be estimated using the results of the attached memorandum. In cases where "in-line" bioretention systems cannot meet the C.3.d criteria, the facilities should incorporate erosion control as needed to protect the facility from high flows. See Figures 1 and 2 below for illustration of the in-line and off-line concepts.
3. Pollutant reduction achieved by GI facilities in street projects will be estimated in accordance with the Interim Accounting Methodology[i] or the applicable Reasonable Assurance Analysis[ii].

Figure 1: Off-line system in El Cerrito where low flow is diverted to the sidewalk planter and high flows continue down the gutter.

Figure 2: In-line system in Berkeley/Albany where low and high flows enter the system and overflows exit through a drain within the system.

[i] The Interim Accounting Methodology for TMDL Loads Reduced Report (BASMAA 2017) describes the methodology that is being used to demonstrate progress towards achieving the PCB and mercury load reductions required during the term of MRP 2.0. The methodology is based on the conversion of land use from a higher to a lower PCB or mercury loading rate during the redevelopment of a parcel. See: www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/Municipal/POC/Final%20Interim%20Accounting%20Methodology%20Report%20v.1.1%20(Revised%20March%202017).pdf

[ii] A Reasonable Assurance Analysis (RAA) is a methodology used to demonstrate that implementation of pollutant control measures (such as GI facilities) over a specified time period will meet required pollutant load reductions associated with a TMDL. The Bay Area Reasonable Assurance Analysis Guidance Document (BASMAA 2017) establishes a regional framework and provides guidance for conducting PCBs and mercury RAAs in the San Francisco Bay Area. See: http://basmaa.org/Announcements/bay-area-reasonable-assurance-analysis-guidance-document

BAY AREA STORMWATER MANAGEMENT AGENCIES ASSOCIATION

GREEN INFRASTRUCTURE FACILITY SIZING FOR NON-REGULATED STREET PROJECTS

Prepared by:
Dubin Environmental
December 13, 2017

BASMAA
Bay Area Stormwater Management Agencies Association

DUBIN Environmental

1. Introduction

The San Francisco Bay Regional Water Quality Control Board's reissued Phase I Municipal Regional Stormwater Permit (Order No. R2-2015-0049, issued 11/19/2015 and referred to as "MRP 2.0") includes a requirement that Permittees complete and implement green infrastructure plans to promote the increased use of green infrastructure in urban areas. These plans will guide the integration of green stormwater facilities into streets, parking lots, parks, building rooftops and similar places where there is an opportunity to retrofit traditional gray infrastructure systems and increase the removal of pollutants and improve water quality.

Provision C.3.j states:

> *Over the long term, the (Green Infrastructure) Plan is intended to describe how the Permittees will shift their impervious surfaces and storm drain infrastructure from gray, or traditional storm drain infrastructure where runoff flows directly into the storm drain and then the receiving water, to green—that is, to a more-resilient, sustainable system that slows runoff by dispersing it to vegetated areas, harvests and uses runoff, promotes infiltration and evapotranspiration, and uses bioretention and other green infrastructure practices to clean stormwater runoff.*

Provision C.3.j.i.(2)(g) requires that projects be designed to meet the treatment and hydromodification sizing requirements in Provisions C.3.c. and C.3.d. However, the provision further states that for street projects that are not Regulated Projects:

> *...Permittees may collectively propose a single approach with their Green Infrastructure Plans for how to proceed should project constraints preclude fully meeting the C.3.d sizing requirements. The single approach can include different options to address specific issues or scenarios. That is, the approach shall identify the specific constraints that would preclude meeting the sizing requirements and the design approach(es) to take in that situation.*

To address this provision and further define the C.3.d sizing requirements for green infrastructure projects, the Bay Area Stormwater Management Agencies Association (BASMAA) contracted with Dubin Environmental to conduct continuous simulation hydrologic modeling to evaluate relationships of facility size (e.g., area, depth, flow rate) to facility performance. The BASMAA Development Committee, and BASMAA member agencies, intend to use these relationships to develop and justify an approach, to be created by the Development Committee, for implementing green street projects when there are constraints on facility size.

This report describes the modeling analysis that was performed to better understand the relationship between bioretention configuration and annual runoff treatment across the different BASMAA stormwater agencies and their climate zones. Long-term continuous modeling was used to compute stormwater runoff, simulate bioretention hydraulics, and estimate the annual percentage of stormwater that is treated. The analysis was performed for 10 different rain gauges that together represent the full range of climate conditions across the BASMAA member agency area. The analysis also considered different bioretention configurations and treatment goals. BASMAA member agencies can use these results to help establish policies and design guidelines to include in their green infrastructure plans.

2. Project Approach

The performance of bioretention facilities was modeled using HSPF (Hydrologic Simulation Program Fortran), which is a physically based, hydrologic model that is maintained and distributed by the US EPA.

HSPF has been used since the 1970s to conduct hydrologic analyses and size stormwater and flood control facilities. For this project, an HSPF model was developed to simulate runoff from a fully paved, 1-acre reference site and route this flow through a bioretention facility. This section describes the rain gauge selection and the HSPF modeling approach. Section 3 describes the modeling results.

2.1 Rainfall and Evapotranspiration Data

There are more than two dozen rain gauges with long-term, hourly data located within the BASMAA area. A list of candidate gauges was prepared from the National Center for Environmental Information (NCEI; formerly the National Climate Data Center or NCDC) network and then evaluated for inclusion. The evaluation focused on gauge data that could downloaded directly from EPA's National Stormwater Calculator, because these datasets have been reviewed and missing records filled with data from available nearby stations (similar to the data included with the EPA BASINS software). The list of candidate gauges was narrowed to 19 locations with 35+ years of data that are geographically distributed through the BASMAA area. The rain gauges were organized into tables that show a) mean annual precipitation (MAP) and b) 6-month, 1-year, and 2-year accumulations for 1-year and 24-hour durations. The different storm depth statistics were used to identify any outliers among the rain gauge data that could indicate problems that would hinder the effort to create regressions among the model results. The rain gauge locations were also plotted in ArcGIS.

The recommended sites were presented to the BASMAA project work group who provided helpful input about their preferences and experiences with different rain gauges. Based on this input, six stations were selected for inclusion in the modeling analysis. After developing the HSPF input and output routines, the number of gauges was increased to 10 by including higher rainfall locations to allow development of regression relationships that span the rainfall characteristics at any likely project location. Table 1 lists the candidate rain gauges included in the modeling analysis. For all gauges, a common 37 year period was used to eliminate the influence of drought and wet periods that occurred when some gauges were operational but not others. Figure 1 shows the mean annual rainfall and Figure 2 shows their locations. The 1-year and 24-hour storm durations are included in Appendix A.

TABLE 1. SELECTED RAIN GAUGES FOR GREEN INFRASTRUCTURE MODELING

2	Name	County/Agency	Years of Record	Mean Annual Rain (in)
049001	Tracy Pumping Plant	Contra Costa	37	12.7
047821	San Jose	Santa Clara	37	15.2
045378	Martinez Water Plant	Contra Costa	37	19.6
047769	SF Airport	San Francisco	37	20.4
047772	SF Downtown	San Francisco	37	21.9
046336	Oakland Museum	Alameda	37	22.8
042934	Fairfield	Fairfield-Suisun	37	24.1
043714	Half Moon Bay	San Mateo	37	28.6
047807	San Gregorio	San Mateo	37	30.0
044500	Kentfield	Marin	37	48.1

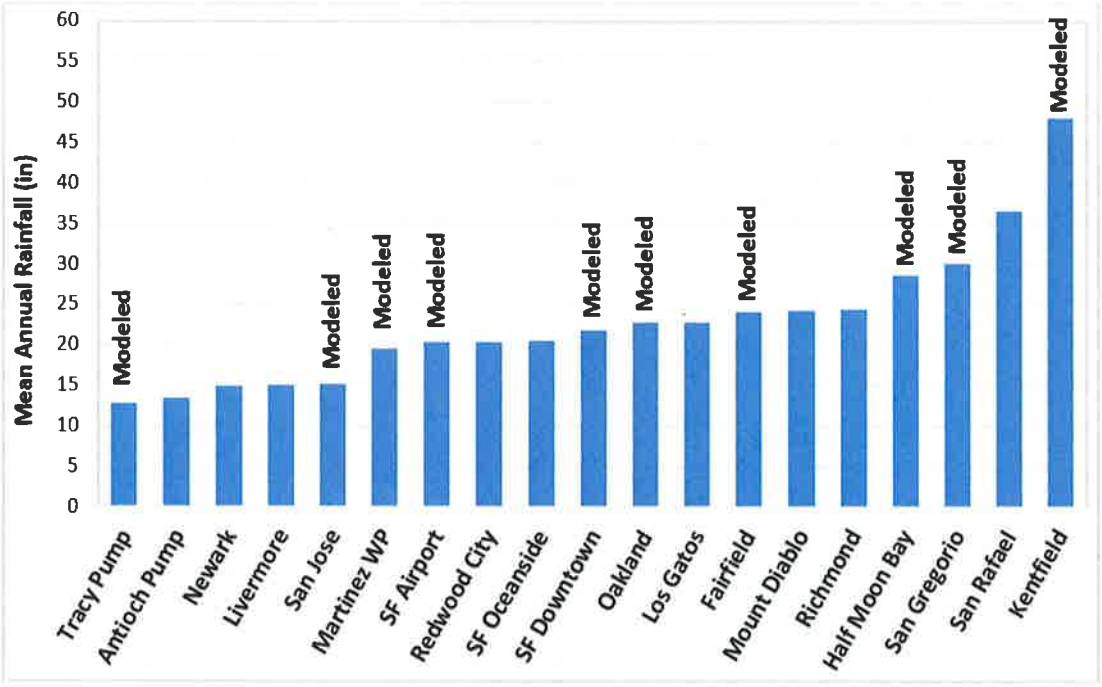


Figure 1. Candidate and selected rainfall sites with mean annual rainfall

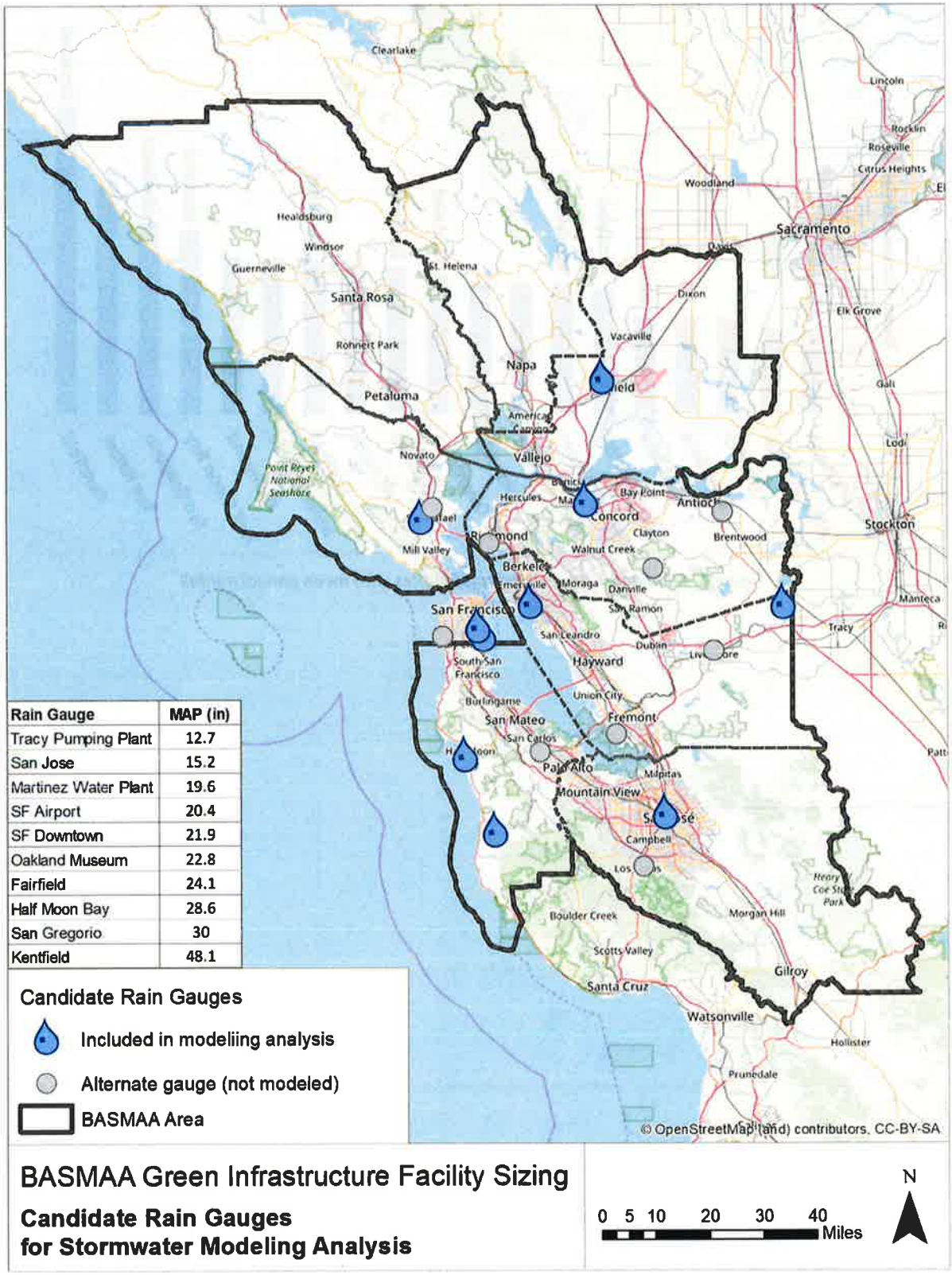


Figure 2. Location of rain gauges used in the modeling analysis

2.2 HSPF Model Setup

An HSPF model was developed to simulate runoff from a fully paved, 1-acre reference area and route this flow through a bioretention facility. The model outputs were then evaluated to determine the fraction of incoming stormwater receiving water quality treatment (defined as the fraction filtered through the bioretention media, evaporated or transpired). The HSPF model was developed with Excel/VBA-based code that enabled us to easily modify the rain gauge, bioretention area, and surface reservoir depth to determine how these watershed and configuration parameters affect the fraction of stormwater being treated.

The model parameters and approach to simulating bioretention hydraulics are discussed in detail below:

- Stormwater runoff flows across the reference 1-acre paved area and enters the bioretention facility. This water is initially detained in a shallow surface reservoir and then infiltrates to the bioretention media.
- Stormwater infiltrates through the bioretention media into an underlying gravel layer. The saturated soil permeability was set to 5 inches per hour (based on the media specification). For unsaturated soils, the relationship between soil moisture and permeability was based on monitoring data collected at three installations in Pittsburg (Contra Costa, 2013). The data showed very little infiltration occurs until the soil reaches about two-thirds saturation, and then infiltration increases roughly linearly until reaching 5 inches per hour at 90 percent saturation. Evapotranspiration also occurs in this layer.
- Stormwater within the gravel layer can move freely and infiltrate to surrounding soils, based on their capacity. If runoff enters the gravel layer more rapidly than it infiltrates, the saturation level in the gravel layer will rise until it reaches the elevation of a perforated pipe underdrain. When this occurs, water will flow through the underdrain to a downstream discharge point (typically the municipal storm drainage system).
- The surface reservoir is also equipped with an overflow structure that will become active if runoff enters the surface reservoir more rapidly than it infiltrates through the bioretention media and the surface reservoir fills to its maximum depth. Water discharged via the overflow relief structure does not receive treatment.

The bioretention configuration was based on the water quality treatment design criteria listed in the MRP 2.0 and accepted design practice in the Bay Area. Table 2 lists the dimensions of the bioretention layers as modeled in HPSF.

TABLE 2. BIORETENTION CHARACTERISTICS IN HSPF MODEL

Component	Characteristics
Surface reservoir	• Area = bioretention area (varies from 0.5% to 5% of upstream impervious area) • Depth = 6 or 12 inches with overflow relief set 2 inches from top of reservoir
Bioretention soil media	• Area = bioretention area • Depth = 18 inches • Saturated permeability = 5 inches per hour • Unsaturated permeability = variable, based on Contra Costa's 2013 monitoring data
Storage (gravel) layer	• Area = bioretention area • Depth = 12 inches • Permeability of surrounding soils = 0.024 inches per hour
Underdrain	• Located at top of gravel layer • Assumed 4-in diameter pipe

2.3 Model QA/QC Process

The HSPF input files and initial model results were carefully examined during the QA/QC process. Model errors and warnings were systematically eliminated and then the results were compared with the results generated from three independent calculation methods:

1. An Excel-based bioretention hydraulics calculator
2. A Matlab-based bioretention algorithm that was used for bioretention modeling in the Central Coast region
3. An EPA SWMM model using the LID module to represent bioretention hydraulics

The comparison was performed for the San Jose and Fairfield gauges with a bioretention sizing factor of 0.02 (i.e., bioretention surface area equal to 2 percent of the upstream impervious area). The estimated annual runoff treatment percentages agreed to within 3 percent, which confirmed the HSPF model was performing as intended.

3. Modeling Scenarios and Results

The HSPF modeling analysis was used to develop bioretention sizing criteria and support policy decisions. Working collaboratively with the BASMAA Development Committee, the modeling analysis addressed the following issues, which are presented in this section:

1. Bioretention area necessary to treat 80 percent of annual stormwater runoff
2. Relationships for estimating annual stormwater treatment percentage across a range of bioretention sizes and mean annual precipitation depths
3. Relationships for estimating annual stormwater treatment percentage for bioretention facilities without an underdrain
4. Bioretention treatment percentage for facilities with no infiltration to surrounding soils
5. Bioretention treatment percentage for facilities with lower bioretention media permeability

The results are summarized graphically here. The full set of results and underlying data were provided separately to the BAASMA Development Committee on 7/28/2017 and are available from BASMAA upon request.

3.1 Bioretention Sizing for Treatment of 80 Percent of Annual Runoff

The performance of bioretention facilities was modeled for 10 different rain gauges and bioretention footprint areas, ranging from 0.5 to 5.0 percent of the upstream tributary area, using the approach described in Section 2. Bioretention configurations with 6-inch and 12-inch deep surface reservoirs were modeled. For each of the model runs, the runoff treatment percentage was computed, and the results were plotted. Figure 3 shows an example for the San Jose gauge. Appendix B shows results for the other rain gauges.

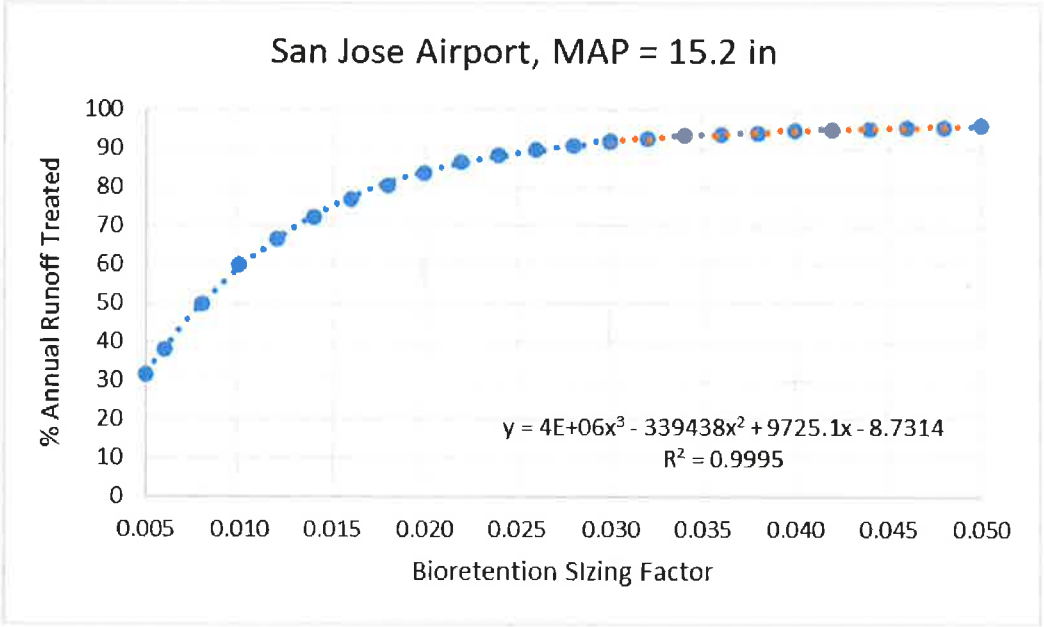


Figure 3. Percent of annual runoff treated for range of bioretention facility sizes using San Jose rain gauge

Using a polynomial regression equation, the model results for each rain gauge/surface reservoir depth scenario were interpolated to estimate the bioretention sizing factor needed to provide 80 percent annual runoff treatment, which is the treatment criterion for regulated water quality projects in the MRP 2.0. The results across the 10 rain gauges showed a clear linear relationship between mean annual rainfall and the bioretention footprint needed for 80 percent annual runoff treatment. Figure 4 and Figure 5 show the results for the 6-inch and 12-inch surface reservoir configurations, respectively.

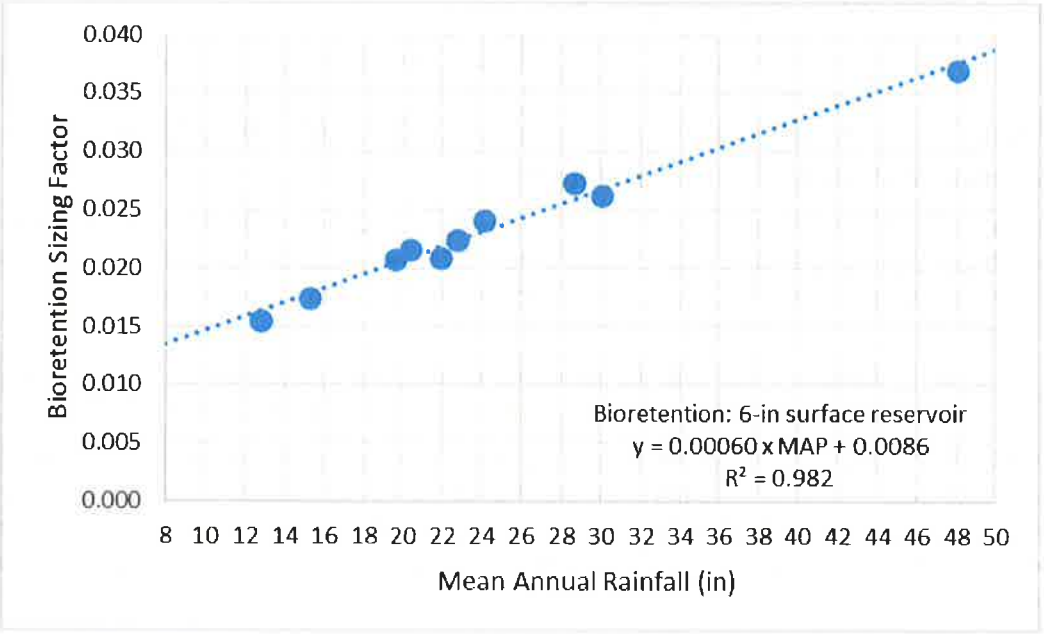


Figure 4. Bioretention size needed to provide treatment of 80 percent of annual runoff; 6-in surface reservoir

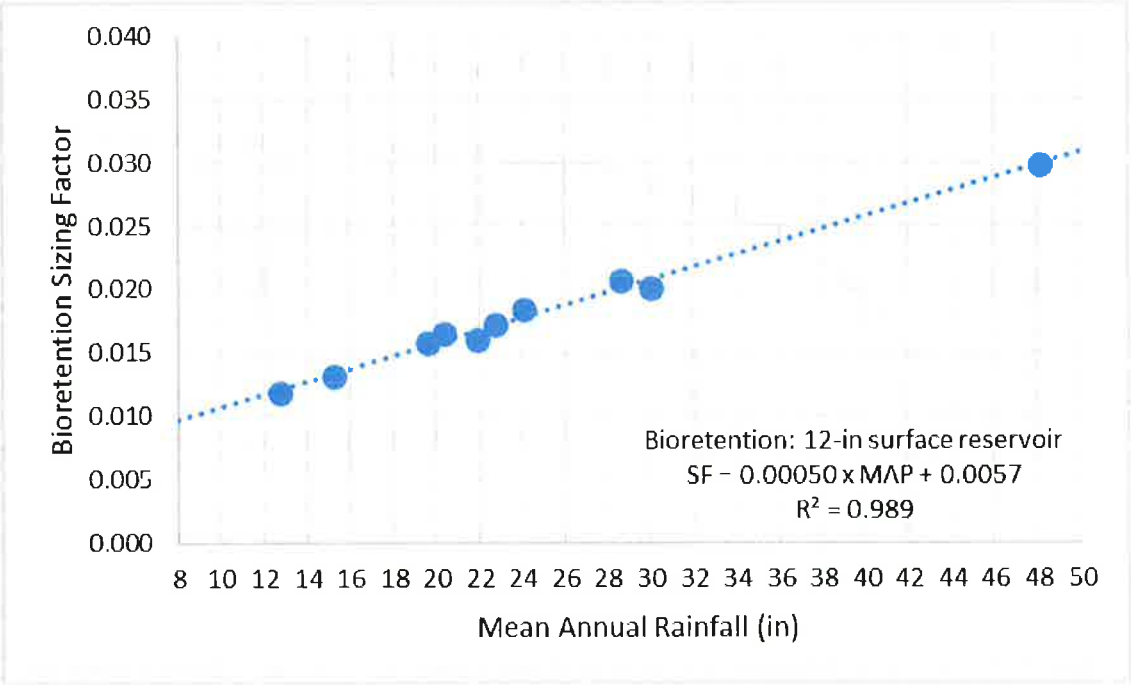


Figure 5. Bioretention size needed to provide treatment of 80 percent of annual runoff; 12-in surface reservoir

The results shown above could be used by BASMAA agencies to set minimum bioretention sizing criteria for projects that must provide treatment of 80 percent of annual runoff. The following equations could be included in BASMAA guidance for green infrastructure manuals.

For bioretention with 6-in surface reservoir configuration:

$$SizingFactor = 0.00060 \times MAP(in) + 0.0086$$

For bioretention with 12-in surface reservoir configuration:

$$SizingFactor = 0.00050 \times MAP(in) + 0.0057$$

3.2 Relationship Among Bioretention Sizing, Annual Precipitation, and Percent of Annual Runoff Treated

The modeling results generated in the previous section were then further evaluated to develop more general relationships among a) bioretention sizing factor, b) mean annual rainfall, and c) annual runoff treatment percentages. The following steps were used for the 6-inch and 12-inch reservoir depth configurations:

1. A polynomial regression was fit to the annual runoff treatment results for each of the 10 rain gauges (see example in Figure 3 above) and surface reservoir depths of 6 and 12 inches.
2. For each rain gauge/surface reservoir depth combination, the regression equation was used to estimate the sizing factors needed to provide 50, 60, 70, 80, 90, and 95 percent annual runoff treatment. This step generated 10 pairs of mean annual rainfall/bioretention sizing factor data for each rain gauge/surface reservoir depth combination (120 pairs in total). Excel's solver function was used for these calculations.

3. For each runoff treatment percentage level (50 percent, 60 percent, etc.), the mean annual rainfall (x-axis) and computed sizing factor (y-axis) were plotted and a linear regression was fit to the data in a manner similar to Figure 4 and Figure 5 above.
4. The linear regressions created for each runoff treatment level (50 percent, 60 percent, etc.) and surface reservoir depth were then plotted together to create a nomograph. Figure 6 and Figure 7 show nomographs for the 6-inch and 12-inch reservoir depths, respectively.

These nomographs are simple but powerful tools that municipal planners can use to estimate the annual treatment percentage for any bioretention facility within the BASMAA member agency area that uses the standard bioretention configuration (i.e., 6-in or 12-in reservoir, 18-in soil media, 12-in gravel layer, underdrain at top of gravel layer). The nomographs should be read as follows:

Step 1: Find the mean annual rainfall for the project location along the horizontal axis

Step 2: Move vertically up the chart to the bioretention sizing factor for the project/installation (note: this step assumes the tributary impervious area and bioretention area have already been planned)

Step 3: Visually interpolate between the closest two "treatment lines" to estimate the percent of annual runoff treated for this location/project.

These nomographs and instructions could be included in BASMAA guidance for green infrastructure manuals and used to a) evaluate the water quality benefits of proposed projects or b) evaluate the treatment provided by existing facilities with the layer depths described above.

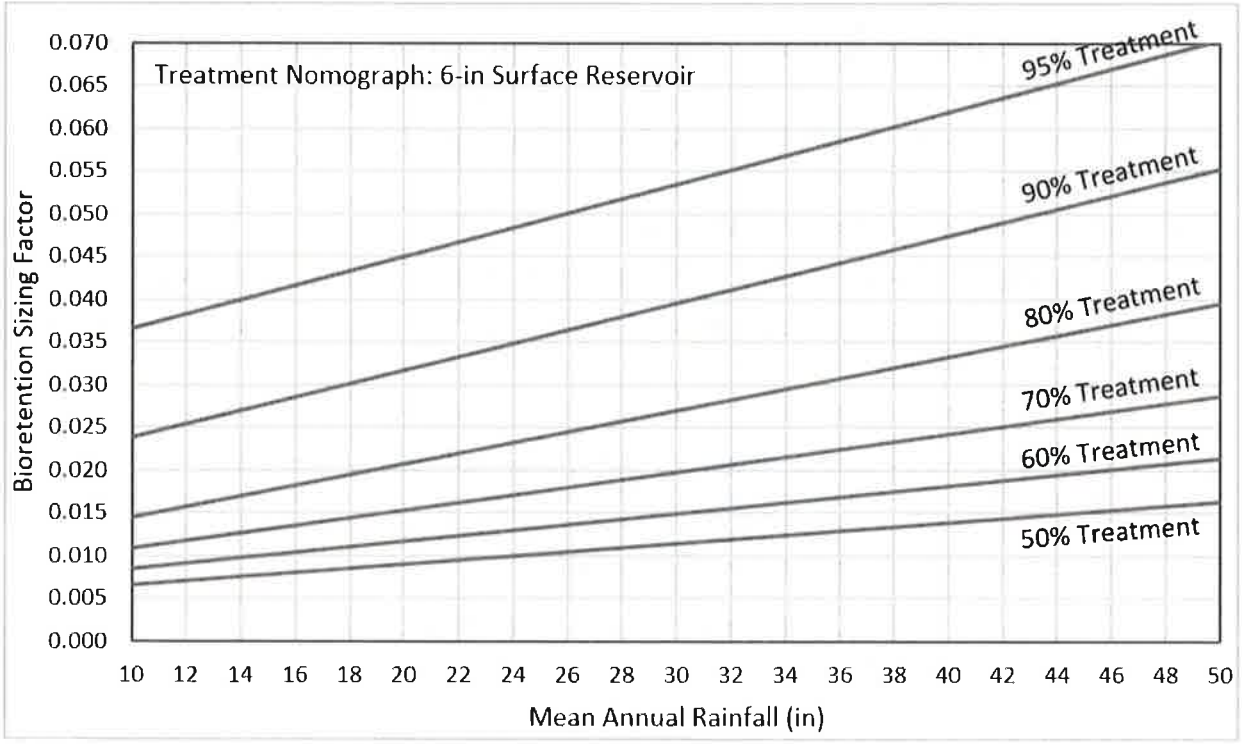


Figure 6. Percent of annual runoff treatment nomograph for bioretention facility with 6-in surface reservoir

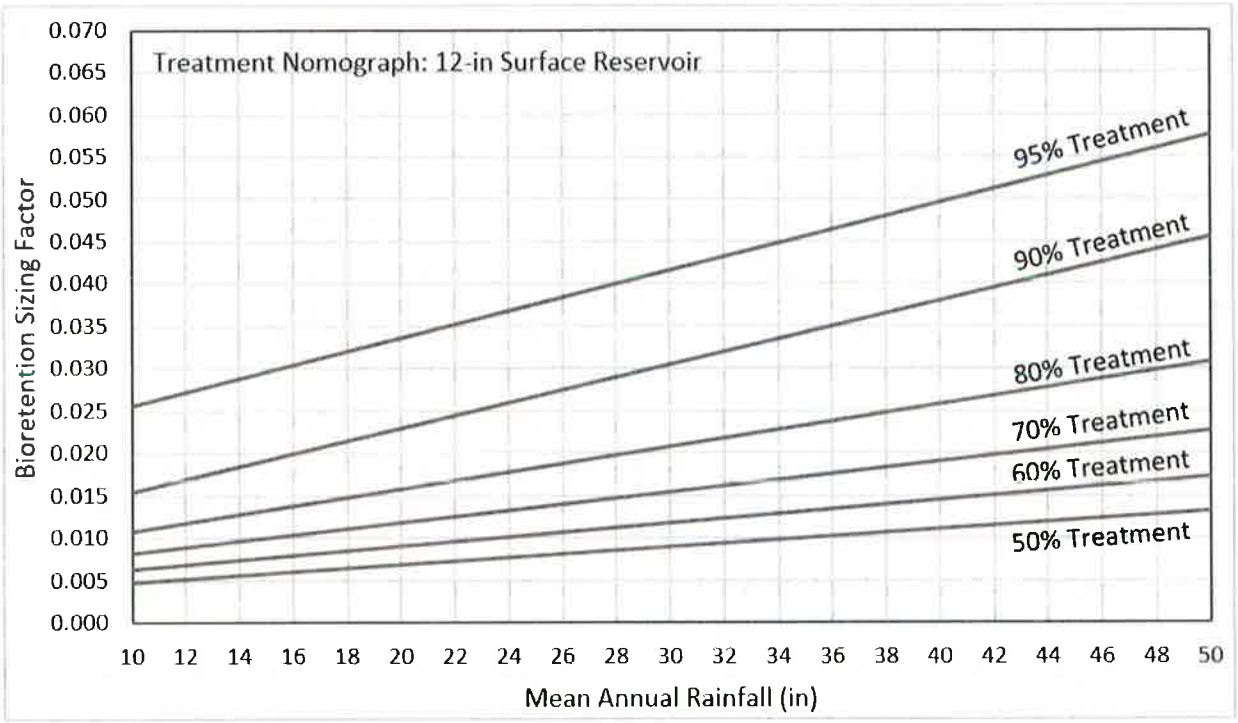


Figure 7. Percent of annual runoff treatment nomograph for bioretention facility with 12-in surface reservoir

3.3 Percent of Annual Runoff Treated by Bioretention Facilities with No Underdrain

Bioretention facilities are occasionally designed with no underdrain, including bioretention facilities in the following conditions:

- High permeability of surrounding (native) soils
- Isolated projects with no downstream drainage system for the underdrain connection
- Small projects that would not justify the additional design and construction costs associated with underdrains and cleanouts
- Projects that were designed and built prior to the development of the current standards

The HSPF model setup was modified to eliminate the underdrain outflows and allow the permeability of the surrounding soils to vary. The annual runoff treatment percentage was computed for a) three rain gauges representing drier, average and wetter than average conditions, b) six rates of permeability of surrounding soils, and c) two bioretention surface reservoir depths (Table 3).

TABLE 3. BIORETENTION WITH NO UNDERDRAIN SCENARIOS

Component	Characteristics
Rain gauges	• San Jose (MAP = 15.2 in) • San Francisco Airport (MAP = 20.4 in) • Fairfield (MAP = 24.1 in)
Permeability of surrounding (native) soils	• 0.2, 0.5, 1.0, 2.0, 3.0, 4.0 inches per hour • Underdrain results also plotted

TABLE 3. BIORETENTION WITH NO UNDERDRAIN SCENARIOS

Component	Characteristics
Surface reservoir depths	• Depth = 6 inches • Depth = 12 inches
Bioretention sizing factors	• Area = 0.5% to 5.0% of upstream impervious acre

Figure 8, Figure 9 and Figure 10 show the modeled annual runoff treatment results for the three rain gauges and a surface reservoir depth of 6 inches. Results for the 12-inch surface reservoir are shown in Appendix C. For rates of permeability of 4 inches per hour, there is little drop off in performance. The annual runoff treatment percentage declines gradually between rates of permeability of 2 to 4 inches per hour and then declines more rapidly for rates of permeability of 1 inch per hour or less. The reduction in performance is more pronounced in wetter areas (as seen in the Fairfield results). These results could be incorporated into the BASMAA guidance for green infrastructure manuals to assess the general performance of existing facilities that were installed with no underdrain.

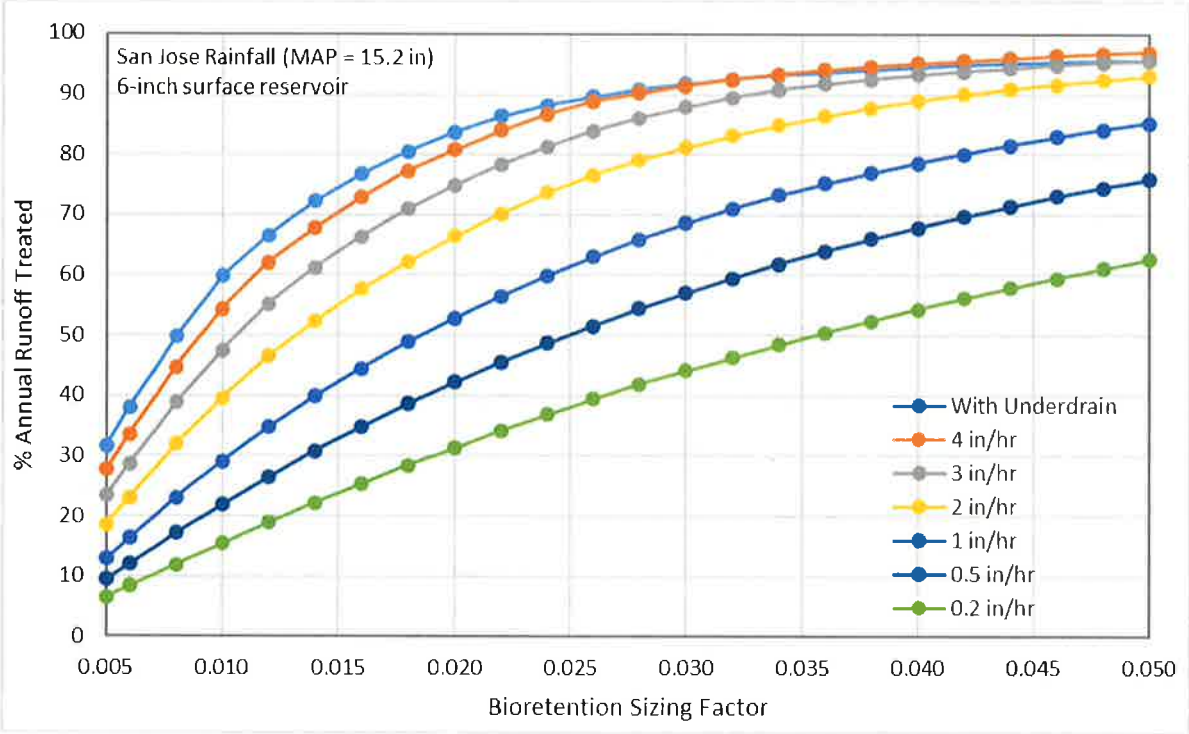


Figure 8. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in), for varying rates of permeability of surrounding soils

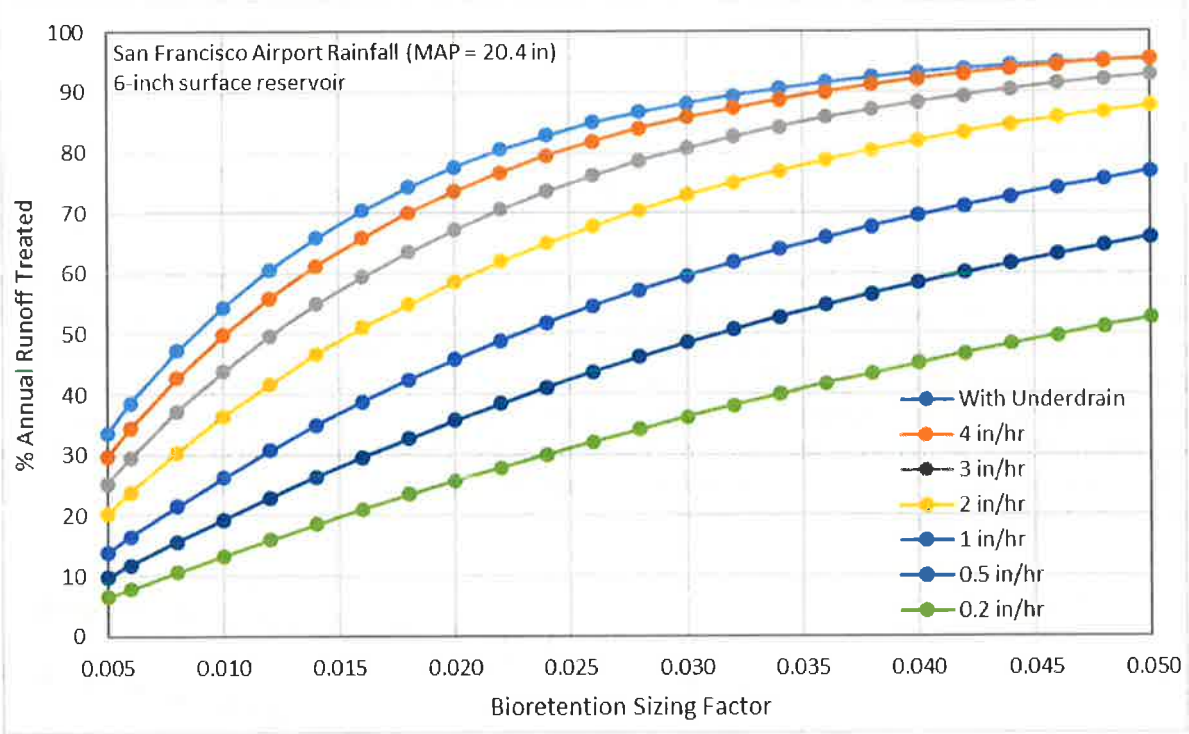


Figure 9. Treatment results for bioretention with no underdrain, San Francisco Airport gauge (MAP = 20.4 in), for varying rates of permeability of surrounding soils

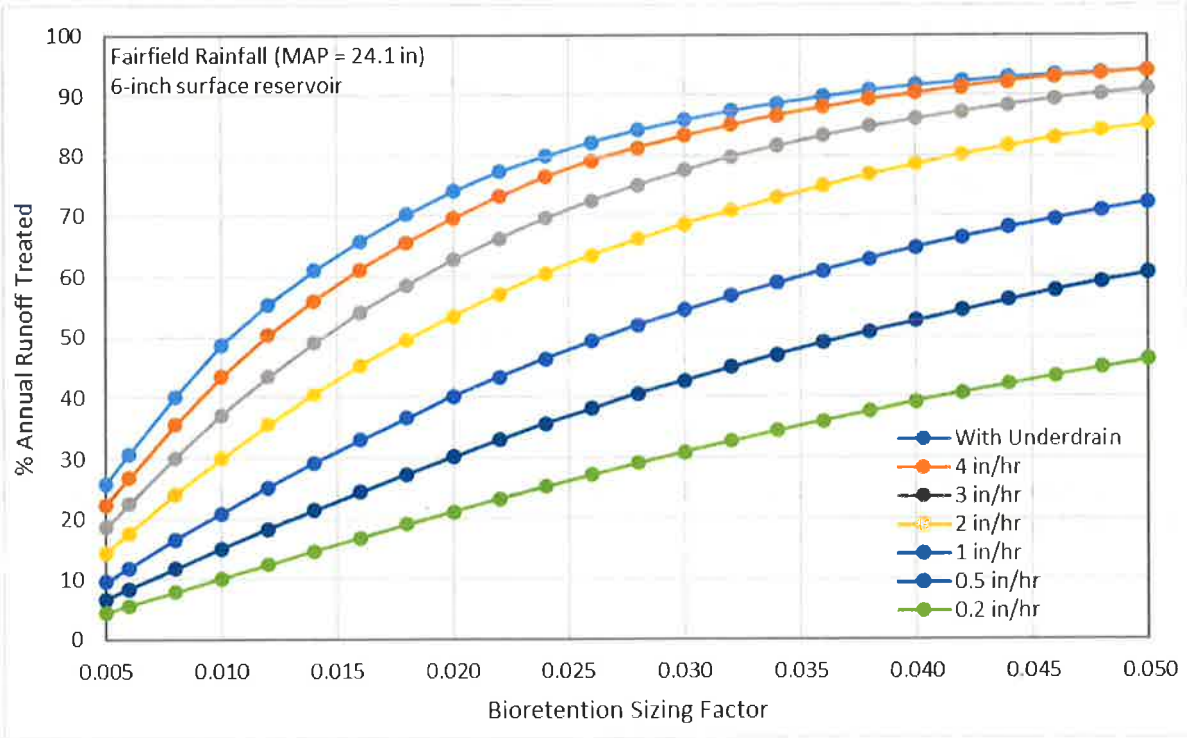


Figure 10. Treatment results for bioretention with no underdrain, Fairfield gauge (MAP = 24.1 in), for varying rates of permeability of surrounding soils

3.4 Percent of Annual Runoff Treated for Bioretention Facilities with No Infiltration to Surrounding Soils

The previous simulations described in Sections 3.1 and 3.2 were conducted for bioretention facilities located in NRCS hydrologic soil group D soils, which are low permeability soils, such as clays. These model simulations used a conservative permeability of 0.024 inches per hour from the bioretention gravel layer to surrounding soils. It was assumed the permeability of surrounding soils would have a negligible effect on the results because the hydraulic capacity of the underdrain is much higher than the permeability of D soils and that when the bioretention media becomes saturated, stormwater would exit mostly via the underdrain. If this assumption is correct, a lined bioretention facility or flow-through planter with no infiltration into surrounding soils should have similar performance.

This assumption was tested directly by running a limited number of simulations with the permeability of the surrounding soils set to a value of zero (i.e., an impervious layer directly below the bioretention facility). The annual treatment percentages were then compared to the previous modeling results (with D soil permeability set to 0.024 inches per hour). These simulations were performed for the Fairfield rain gauge and a bioretention facility with a 6-inch surface reservoir for sizing factors ranging from 0.005 to 0.050.

Figure 11 shows the two sets of model results. For the impermeable bottom scenario, the annual treatment percentage was on average 0.8 percent less the scenarios with a D soil permeability of 0.024 inches per hour (minimum difference = 0.4 percent; maximum difference = 1.5 percent). Therefore, the sizing curves and nomographs in Figure 4 through Figure 7 can be used for lined facilities with no infiltration.

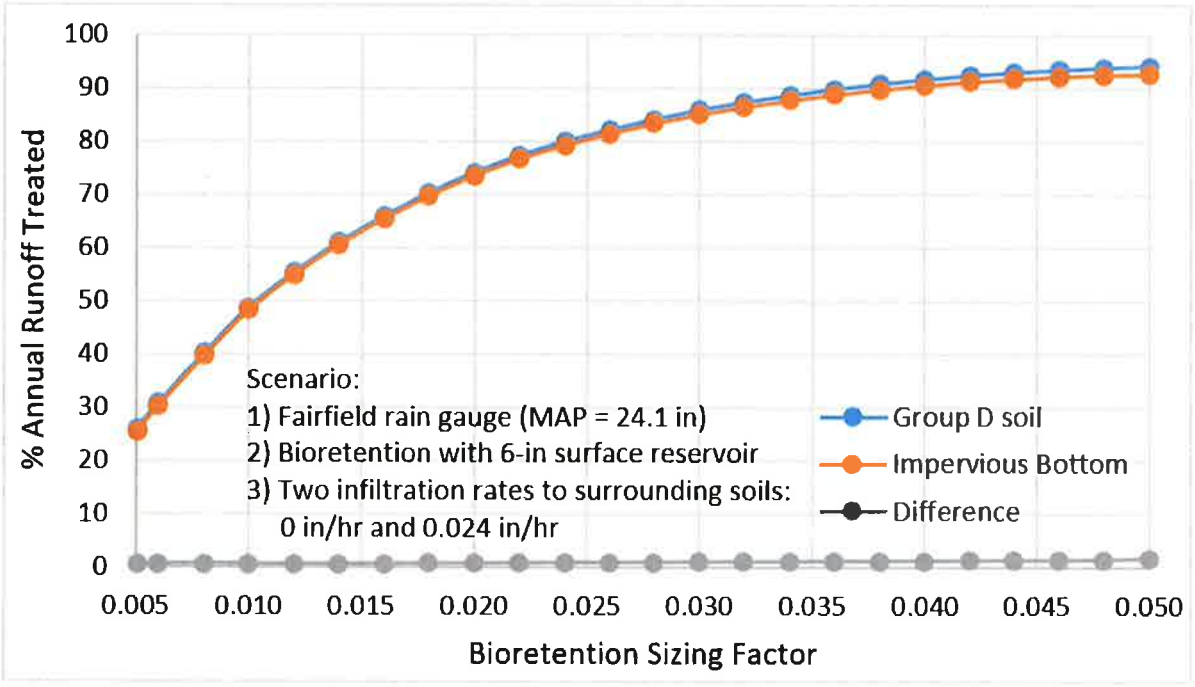


Figure 11. Comparison of model results for Group D soils and impermeable bottom scenarios

3.5 Percent of Annual Runoff Treated for Bioretention Facilities with Lower Media Permeability

The final modeling analysis examined the effect of modifying the bioretention media properties to reduce its saturated permeability from 5 inches per hour to 2 or 3 inches per hour. A lower permeability media would expand the list of available plantings and provide additional flexibility for landscape designers. However, the lower permeability would also reduce the bioretention's capacity for treating runoff during intense storms.

Due to budgetary constraints, this modeling analysis was limited to two scenarios: San Jose rain gauge, 6-inch surface reservoir depth, sizing factors ranging from 0.005 to 0.05, and saturated bioretention media permeability of 2 and 3 inches per hour. Figure 12 shows the percentage of annual runoff treated across the range of bioretention sizing factors and permeability rates. All of the scenarios include an underdrain, so the media permeability is the facility characteristic that controls the treatment percentage (i.e., the rate limiting step). The reduction in treatment percentage could be significant, particularly for smaller facilities. For example, the percent of annual runoff treated for a bioretention facility with a sizing factor of 0.02 would be reduced from 84 percent to 74 or 65 percent (for media permeability rates of 3 and 2 inches per hour, respectively).

Another way to consider the effect of lower media permeability is to estimate *how much larger a facility would need to be* to treat 80 percent of annual runoff. For the San Jose gauge, a sizing factor of 0.017 is needed with the standard bioretention media specification. If the media permeability were reduced to 3 or 2 inches per hour, the sizing factor needed to treat 80 percent of annual runoff would be 0.024 or 0.030, respectively, which represents a 37 to 75 percent increase in the facility footprint.

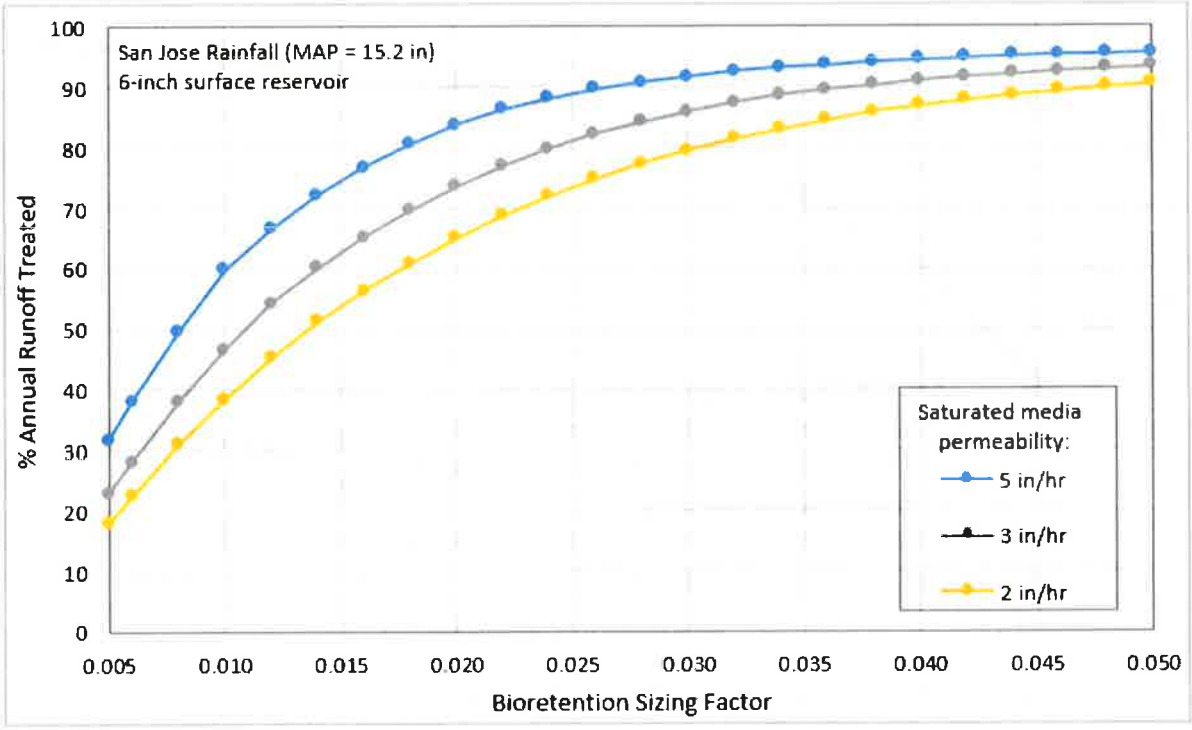


Figure 12. Treatment results for bioretention with variable media permeability, San Jose gauge (MAP = 15.2 in)

As a final note, the media permeability modeling was limited to two scenarios (one rain gauge, one facility configuration, two permeability rates). However, these results could be extended by noting that they are

generally similar to the "no underdrain" results shown in Section 3.3 (e.g., comparing the results for a media permeability of 2 inches per hour to a 2-inch per hour permeability of surrounding soil). When comparing the two sets of results, the percent of annual runoff treated for the lower media permeability is a little lower (0.5 to 2.5 percent) than the corresponding "no underdrain" scenario and the shape of the curve in Figure 12 is similar to the Figure 8 in Section 3.3.

4. Summary and Conclusions

Bioretention facilities are a useful and flexible approach for improving stormwater quality in urban areas. This project developed a set of useful tools that will help municipal staff plan green infrastructure projects in constrained public rights-of-way and assess the effectiveness of existing facilities.

1. Bioretention Sizing Criteria for 80 Percent Annual Runoff Treatment

   The modeling analysis in Section 3.1 showed that bioretention facility performance is closely related to mean annual rainfall. For most locations, the bioretention area necessary to treat 80 percent of annual stormwater ranges from 1.5 to 2.5 percent of the connected upstream impervious area. The precise bioretention area necessary for any project within the BASMAA area (under the guidelines to be developed by BASMAA) can be calculated using the regression equations in Section 3.1.

2. General Sizing Relationships that Apply Throughout the BASMAA Area

   The modeling analysis in Section 3.2 developed nomographs that estimate the annual stormwater treatment percentage across a range of bioretention facility sizes and mean annual rainfall depths. These nomographs can be used to estimate the annual treatment percentages for retrofit projects with space constraints and will enable municipal staff to compare bioretention with other treatment technologies. These nomographs can also be used to assess the effectiveness of existing facilities.

3. Performance of Bioretention Facilities with No Underdrain and Varying Rates of Permeability of Surrounding Soils

   The modeling analysis in Section 3.3 demonstrated the relationship between stormwater treatment percentage and level of permeability of surrounding soils for bioretention facilities without an underdrain. Graphics were developed for rain gauges in wetter and drier areas. The results of this analysis can help assess existing installations and also inform designers about the benefits and tradeoffs of constructing bioretention with no underdrain.

4. Performance of Bioretention Facilities with No Infiltration

   The modeling analysis in Sections 3.1 and 3.2 included the conservative assumption that bioretention facilities were installed in NRCS Group D soils with a very low permeability. The modeling analysis in Section 3.4 compared these results to bioretention facilities with no infiltration to surrounding soils (e.g., facilities with a liner or concrete bottom). The results were very similar, which confirms that the sizing guidance developed in Sections 3.1 and 3.2 can apply to flow-through planters or similar facilities that do not infiltrate to surrounding soils.

5. Sizing Criteria for Facilities with Lower Permeability Soil Media

   The modeling analysis in Section 3.5 demonstrated the relationship between percent of annual runoff treated and bioretention soil media permeability. Reducing media permeability would allow for a wider range of bioretention plantings but would also result in a reduction in the percent of annual runoff treated for the same size drainage area. The reduction would be particularly notable for bioretention facilities with smaller sizing factors. The results of the bioretention media permeability analysis were similar to the no underdrain scenarios in Section 3.3 The Section 3.3 results could be used to estimate how reducing media permeability would influence treatment percentages across a wider range of scenarios.

In general, the bioretention surface area sizing criteria for treating 80% of the annual runoff derived from the modeling analyses described herein are significantly lower than the sizing factors that municipalities in the Bay Area have been requiring regulated projects to meet for compliance with permit requirements for some time. As stated in the Introduction (Section 1), the BASMAA Development Committee and BASMAA member agencies intend to use these sizing relationships to develop and justify a "single approach" for implementing non-regulated green street projects when there are constraints on facility size. A work group of the Development Committee was formed to develop policies and guidelines for implementing the new sizing criteria and addressing other related issues. These include defining the conditions, constraints, and types of projects for which the reduced sizing factors can be used; the method for applying the sizing factors; guidelines for when dimensions of other components such as media depths can be adjusted; how the design of other types of green infrastructure measures may be modified; the effectiveness of smaller or modified green infrastructure facilities in terms of pollutant load reduction; and other considerations.

5. References

Contra Costa Clean Water Program (CCCWP). 2006. Hydrograph Modification Management Plan. April 16, 2006.

Contra Costa Clean Water Program (CCCWP). 2013. IMP Monitoring Report, IMP Model Calibration and Validation Report. September 20, 2013.

Appendix A: Storm Depths for 1-Hour and 24-Hour Durations

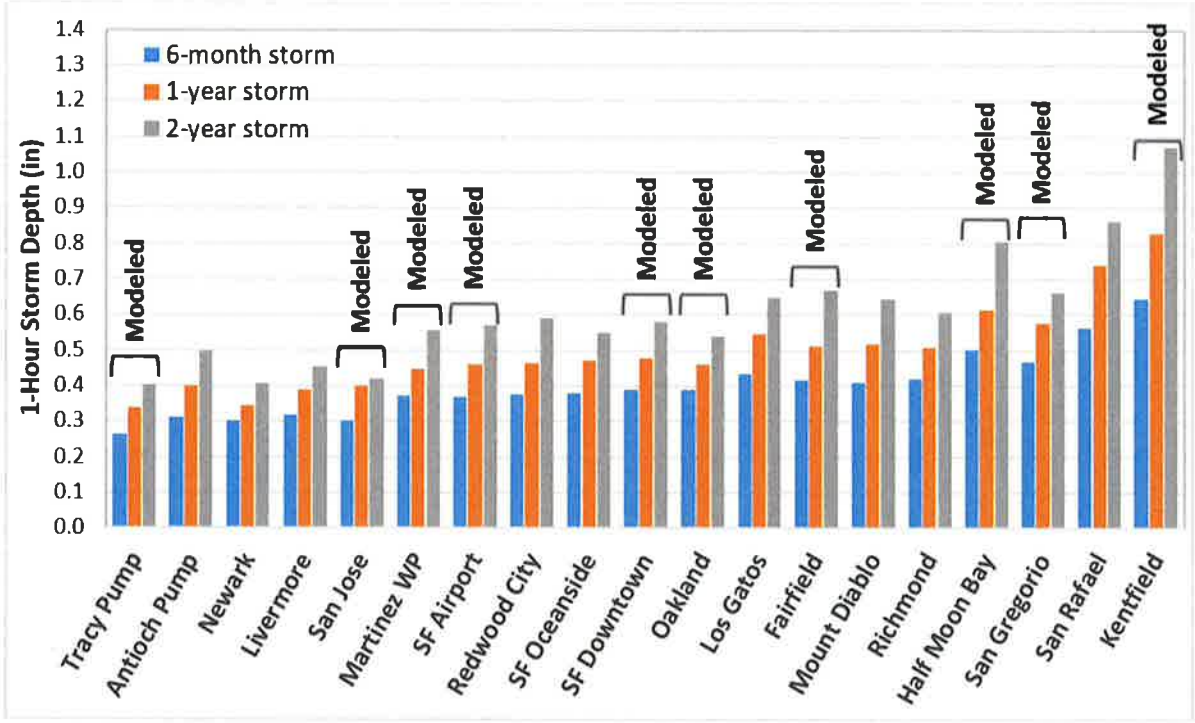


Figure 13. Storm depths for 1-hour duration

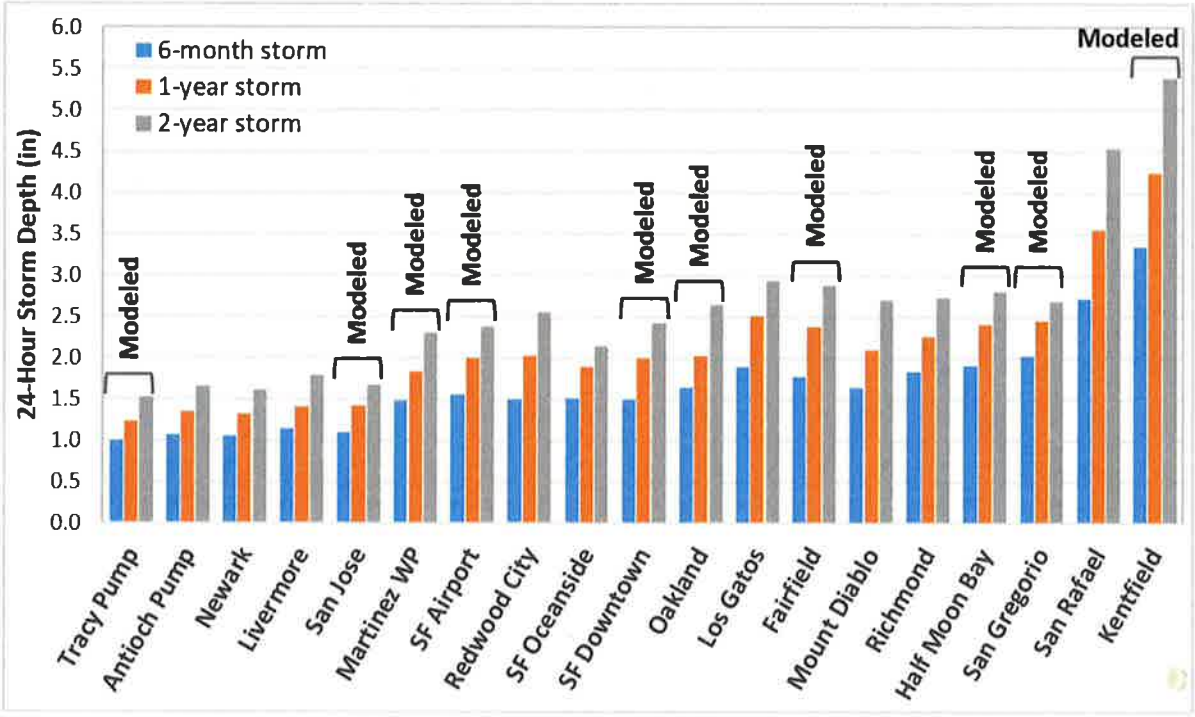


Figure 14. Storm depths for 24-hour duration

Appendix B: Treatment Percentage Results Graphics for All Rain Gauges

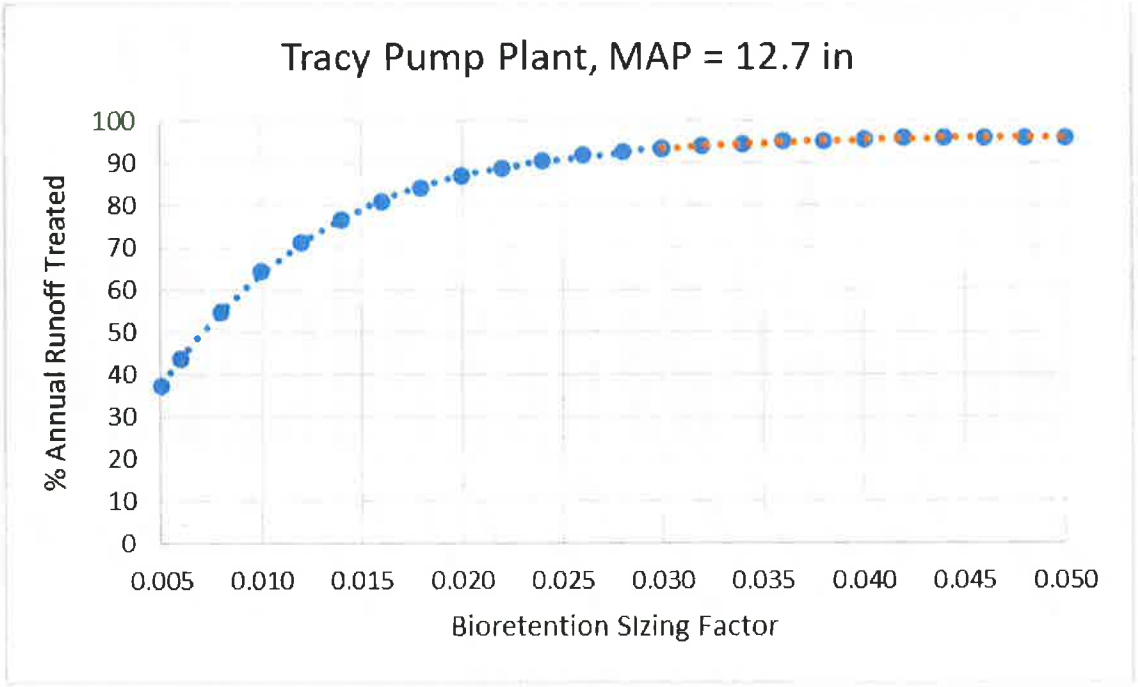


Figure 15. Annual treatment percentage for the Tracy Pump Plant rain gauge

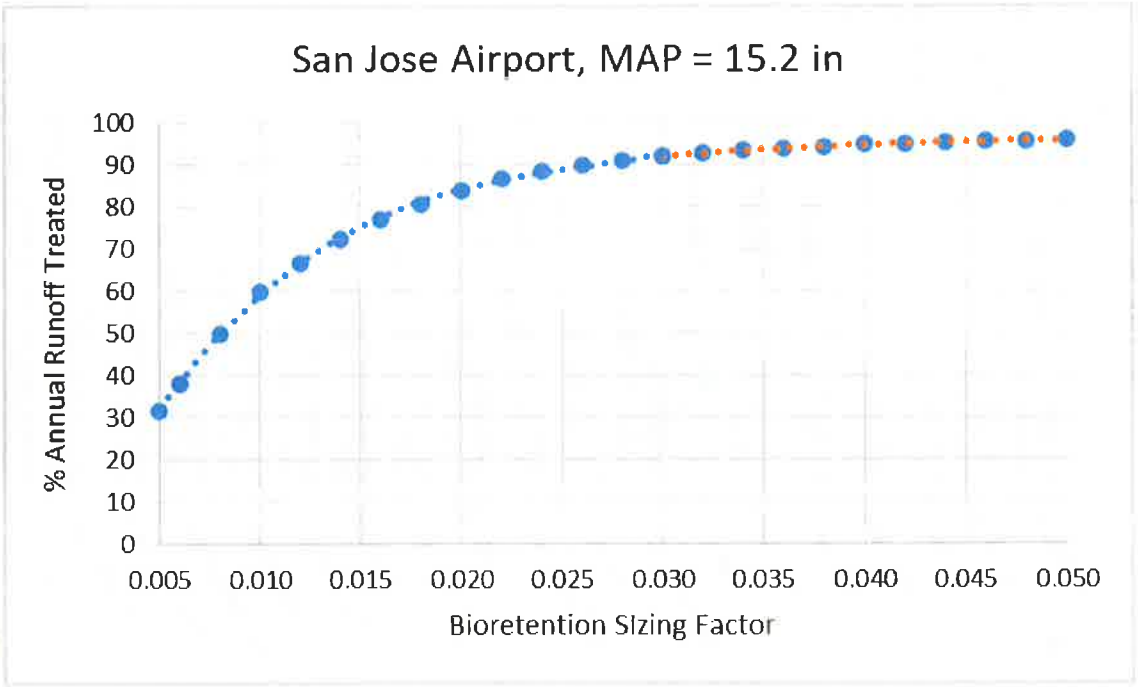


Figure 16. Annual treatment percentage for the San Jose rain gauge

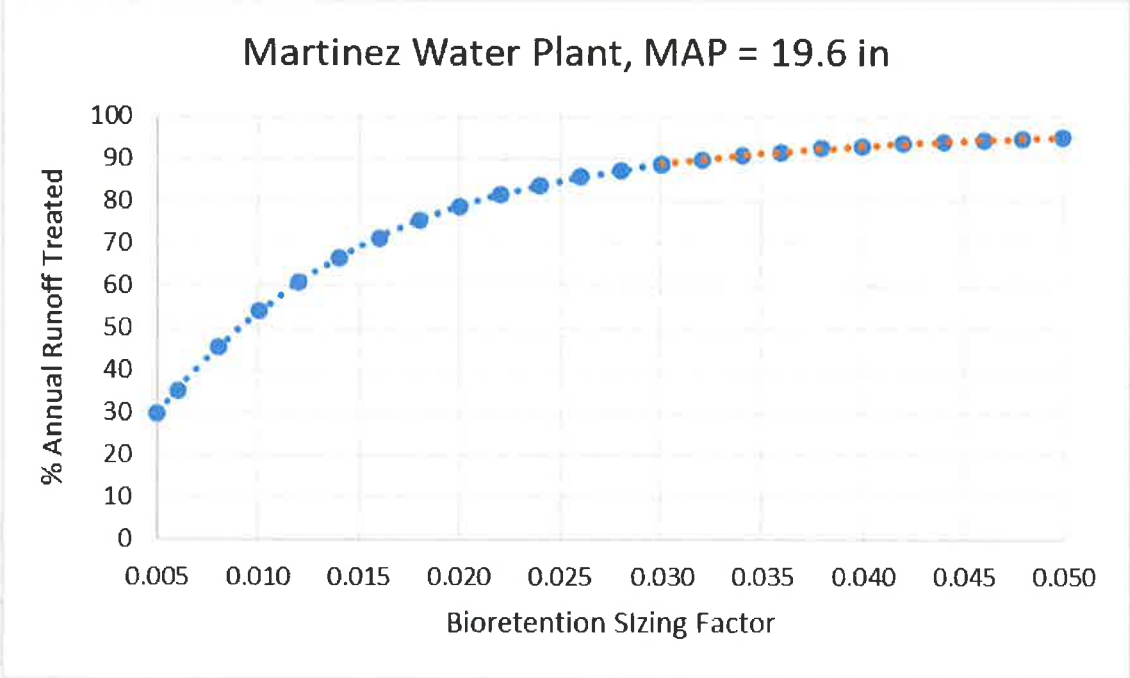


Figure 17. Annual treatment percentage for the Martinez Water Plant rain gauge

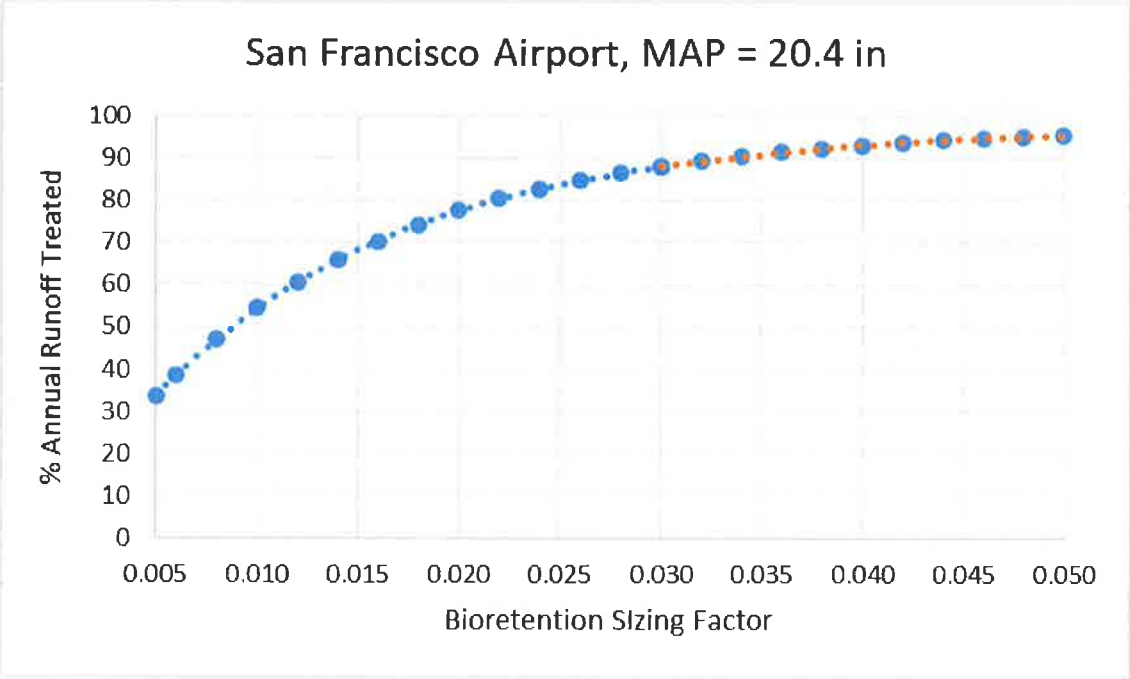


Figure 18. Annual treatment percentage for the San Francisco Airport rain gauge

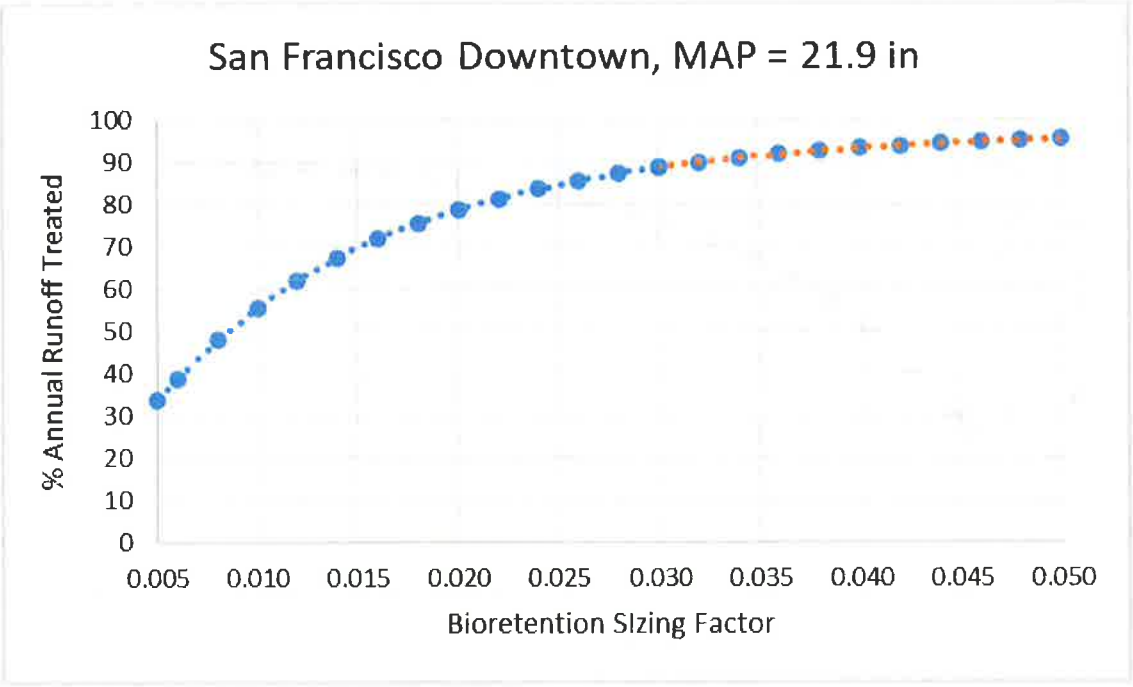


Figure 19. Annual treatment percentage for the San Francisco Downtown rain gauge

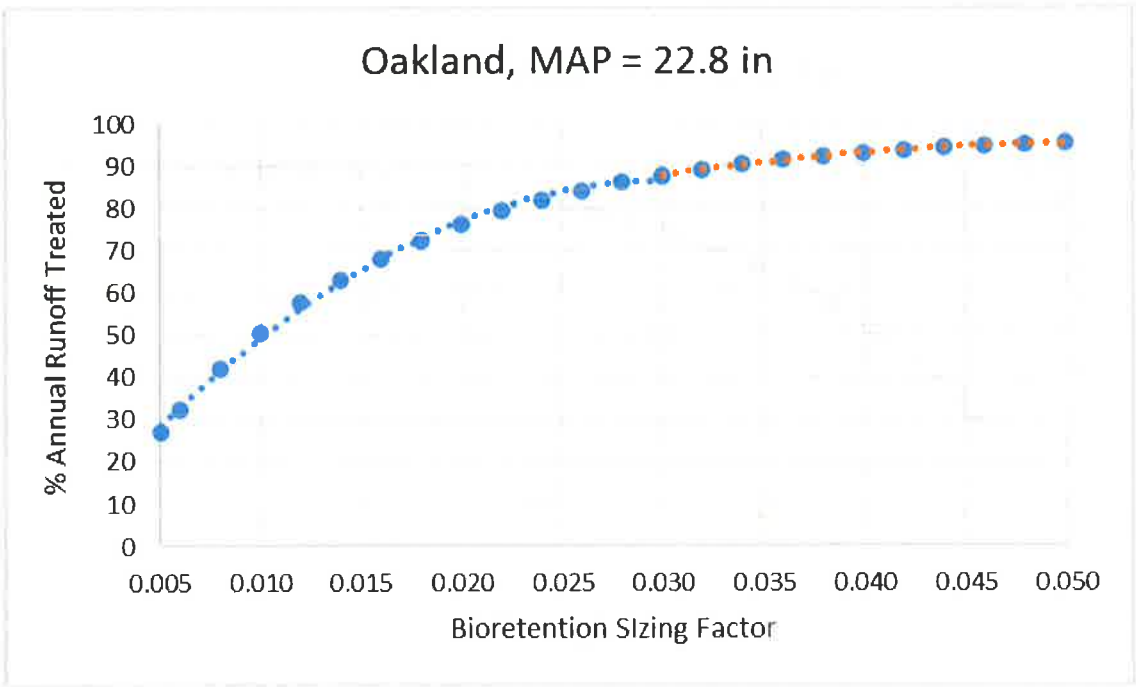


Figure 20. Annual treatment percentage for the Oakland rain gauge

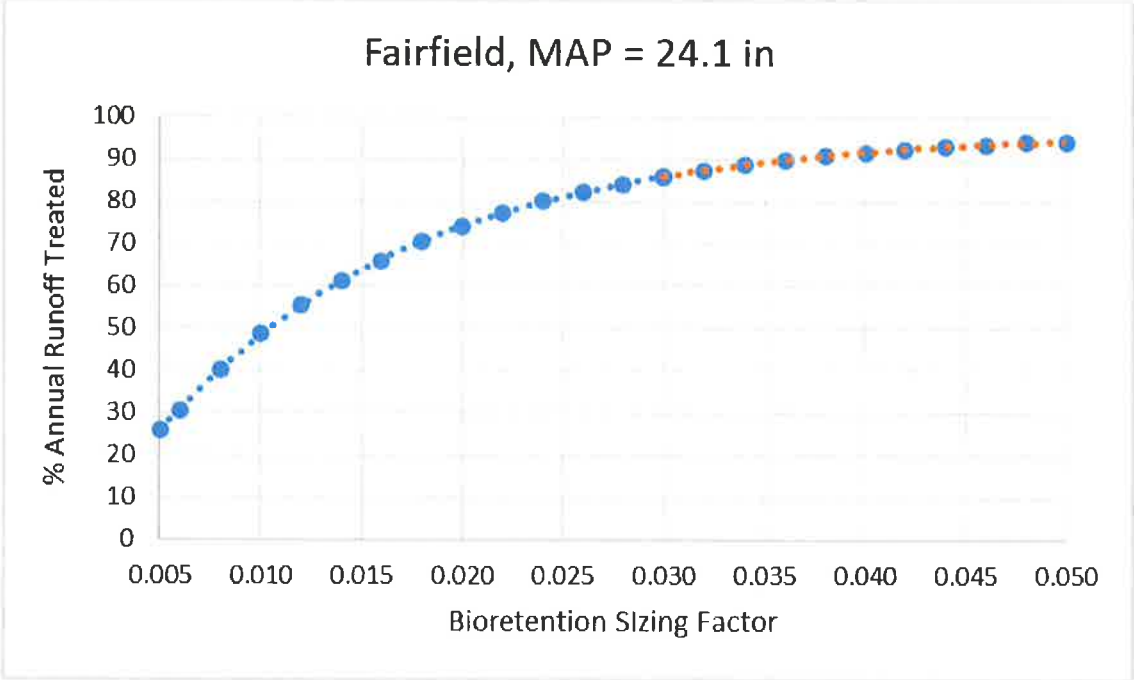


Figure 21. Annual treatment percentage for the Fairfield rain gauge

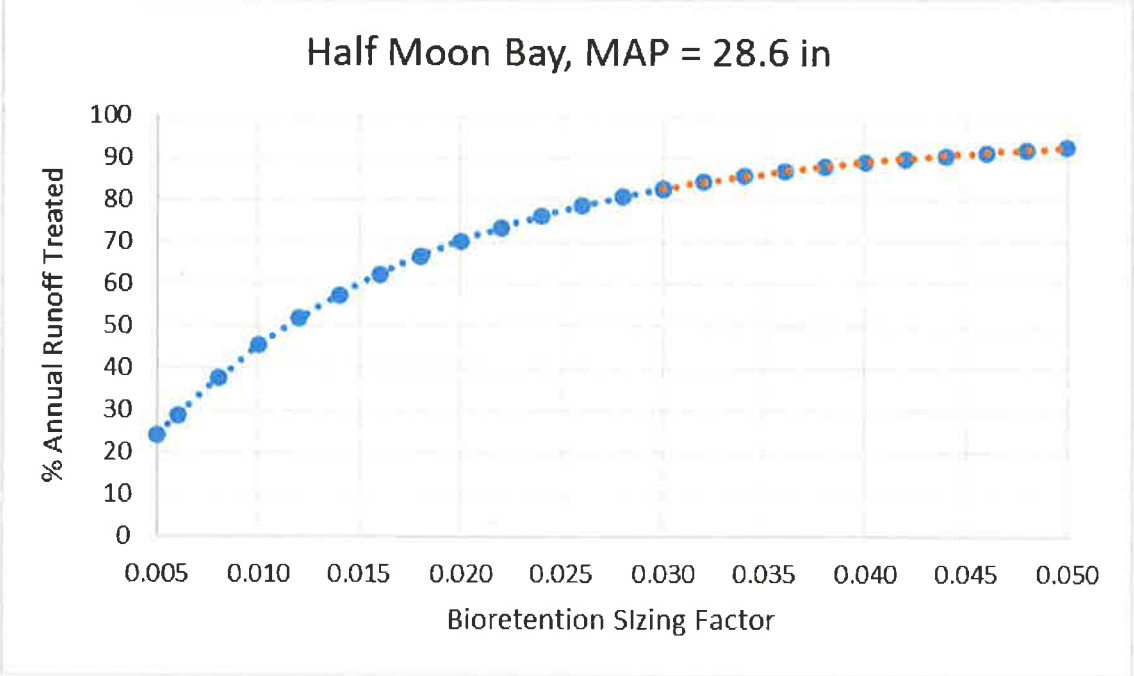


Figure 22. Annual treatment percentage for the Half Moon Bay rain gauge

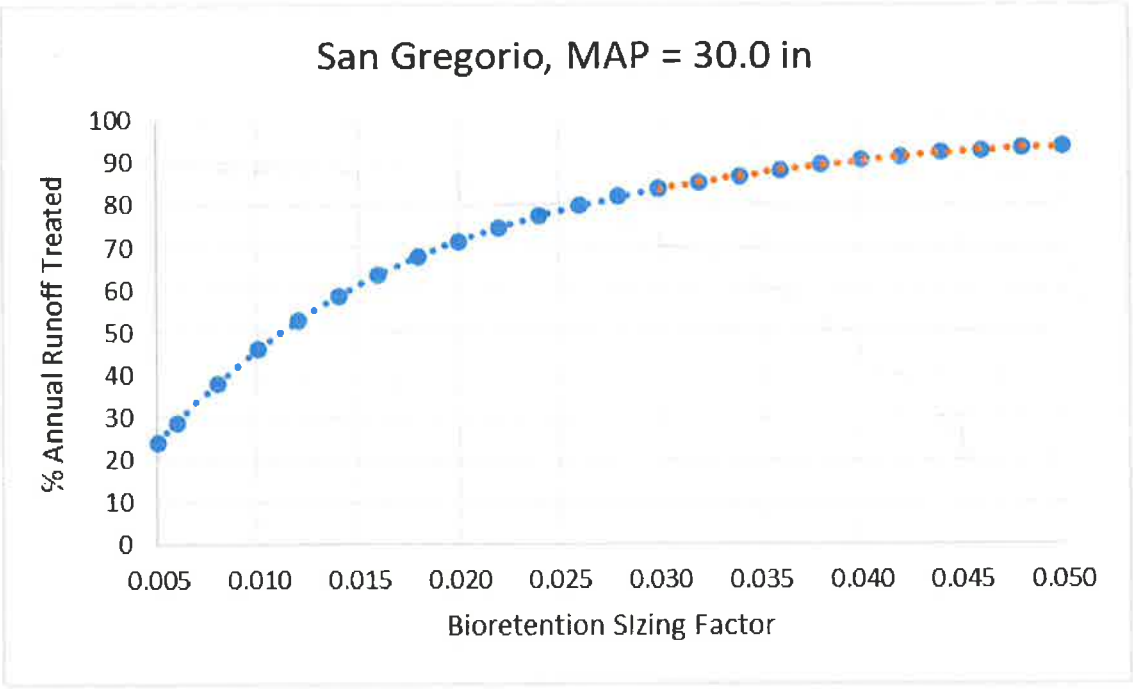


Figure 23. Annual treatment percentage for the San Gregorio rain gauge

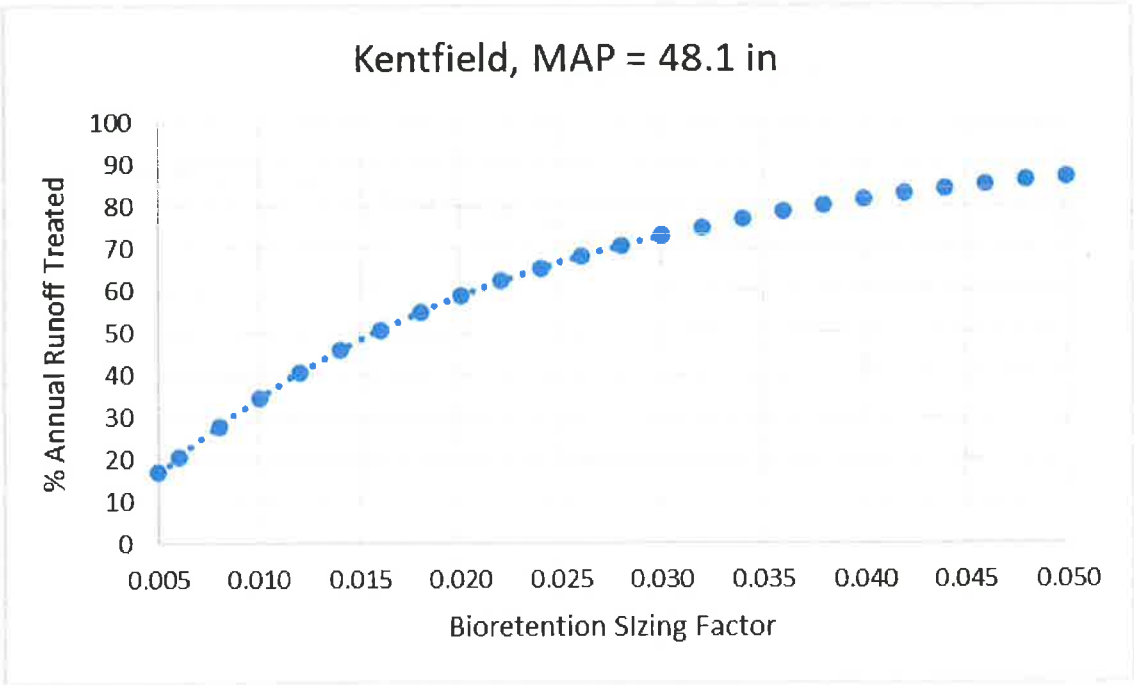


Figure 24. Annual treatment percentage for the Kentfield rain gauge

Appendix C: Bioretention with No Underdrain, 12-inch Surface Reservoir Results

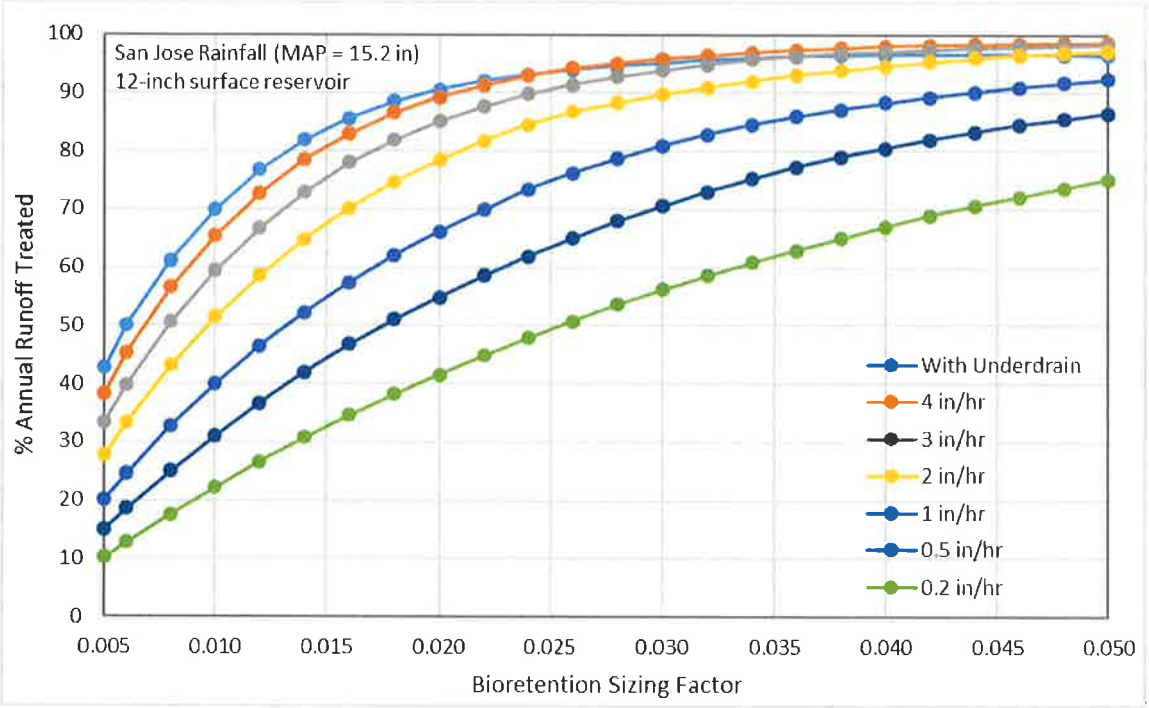


Figure 25. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)

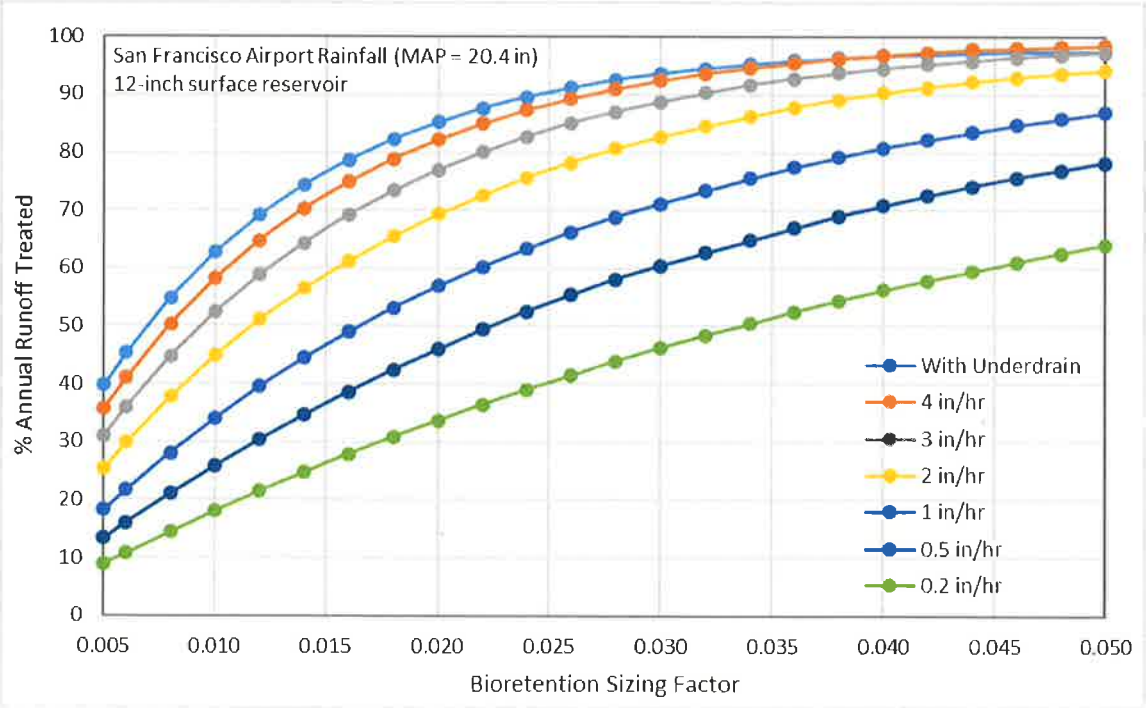


Figure 26. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)

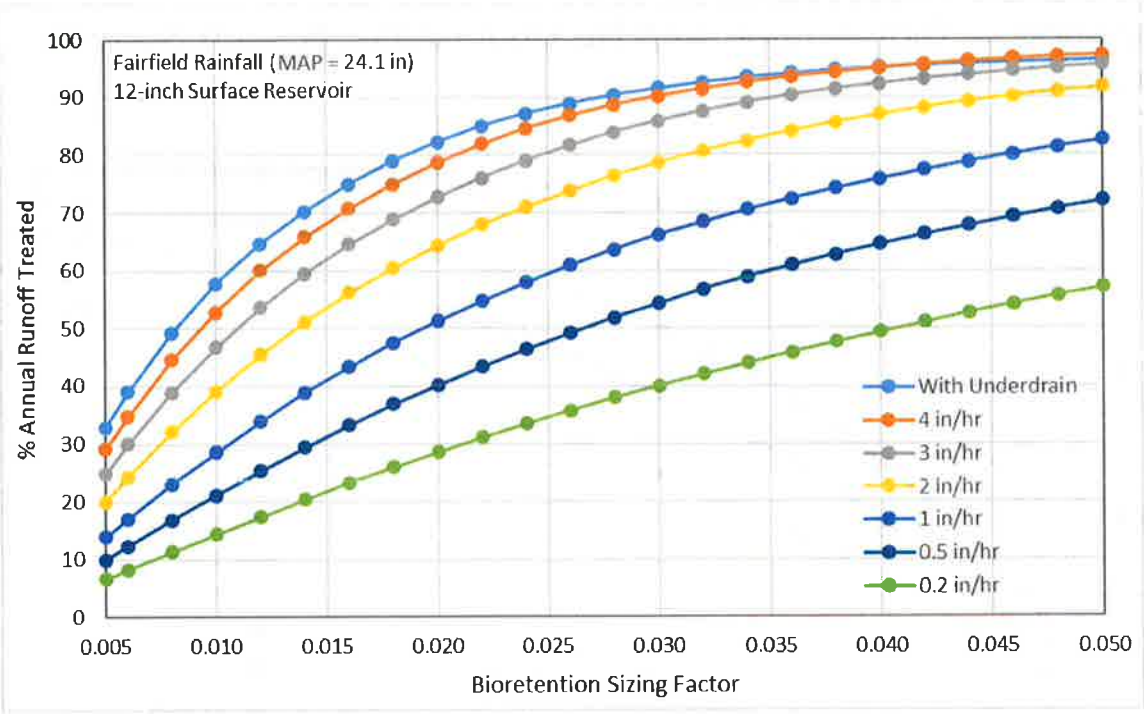


Figure 27. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)

Appendix G. Funding Matrix

Green Infrastructure Funding Matrix

July 2019

Summary Matrix Contents

	Funding Category	GI Nexus	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
Traditional Mechanisms									
7.2.1	Parcel Taxes	Can fund all or any parts of a GI program as stipulated in the ballot question and authorizing ordinance	Usually a 2/3 majority of voters (general taxes require only 50% majority, but can only go to General Fund)	* Flexible and legally stout; * Debt can be issued in most cases; * Most voters are familiar with Parcel Taxes	* Requires voter approval at the 2/3 level; * Must compete with other ballot measures	X	X	X	X
7.2.1	Other Special Taxes	* Business License Tax; * Vehicle License Fees; * Sales Tax; * Utility Users Tax; * Transit Occupancy Tax	Typically require a 2/3 voter approval	* Most are flexible in how they can be used; * 50% threshold can be used if a general tax;	* 2/3 voter approval is diffucult to attain; * Ballot measure can be expensive; * If a general tax, then GI must compete with other General Fund needs; * Must compete with other ballot questions	X	X	X	X
7.2.1	Property-Related Fees	Establishes Storm Drainage as a separate utility service and can fund all or any parts of a GI program	Prop 218 compliance; * Rigorous rate study; * Must define services and service area; * Property owners approval for non-Water, -Sewer, and -Garbage	* Flexible and legally stout; * Debt can be issued in most cases	* Ballot measure required if for a Storm Drain service - usually voted on by property owners (Not registered voters); * Ballot measure requires significant public outreach; * Public not familiar with balloted property-related fees	X	X	X	X
7.2.1	General Obligation Bonds	Can fund Capital GI Projects through debt taken on by municipality	* Voter approval at 2/3 level; * Will need Financial Advising Consultant	* Can fund capital projects or programs with debt paid back over time through property taxes; * Typically easier to pass than a parcel tax; * Taxes based on property value, so annual obligation of individual prop owner is vague	Can only be used for capital costs - Cannot be used for O&M or staff costs		X	X	

Funding Category		GI Nexus	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
7.2.1	Senate Bill 231	Allows for adoption of property-related fees without having to go to ballot	* Cost of Service Analysis * Rate Study * Prop 218 Protest Hearing	Avoids the cost and risk of a ballot measure	* Taxpayers groups vow to sue on grounds of consititution / court provisions * Governing boards will still have political pressure to not raise rates	X	X	X	X
7.2.1	Regulatory Fees	Fees and charges for performing administrative activities related to GI	Cannot exceed the actual cost of performing activies such as permit issuanc, inspections, on-site mitigation, etc.	* No voter approval is needed; * Usually included in Master Fee Schedule; * Most municipalities already have these in place	Does not pay for capital improvements or O&M	X			
7.2.1	Developer Impact Fees	Could incorporate fees for mitigating stormwater impacts to help fund GI - Would not relieve developer of NPDES requirements	Must comply with AB 1600 and include a rigorous nexus study	Could partially fund GI	* Requires a nexus study, often times by a consultant; * Nexus study must demonstrate connection between development and GI need; * Administration of funds requires resources; * AB 1600 requires 5-year window for programming funds;		X	X	
7.2.1	Re-Alignment	GI that promotes groundwater recharge, diversion to wastewater treatment, or trash capture can be incoporated into existing property-related fee structures without need for ballot measure	Prop 218 compliance for realignment to Water, Sewer or Garbage - must demonstrate applicability	* Existing non-balloted fee mechanisms can help pay for GI services; * Enhances integration of GI into other muncipal activities; * Causes other utilities to recognize the value of GI programs	* Limited to activities attributable to other funded revenue centers; * Prop 218 hawks could challenge; * Outside revenue center will need to raise rates to fund GI activity - politically unpopular; * Has not been widely used; * May be unpopular with Water, Sewer and Garbage managers; * Water or sewer may be handled by separate agencies, making realignment impossible	X	X	X	X

Funding Category		GI Nexus	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
7.2.1	Grants	One-time infusion of funds for qualifying projects from State or other granting authority	* Project concept must conform to grant requirements; * Most grants are competetive with limit funding available	* Grants are outside sources of funding that do not need to be repaid; * Readiness is a plus, so can benefit a project or program that is well developed and possibly designed; * Some State Revolving Fund loans can be converted to grants through forgiveness clauses	* Projects must be tailored to grant requirements, possibly causing scope and schedule creep; * Most grants require matching funds from other sources; * Most grants require commitment to post-project O&M, but do not fund those activities; * Little control over timing - can be difficult to coordinate with other funding sources; * Competitive nature lowers chances of obtaining grant; * Applying for grants can be time-consuming and require outside help from a grant writer; * Grant administration requires significant resources	X	X	X	???
7.2.1	Loans	Debt instruments can help accelerate project deliver while paying off debt over time	* Must have dedicated revenue stream to pay off debt; * Must have adequate credit rating to secure reasonable interest rates; * Some Bonds require voter approval	* Can leverage a modest revenue stream by borrowing money up front for rapid project delivery while paying off debt over longer periods of time; * Accelerates project delivery and makes coorination with other funding or projects easier	* Must have dedicated revenue stream to service debt; * Some debt mechanisms require voter approval (GO Bonds, Revenue Bonds, EIFD Bonds)	???	X	X	
Special Financing Districts									
7.2.2	Benefit Assessments	Can fund the construction and maintenance of GI projects	Prop 218 compliance; * Rigorous Engineer's Report; * Must deduct general benefit from special benefit; * Property owners approval is required through a ballot proceeding (weighted voting); * Works best with new development due to voting requirement	* Flexible and legally stout; * Can fund both construction and maintenance; * Can use bonded indebtedness	* General Benefit must be separated and paid for by other sources; * Votes are weighted by assessment amount, favoring large land owners		X	X	X

Funding Category		GI Nexus	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
7.2.2	Community Facilities District	Can fund the construction and maintenance of GI projects	Requires vote by majority of landowners or 2/3 majority of registered voters	* Usually formed by developer, so only one ballot is cast; * Very flexible - can fund all aspects; * Subsequent annexation is simple; * Tax rate can be tiered to allow for retirement of debt yet continue with O&M; * Annual administration is more streamline than benefit assessments	* Difficult to form in an existing community due to 2/3 majority requirement; * Known as a Mello-Roos tax - which can have a negative connotation		X	X	X
7.2.2	Business Improvement Districts	Business and property owners tax themselves to build and maintain GI improvements	Formed by a municipality through a notice and protest hearing process.	* Flexible and legally stout; * Can fund both construction and maintenance; * Local improvements can generate local support and involvement * GI improvements can also be amenities; * Can enhance sense of ownership and pride in the neighborhood when results are visible	* Cannot use debt financing; * Opposing businesses can disrupt the progress; * Can burden businesses & property owners so they are unwilling to support other funding measures		X	X	X
7.2.2	Enhanced Infrastructure Financing Districts (EIFD)	Captures property tax increment similar to redevelopment (RDA) for building and maintaining infrastructure like GI	<u>With No Debt</u>: * Establish a Public Finance Authority; * Adopt a Financing Plan; * Resolution(s) from participating agencies <u>With Debt</u>: * All of the above; * Get approval from at least 55% of voters in District	* Can fund many types of projects; * Does not require a vote (unless debt is part of the plan, then a 55% majority is required); * Can include multiple municipalities and special districts, so area can be tailored to needs (e.g. watersheds, high legacy pollutant areas, countywide); * Does not require a blight finding; * Can overlap with former RDA areas; * Works well with master planned community with a single land owner; * Planning costs can be paid for from proceeds (with limitations); * EIFD can go for up to 45 years	* Cannot be used for operations, maintenance and repairs; * Education districts are not permitted to participate, so revenues would be much less than RDA; * If overlapping a former RDA area, then cannot proceed until RDA is issued a finding of completion from the State; * GI is only a small piece of what an EIFD can do - it may take a back seat to other, larger community concerns; * Some agencies (i.e. special districts) may not agree to their portion of tax increment to be diverted thereby reducing revenue potential	???	X	X	

Funding Category		GI Nexus	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
Alternative Compliance									
7.2.3	Alternative Compliance	Allows developers who cannot meeting GI requirements on-site to build (or pay for) off-site construction of GI elements	Municipality would need to have alternative projects ready - could bedone case-by-case	* Enables higher density development in certain areas (such as TOD and PDA); * Enables GI in public spaces that private developers would not normally participate in; * Funds can be pooled to finance larger or regional projects that can be more effective; * Post-project O&M can be added in the form of a cash payment or other consideration; * Municipality can be flexible in enforcement to allow hybrid compliance;	* Ad hoc negotiation with developers can be challenging * Agency will need to have off-site or regional projects ready to bring to negotiation	X	X	X	X
7.2.3	In-Lieu Fee	Allows developers who cannot meet GI requirements to pay into fund that would finance off-site or regional projects	Municipality would need to estimate the costs of of mitigation - could bedone case-by-case	* Enables higher density development in certain areas (such as TOD and PDA); * Enables GI in public spaces that private developers would not normally participate in; * Funds can be pooled to finance larger or regional projects that can be more effective; * Municipality can be flexible in enforcement to allow hybrid compliance; * Municipality may consider informal fee process, negotiating each individual developer through COA; * Funds can be leveraged for grants or loans	* Case-by-case approach can be difficult; * Developers will try to evade costs; * May need to comply with AB 1600	X	X	X	X

Funding Category		GI Nexus	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
7.2.3	Credit Trading Programs	Creates GI Credit program for developers and others to trade GI responsibilities to others who have better capability to meet GI goals	A municipality (or regional entity) must create credit trading program including: * Definition of GI Credits; * Relative Value of Credits; * Timing of responsibilities; * Eligibility	* Allows developers who cannot meet NPDES or GI requirements to buy credits created by other entities; * Encourages developers or other entities who have greater GI capacity to over-build GI in order to sell credits in future; * Present value of future O&M costs can be incorporated into credit value; * Allows for flexibility to guide GI to areas with greater pollutant loading need; * May save developers money	* Very few Programs (to use as an example) have been implemented - particularly in California; * Credits may need to stay within same watershed; * Overbuilding GI in some areas may not help other areas; * Overbuilding GI can lead to overlapping GI zones; * Unclear if developers are willing to overbuild on speculation of future sale of credits; * Unclear how value of credits would be established; * Unclear if municipality would be credit broker, or if developers can deal directly with each other; * May be difficult to apply credits to public rights of way; * Costing future O&M is difficult		X	X	X
Partnerships									
7.2.4	Multi-Agency	Encourages partnerships with non-Stormwater agencies to explore GI co-benefits in their work	Examples may include: * Spreading basins for groundwater agencies; * GI project sites on school grounds; * GI on housing authority sites	* Can generate credits for Credit Trading Program; * Expands GI potential and awareness; * Flexible; * Can leverage limited GI funding to greater benefit	* Not cookie-cutter; requires customization; * May be diffucult to find partners	X	X	X	???
7.2.4	Transportation	Encourages partnerships with transportation agencies to explore GI co-benefits in their work and take advantage of Complete Streets or Green Streets programs	Examples may include: * Permeable pavements; * Roadside rain gardens; * Cisterns	* Most municipalities are also transportation agencies, so internal project coordination more likely; * Can generate credits for Credit Trading Program; * Expands GI potential and awareness; * Can leverage limited GI funding to greater benefit; * Recent increase in Gas Tax may make more room for GI elements	* Not cookie-cutter; requires customization; * May be diffucult to find partners; * Road condition woes prevail, making it difficult to shift funding to GI and other amenity-type elements; * Transportation grants may preclude using funds for GI	X	X	X	???

Funding Category		GI Nexus	Requirements	Pros	Cons	Staff	Planning	Capital	O&M
7.2.4	Caltrans Mitigation	Caltrans looks for opportunities for off-site mitigation of stormwater impacts of their highways	Local municipalities may enter in a cooperative agreement with Caltrans to build GI as a way for them to mitigate stormwater impacts of their highways	* Caltrans may furnish funding for local or regional projects that help them meet their obligations; * Locals can propose solutions that benefit both Caltrans and the local agencies	* Caltrans cooperative agreements can be cumbersome and bureaucratic; * Projects that work for Caltrans may be difficult to develop		X	X	???
7.2.4	Public-Private ("P3")	Private enterprises can provide overall solutions to GI programs through better access to resources and capital	P3 is primarily a deliver system for projects where debt provides near-term funding and project acceleration	* Bypasses some of the bureaucracy; * Can make existing funding sources work more efficiently; * Draws on private sector expertise and financing; * Debt may be tax-exempt; * Debt accelerates project delivery; * Can include design, build, finance, operate; * Debt is private - may not affect public ageny's debt capacity	* Does not provide additional funding; * Dedicated revenue stream is needed - cash flow is an important element		X	X	X
7.2.4	Financial Capability Assessment	Can allow an agency to delay compliance with certain NPDES permit requirements	Follow EPA guidelines for application	Allows a qualifying agency to defer compliance with certain Permit compliance requirements	* Not a source funding - only can grant time extenstions to Permit compliance; * Communities must meet several criteria such as poverty rates, income distibutions, bond ratings, etc.				
7.2.4	Not-for-Profit & Volunteers	Volunteer groups can be a resource for GI operations and maintenance (O&M) as well as program planning	* To be effictive, volunteers need organization and oversight; * Can be used to supplement paid contractors, or perform entire projects	* "Free" labor; * Some volunteers provide needed expertise; * Increases awareness of GI program; * Some non-profit organizations have ready-made volunteer groups that are trained and organized; * Can build public support for dedicated revenue mechanism such as a fee; * Education program for community	* Requires significant staff resources to recruit, organize, train and plan & supervise the work; * Can be unreliable - hard to build schedule and cost forecasts around volunteer work force; * Can create conflict with prevailing wage requirements; * Difficult to incorporate into project construction work		X	???	X