NEWARK
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Green Stormwater Infrastructure Plan

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List of Acronyms

Acronym	Definition
ACCWP	Alameda Countywide Clean Water Program
AGOL	ArcGIS Online
BAHM	Bay Area Hydrology Model
BASMAA	Bay Area Stormwater Management Agencies Association
DMA	Drainage management area

G(S)I	Green (stormwater) infrastructure
LID	Low impact development
MRP	Municipal Regional Stormwater Permit
HM	Hydromodification management
RWQCB	Regional Water Quality Control Board
PCBs	Polychlorinated biphenyls
TMDL	Total maximum daily load

1. Introduction

1.1 Statement of Purpose

The purpose of the Green Stormwater Infrastructure Plan (GSI Plan) is to guide the identification, implementation, tracking, and reporting of green infrastructure projects within the City of Newark in accordance with the Municipal Regional Stormwater Permit (MRP), Order No. R2-2015-0049, adopted by the San Francisco Bay Regional Water Quality Control Board on November 15, 2015. "Green stormwater infrastructure" or "green infrastructure" in this context refers to sustainable systems of constructed softscape features that slow runoff by dispersing it to vegetated areas. Additional benefits to water resource management of GSI include promoting infiltration and evapotranspiration, utilizing bioretention and other low impact development practices to harvest and clean stormwater runoff.

1.2 Physical Setting

Located in southern Alameda County and the southeastern end of the San Francisco Bay, the City of Newark comprises portions of three different watersheds – the Newark Slough, Plummer Creek, and Mowry Slough Watersheds. The three watersheds have tributaries that originate in the neighboring cities of Fremont and Union City, flow through the City of Newark, and eventually terminate in the San Francisco Bay. In total, the combined three watersheds comprise 20.3 square miles of watershed area and 28.5 miles of open, natural and engineered, channels (Figures 1 and 2). The Newark Slough Watershed drains 4.9 square miles of urban flatlands near the Dumbarton Bridge in Newark and part of Fremont into the Newark Slough via a system of underground culverts and engineered channels. The slough winds its way through a system of salt pond levees to San Francisco Bay. The 2.6-square-mile Plummer Creek Watershed shares Newark Slough Watershed's southern border and, similarly, drains a small area of the urban flatlands of Newark and Fremont. The watershed is primarily drained by Line F-1, an engineered channel built to carry storm runoff to Plummer Creek. Located in Newark and Fremont, the 12.8-acre Mowry Slough Watershed drains through culverts and engineered channels from the base of the East Bay hills to a system of stormwater treatment wetlands called Tule Ponds at Tyson Lagoon and through the gently sloping urban plain toward South San Francisco Bay (Source: Alameda County Flood Control and Water Conservation District). Nearly 15 miles of this drainage runs through aboveground engineered channels. The channels drain to Mowry Slough, which winds around Cargill Salt's crystallizer ponds across the bay marsh plain. San Francisco Bay's most productive harbor seal rookery is located on the banks of Mowry Slough. Development in the City of Newark is predominantly urban, with intentions for rapid development and redevelopment in both private and public fronts (Figure 3).

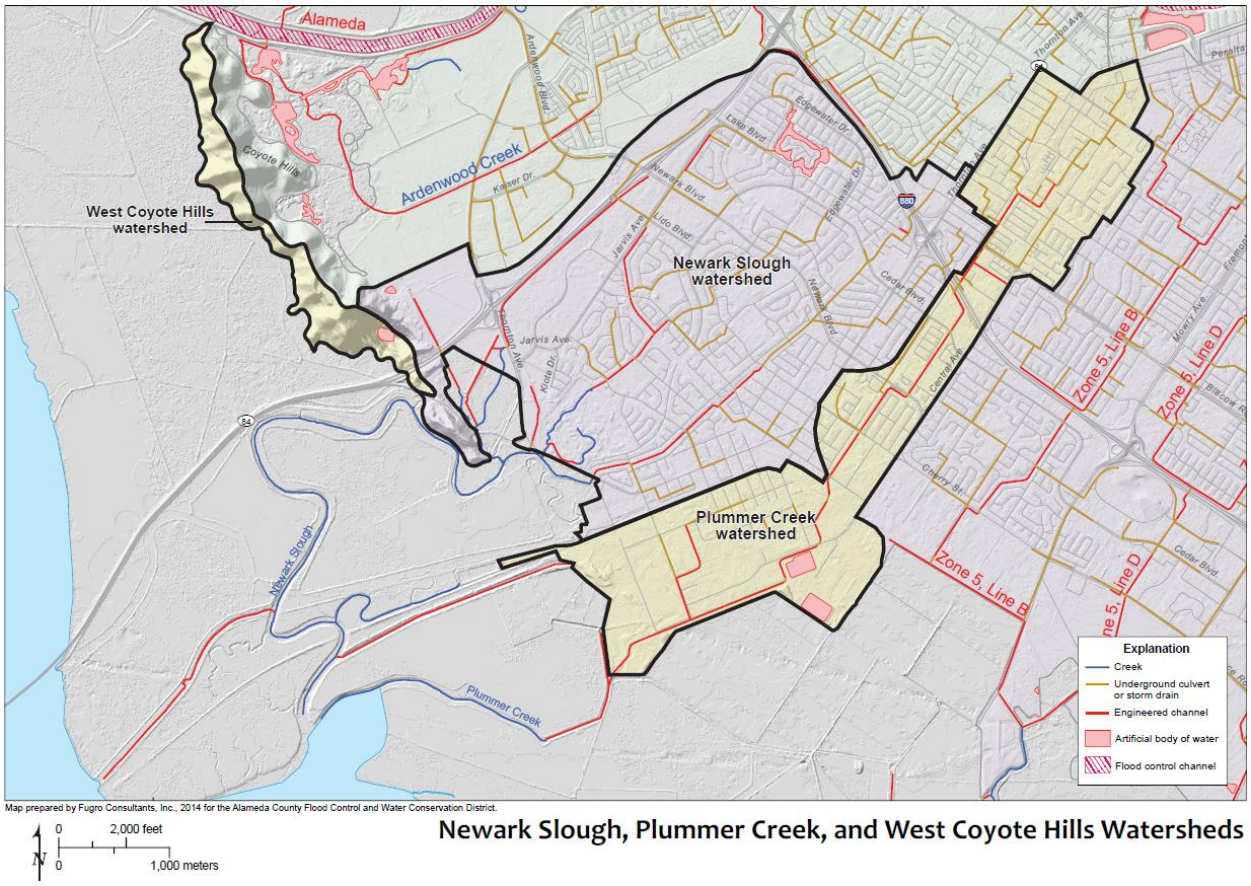


Figure 1. The Newark Slough Watershed drains the flatlands of Newark and Fremont via a system of underground storm drains and engineered channels into Newark Slough and San Francisco Bay. The Plummer Creek Watershed drains the urban flatlands into Plummer Creek and the South San Francisco Bay. Courtesy of the Alameda County Flood Control and Water Conservation District.

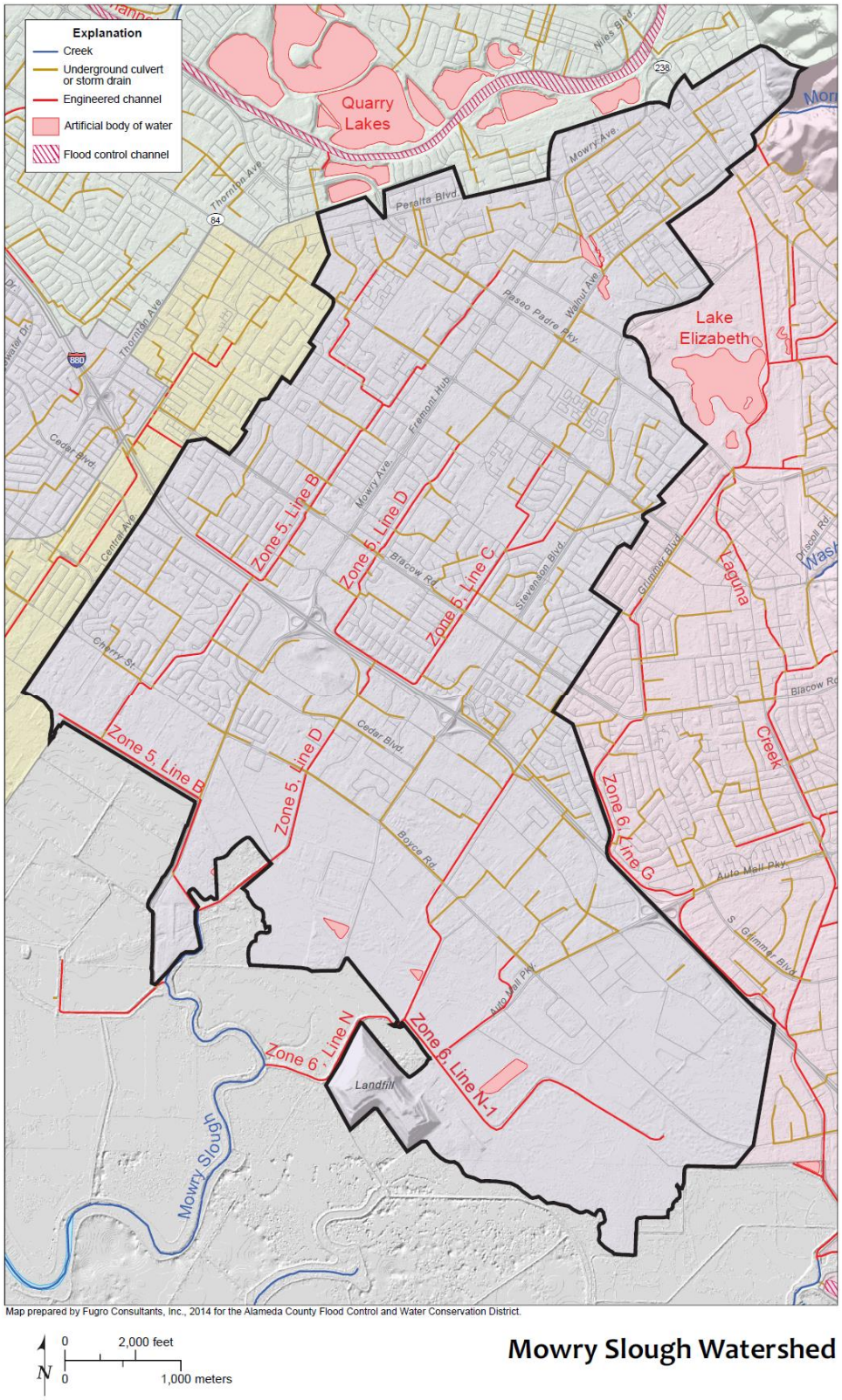


Figure 2. The Mowry Slough watershed flows from the northeast edge of Fremont to Mowry Slough and southern San Francisco Bay. Courtesy of the Alameda County Flood Control and Water Conservation District.

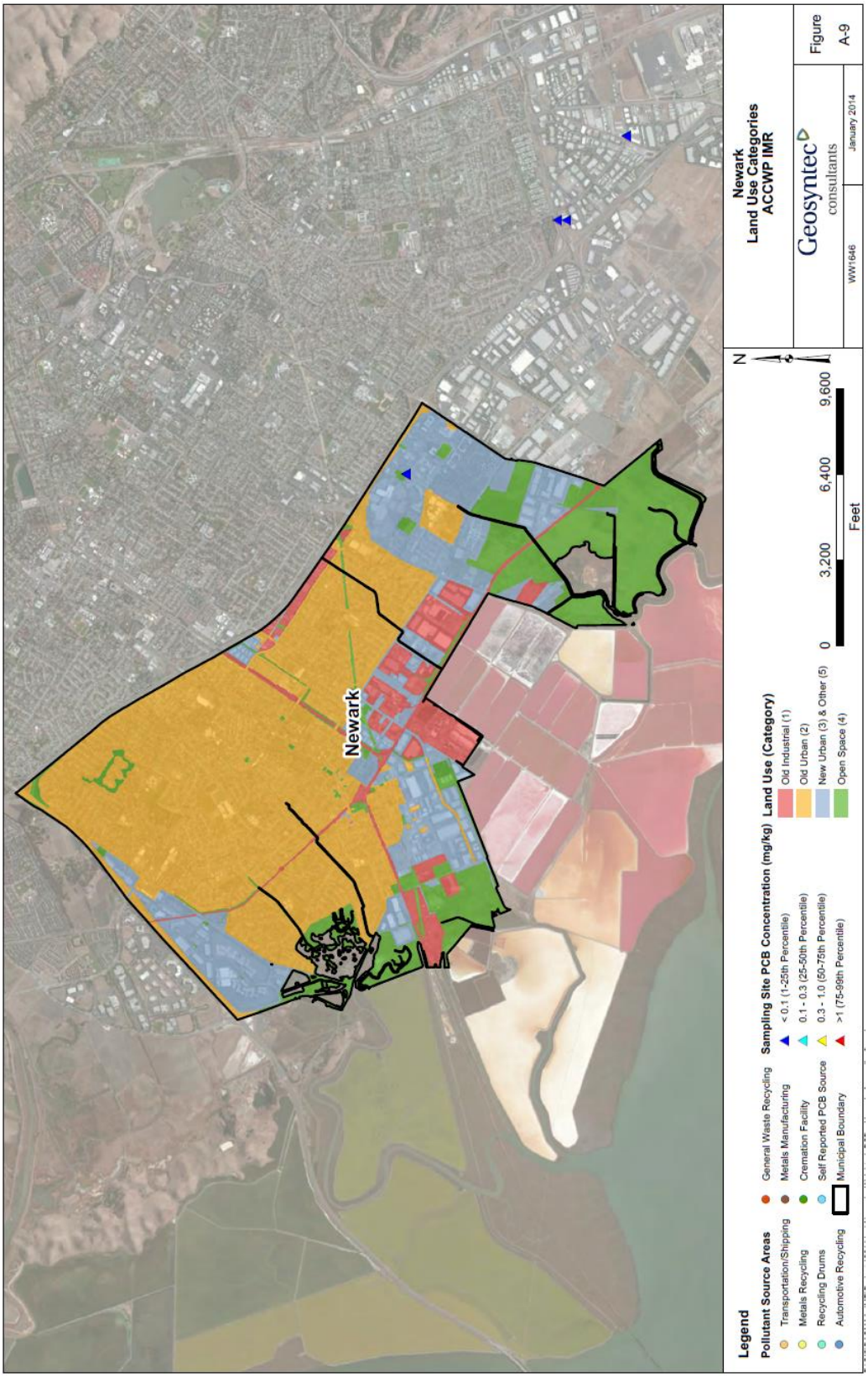


Figure 3. City of Newark Land Use map, courtesy of Geosyntec Consultants, Inc.

1.3 Green Stormwater Infrastructure and Stormwater Measures

The availability of all water resources is driven by the hydrologic cycle – the cycle by which water transitions on, above, and below the surface of the earth. Of total global water reserves, 2.5% is in freshwater form. Further, of the total freshwater supply, only 1.2% is accessible through surface water. Harvesting and utilizing this limited, yet vital, resource is a major initiative for GSI implementation. When land is developed, pervious areas, such as native soil fields, are converted into impervious surfaces. Areas such as pavement, concrete, or other impacted soils may prevent stormwater infiltration from replenishing groundwater systems. The construction of impervious roads, sidewalks, parking lots, and other structures increases the amount of runoff contributed by an area (Figure 4). Increased surface runoff yields increased flow velocity and pollutant transport during storm events, impacting stream hydrology patterns and watershed quality.

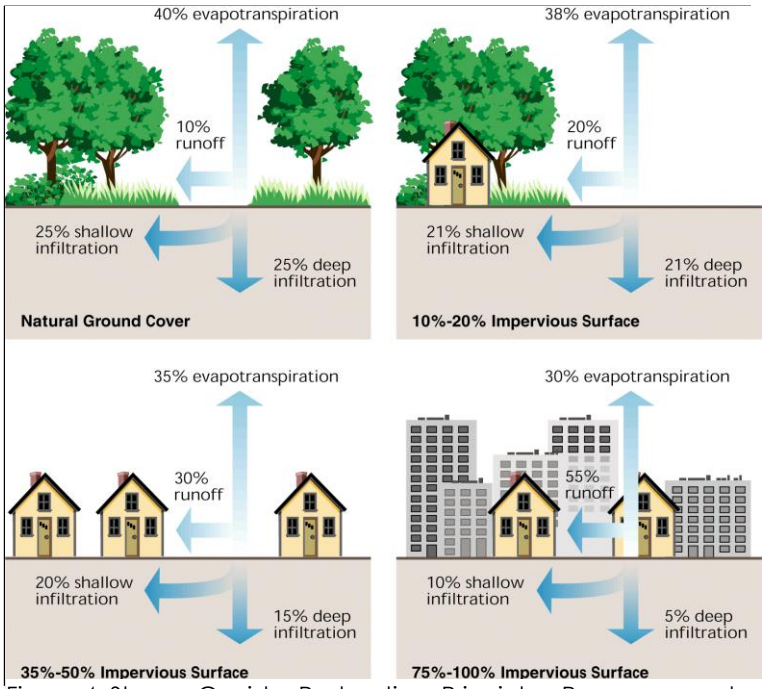


Figure 4. Stream Corridor Restoration: Principles, Processes, and Practices, 10/98, by the Federal Interagency Stream Restoration Working Group (FISRWG).

Green stormwater infrastructure (GSI) is designed to improve stormwater runoff quality prior to discharging it to local creeks and San Francisco Bay. GSI is engineered or man-made infrastructure that is based on natural processes to manage stormwater runoff. In addition to reducing pollutants transported to creeks and San Francisco Bay, GSI systems provide a variety of other benefits. The retention and infiltration of stormwater can reduce localized flooding, reduce flows that may cause erosion in creek channels, decrease downstream flows to mitigate impacts of sea level rise, and recharge groundwater aquifers. Examples of GSI include bioretention areas, flow-through planters, trees and nonproprietary tree-well filters, and pervious/permeable pavement. These methods of GSI may be implemented at different scales

throughout the City of Newark:

- **Green streets:** A green street is designed to redirect roadway runoff from typical gray infrastructure, such as storm drain pipes, to green stormwater infrastructure. The street may be designed such that stormwater runoff flows into vegetated areas or infiltrates into the ground through permeable pavement.
- **Parcel-based project:** Parcel-based projects mitigate stormwater impacts by reducing stormwater runoff through capture and reuse and/or by infiltrating and treating stormwater on-site before it enters the storm drain system. Bioretention areas constructed in parcel-based projects typically capture stormwater runoff from parking lots, rooftops, and other impervious surfaces generated on the parcel itself. It is also possible to design a parcel-based GSI facility such that it collects and treats stormwater runoff from impervious surfaces immediately adjacent to the parcel (e.g. stormwater runoff from the adjacent roadway).
- **Regional project:** Regional projects are large-scale stormwater capture and treatment facilities that are intended to collect and treat runoff from a large drainage area. These projects are often the most cost-effective due to multiple benefits achieved and economies of scale.

When evaluating and planning for Green Stormwater Infrastructure projects within the City of Newark, a variety of GSI methods may be considered and applicable for projects of overall varying scale. Project types for potential and planned GSI implementation are discussed further in Section 2 of this Plan.

1.4 MRP Requirements

This Green Infrastructure Plan has been developed to comply with Green Infrastructure Plan requirements in Provision C.3.j of the MRP, which states in part:

> The Plan is intended to serve as an implementation guide and reporting tool during this and subsequent Permit terms to provide reasonable assurance that urban runoff TMDL wasteload allocations (e.g., for the San Francisco Bay mercury and PCBs TMDLs) will be met, and to set goals for reducing, over the long term, the adverse water quality impacts of urbanization and urban runoff on receiving waters. For this Permit term, the Plan is being required, in part, as an alternative to expanding the definition of Regulated Projects prescribed in Provision C.3.b to include all new and redevelopment projects that create or replace 5,000 square feet or more of impervious surface areas and road projects that just replace existing imperious surface area. It also provides a mechanism to establish and implement alternative or in-lieu compliance options for Regulated Projects and to account for and justify Special Projects in accordance with Provision C.3.e.

Over the long term, the 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.

The Plan shall also identify means and methods to prioritize particular areas and projects within each Permittee's jurisdiction, at appropriate geographic and time scales, for implementation of green infrastructure projects. Further, it shall include means and methods to track the area within each Permittee's jurisdiction that is treated by green infrastructure controls and the amount of directly connected impervious area. As appropriate, it shall incorporate plans required elsewhere within this Permit, and specifically plans required for the monitoring of and to ensure appropriate reductions in trash, PCBs, mercury, and other pollutants.

Table 1-1 below links each section of this plan to the applicable MRP provision.

Table 1-1: Green Infrastructure Plan Sections and Applicable MRP Provisions

Section of Green Infrastructure Plan	**Applicable MRP Provision**
1. Introduction	C.3.j
2. Prioritizing and Mapping Planned and Potential Projects	C.3.j.i.(2)(a) – (c), and C.3.j.i.(2)(j)
2.1 Approach for Prioritizing and Mapping Projects	C.3.j.i.(2)(a)
2.2 Summary of Prioritized Projects	C.3.j.i.(2)(b)
2.3 Impervious Surface Retrofit Targets	C.3.j.i.(2)(c)
2.4 Prioritized Projects for Alternative Compliance Program or Early Implementation	C.3.j.i.(2)(j)
3. Tracking and Mapping Completed Projects	C.3.j.i.(2)(d) & C.3.d.iv.(1)
4. Summary of General Guidelines for GI Projects	C.3.j.i.(2)(e), C.3.j.i.(2)(f), C.3.j.i.(2)(g)
5. Relationship to Other Planning Documents	C.3.j.i.(2)(h) & (i)
6. Evaluation of Funding Options	C.3.j.i.(2)(k)
Appendix A. Maps of Prioritized Projects	C.3.j.i.(2)(b)
Appendix B. Workplan for Completing Prioritized Projects	C.3.j.i.(2)(j)
Appendix C. General Guidelines for GI Projects	C.3.j.i.(2)(e), C.3.j.i.(2)(f), C.3.j.i.(2)(g)
Appendix D. Evaluation of Funding Options	C.3.j.i.(2)(i)

2. Prioritizing and Mapping Planned and Potential Projects

Section 2 describes the use of a mechanism for prioritizing and mapping GI projects as required in Provision C.3.j.i.(2)(a), provides a summary description of lists of prioritized GI projects and other outputs of the mechanism per Provision C.3.j.i.(2)(b), presents targets for areas of impervious surface to be retrofitted as required in Provision C.3.j.i.(2)(c), and discusses prioritized projects for alternative compliance or early implementation.

2.1 Approach for Prioritizing and Mapping Projects (GI Mechanism)

This section describes the Alameda Countywide Green Infrastructure Mechanism ("GI Mechanism") used to prioritize and map areas for planned and potential green infrastructure projects. The mechanism consists of the Alameda Countywide Multi-Benefit Metrics Prioritization Protocol ("prioritization protocol") interface and the Alameda County/Contra Costa Project Tracking and Load Reduction Accounting Tool ArcGIS Online web application ("AGOL tool"). To date, the mechanism has been used to prioritize and map public projects for implementation by 2020, by 2030, and by 2040, as described below. It also includes capabilities to prioritize and map private projects, where appropriate.

As described below, the mechanism includes criteria for prioritization, such as specific logistical constraints, water quality drivers (load reductions of mercury and PCBs consistent with TMDLs), and opportunities to treat runoff from private parcels in street right-of-way (ROW). It also produces outputs, including maps and project lists, which can be incorporated into the City of Newark's long-term planning and capital improvement processes. Outputs of the mechanism are included in Appendix A, Maps of Prioritized Projects.

Prioritization of Areas for Planned and Potential Projects

An overview of all potential projects, and those included on the City of Newark's Short List of High Priority Projects, included in Appendix A, are outputs of the GI mechanism. The prioritization protocol that produced these outputs is a stepwise GIS analysis documented in the Alameda Countywide Stormwater Resource Plan Screening and Prioritization using Multi-Benefit Metrics Technical Memorandum[1] and summarized below.

Step 1. Identify planned projects – Planned future green infrastructure projects within Alameda County were identified and entered into a GIS layer, based on project information provided by local agencies within the county.

Step 2. Identify opportunity sites – Additional potential project locations were identified and catalogued by the Alameda Countywide Clean Water Program consultant

[1] Geosyntec. 2017. Alameda Countywide Stormwater Resource Plan Screening and Prioritization using Multi-Benefit Metrics Technical Memorandum. December 13.

Geosyntec using a GIS-based opportunity analysis. The project opportunity analysis followed the steps listed below:

a. Identify publicly-owned parcels.
b. Screen identified public parcels to include only those that are at least 0.1 acre in size and with an average slope of less than 10 percent. Parcels that met these criteria were screened for physical feasibility.
c. Identify non-interstate highway public right-of-way (ROW) within urban areas. Roadways considered included state and county highways and connecting roads and local, neighborhood, and rural roads.
d. Identify land uses or adjacent land uses of the sites resulting from steps b and c.
e. Screen sites identified in steps b and c to remove sites with the following physical constraints:
    i. Regional facilities were not considered for sites that were greater than 500 feet from a storm drain due to limited feasibility in treating runoff from a larger drainage area;
    ii. Parcel-based facilities were not considered for sites that were more than 50% undeveloped due to the limited potential for pollutant reduction of concern load reduction;
    iii. Sites with more than 50% of their drainage area outside of the urbanized area, as these sites would not provide opportunity for significant pollutant of concern load reduction;
    iv. Sites with more than 50% overlying landslide hazard zones to avoid the potential for increasing landslide risk.

Step 3. Classify planned projects and opportunity sites in preparation for metrics-based evaluation – A GIS analysis was performed to classify the planned projects identified in step 1 and the opportunity sites identified in step 2 according to four parameters listed below:

a. Green infrastructure project type – Each project received one of the following classifications: parcel-based, regional, or ROW/green street project.
b. Infiltration feasibility - Each project location received one of the following classifications for infiltration: infeasible, partially feasible, or feasible.
c. Facility type – Each project received one of the following classifications: green infrastructure[2], non-green infrastructure treatment control facility, water supply augmentation, flood control facility, hydromodification control, public use area or public education area, programmatic stormwater management opportunity.
d. Drainage area information – A drainage area was identified for each project.

[2] All opportunity sites identified in step 2 were classified as GI projects. Based on information provided by local agencies in step 1, other classifications were assigned, where appropriate, to planned projects. Projects that were not classified as GI have co-benefits that may include GI.

Step 4. Score projects using an automated metrics-based evaluation – A quantitative metrics-based multiple benefit evaluation was performed using an automated process. Projects or opportunity sites received a score of 0, 1, or 2 for each of the 12 metrics listed below. The automated scores were used to preliminarily rank the projects by watershed, jurisdiction, project type, and/or project stakeholder(s). Geosyntec provided a jurisdiction-specific list of planned projects and opportunity sites located in Newark, including an automated score for each project. Spatial data for the projects included in the list were provided in both GIS shape file and Google Earth KMZ file formats.

a. Parcel area (for regional and parcel-based projects only)
b. Location slope
c. Infiltration feasibility
d. PCBs/mercury yield classification in project drainage area
e. Regional facility
f. Removes pollutant loads from stormwater
g. Augments water supply
h. Provides flood control benefits
i. Re-establishes natural water drainage systems
j. Develops, restores, or enhances habitat and open space
k. Provides enhanced or created recreational and public use areas with potential opportunities for community involvement and education
l. Trash capture co-benefit

Step 5. Rank the projects based on local considerations – The City of Newark reviewed the jurisdiction-specific list of planned projects and opportunity sites provided in step 4 as part of preparing the Master List of Prioritized Planned and Potential Projects ("Master List") included in Appendix A, Maps of Prioritized Projects. The City of Newark prepared the Master List, which provides a final ranking and prioritizing of planned and potential projects, based on the automated scores derived in step 4 and the additional considerations listed below. Additional considerations may be applicable and incorporated when evaluating potential projects. These considerations include, but may not be limited to:

a. Cost Considerations:
    i. Capital costs
    ii. Maintenance costs
    iii. Funding sources
b. Opportunity Considerations:
    i. Opportunities to treat runoff from private parcels in retrofitted street ROW
    ii. Synergies with upcoming transportation and other CIP projects
    iii. ROW projects on pedestrian or bicycle priority streets
c. Load Reduction Potential:
    i. Load reduction potential for PCBs and mercury
d. Labor/Staff Considerations:
    i. Ease of construction/installation

    ii. Complexity and/or frequency of operations and maintenance
e. Multiple Benefits:
    i. Consideration of achieving multiple benefits
    ii. Potential for aesthetic, community, or other benefits not previously identified
f. Safety and Security Considerations:
    i. Potential to cause a safety hazard and/or measures needed to avoid creating a safety hazard
    ii. Potential for vandalism
g. Implementation Considerations:
    i. Potential for implementation challenges due to site constraints or community opposition
    ii. Existing project concepts with strong community support

Mapping of Planned and Potential Projects

The map of planned and potential projects included in Appendix A, Maps of Prioritized Projects, are outputs of the GI mechanism. Spatial data provided to The City of Newark as part of the prioritization protocol was entered into the AGOL tool to produce these maps. Because the AGOL tool is also used for tracking and reporting on both the initial approval and ongoing operation and maintenance inspections of Provision C.3 Regulated Projects, it provides a complete life-cycle approach for mapping planned and potential GI projects, as well as features related to completed projects described in Section 3, Tracking and Mapping Completed GI Projects.

2.2 Summary of Prioritized Projects (Outputs of the GI Mechanism)

This section provides summary information regarding the outputs of the GI Mechanism included in Appendix A, which are listed below:

- Prioritization Criteria
- Master List of Prioritized Planned and Potential Projects
- Short List of High Priority Projects
- Maps of Planned and Potential Projects

Prioritization Criteria

The prioritization criteria incorporated in the GI Mechanism are presented in Appendix A. These criteria are applied in the automated metrics evaluation described in step 4 of the prioritization protocol described in Section 2.1, Approach for Prioritizing and Mapping Projects (GI Mechanism).

Master List of Prioritized Planned and Potential Projects

The Master List of Prioritized Planned and Potential Projects ("Master List"), included in Appendix A, is an output of Step 5 of the prioritization protocol described in Section 2.1, Approach for Prioritizing and Mapping Projects (GI Mechanism).

Five planned and potential projects are included in the Master List, which presents the following information regarding each project

- Project name (if any)
- Project stakeholder(s) (if any)
- Project type (the classification assigned in preparation for metric-based evaluation)
- Jurisdiction in which the planned or potential project is located
- Assessor's parcel number (if any)
- Property owner (if the information is available)
- Whether the property is in public or private ownership
- Street name (if available)
- Individual score for each metric in the metric-based evaluation

The Master List includes the following additional information, which was developed by the City of Newark, after considering the topics listed in Step 5 of the Approach for Prioritizing and Mapping Projects.

- Rank assigned to the project
- Reasoning for the rank assigned to the project

Short List of High Priority Projects

The Short List of High Priority Projects ("Short List"), depicted in Appendix A, includes top-ranked projects as evaluated in conjunction with the Prioritization Mechanism detailed previously in this section. The Short List includes information regarding each high priority project, as needed to evaluate projects for potential inclusion in the City of Newark's capital improvement projects list and to identify potential funding options. Summary information is provided below for three projects included in the Short List of High Priority Projects:

- **Lindsay Tract** is an anticipated public streets greening project, encompassing the public right-of-way of George Avenue and portions of Mulberry, Olive, and Magnolia Streets. This section of the City of Newark is one of the oldest residential developments in the City, constructed before drainage factors and flood control measures were taken into consideration. This is a high priority project for the immediate benefit to our residents as well as to retrofit the street sections immediately adjacent to Thornton Avenue, a major thoroughfare for the City. (Figure 5)
- The **Historic Newark District Streetscape Project** encompasses a section of Thornton Avenue, between Olive Street and Ash Street. As a major thoroughfare for the City of Newark, Thornton Avenue receives heavy traffic through this commercial mixed use portion of the City. This project was ranked as a high priority project, based on multifaceted benefits to the community in conjunction with the positive environmental impact associated with this high-traffic area. Incorporation of community amenities, such as bike lanes and increased dedication for pedestrians provide opportunities to incorporate green stormwater infrastructure facilities. (Figure 6)

- The **Cedar Boulevard Linear Park** will be located along the undeveloped portion of Cedar Boulevard, between its terminus south of the Union Pacific Rail Road tracks and Bridgepointe Drive. This project was ranked as a high priority project, due to its community benefits and availability of the currently under-enhanced section of Cedar Blvd. (Figure 7ab)

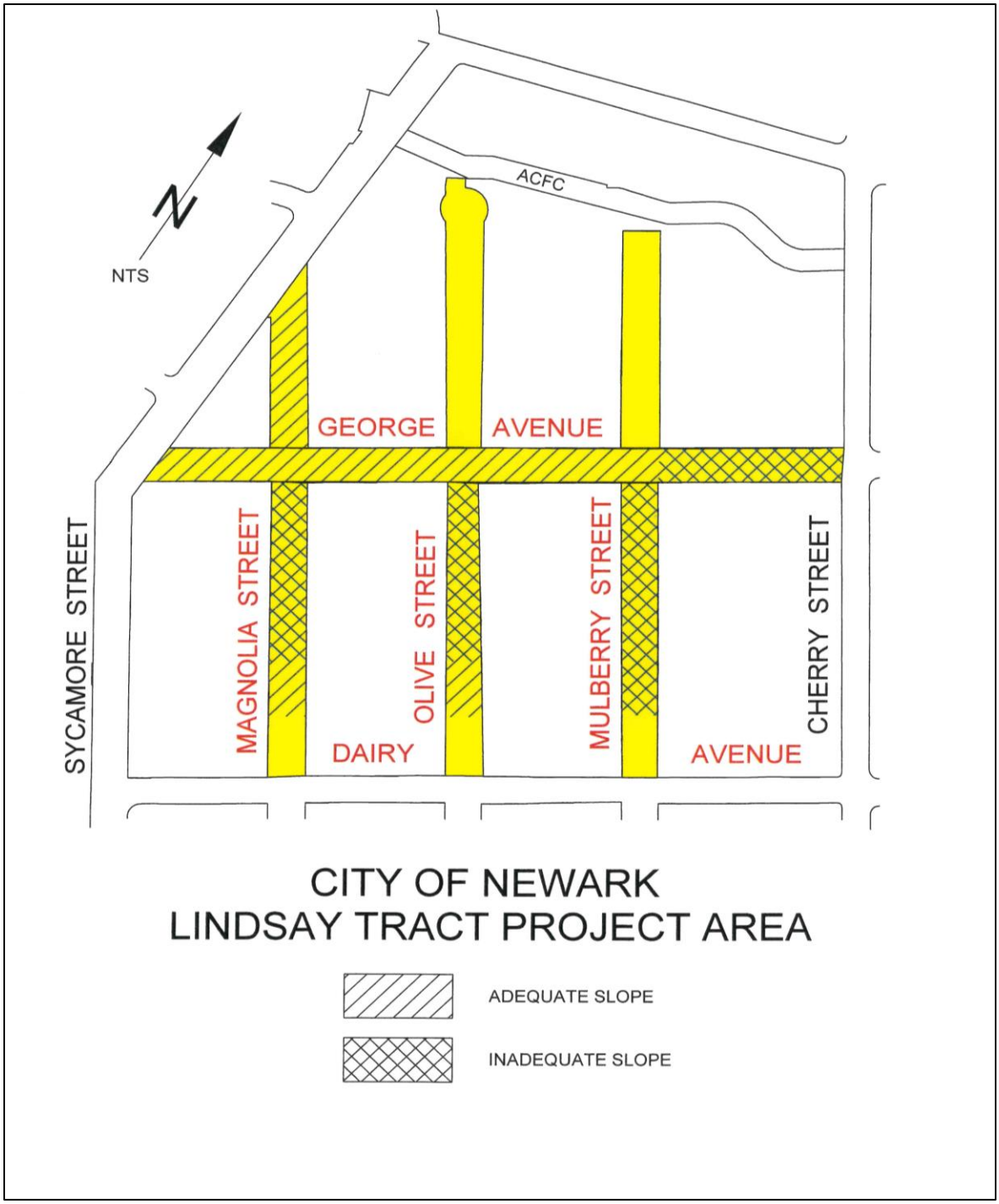
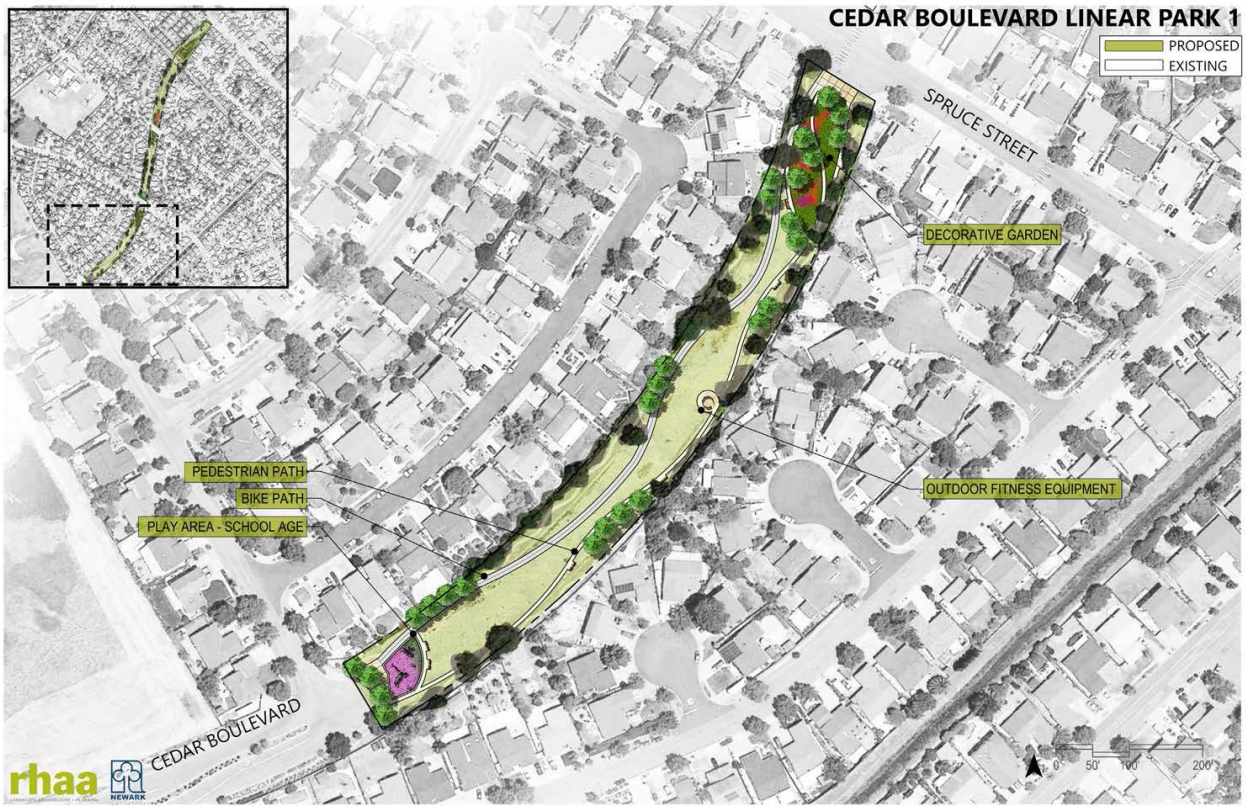


Figure 5. Schematic project limits for the Lindsay Tract project and overview for drainage improvements.

Figure 6. Representation of existing condition (above) at the intersection of Thornton Avenue and Olive Street, proposed entrance to the Historic Newark District Streetscape project. Representation of potential improvements (below) incorporate pedestrian amenities and greening benefits proposed.



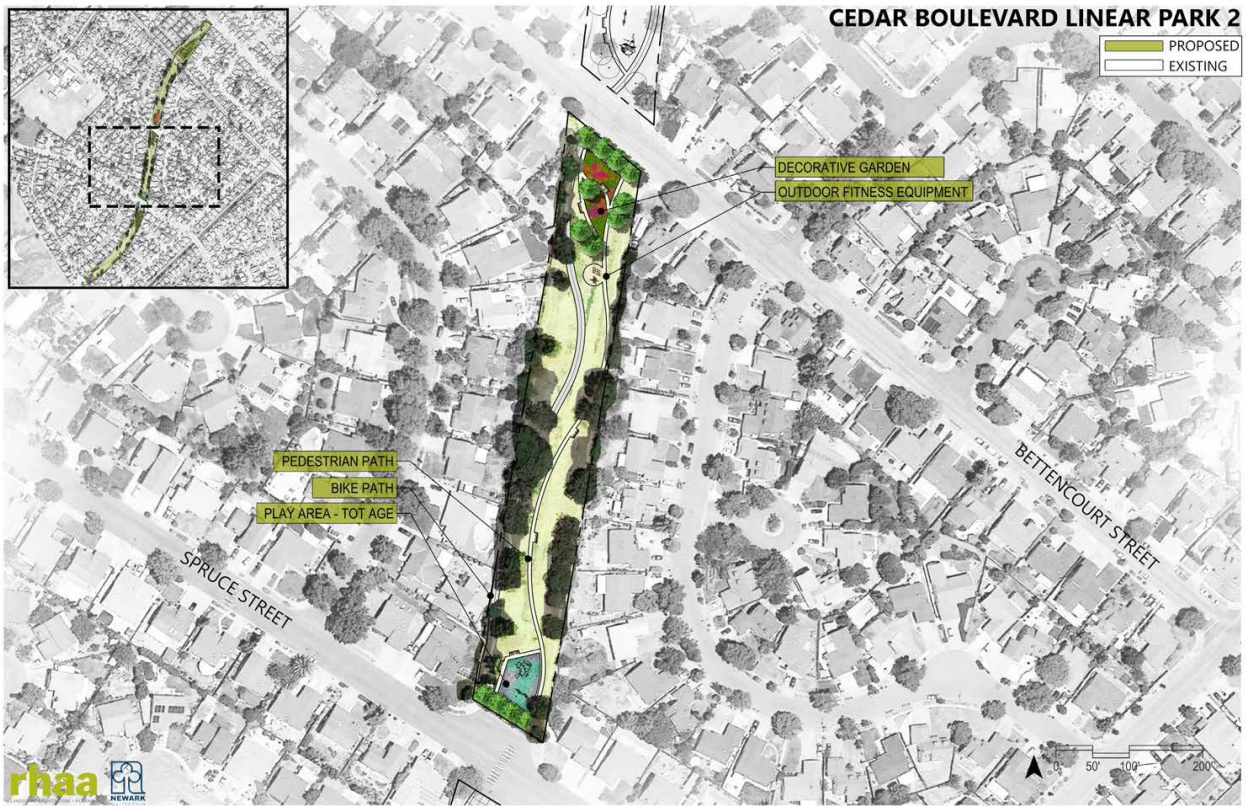
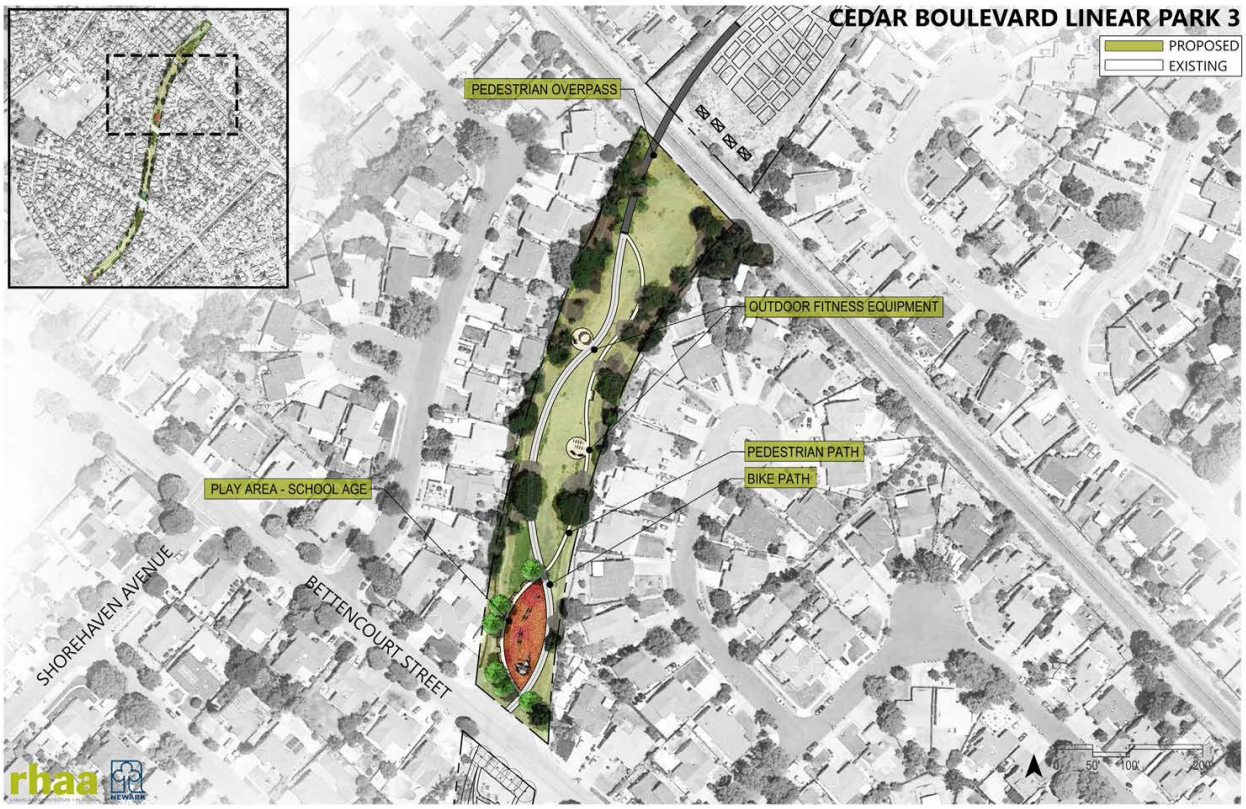


Figure 7a. Views of proposed layout for the Cedar Boulevard Linear Park, revitalizing approximately 9.25 acres of unimproved Cedar Boulevard into usable public space.



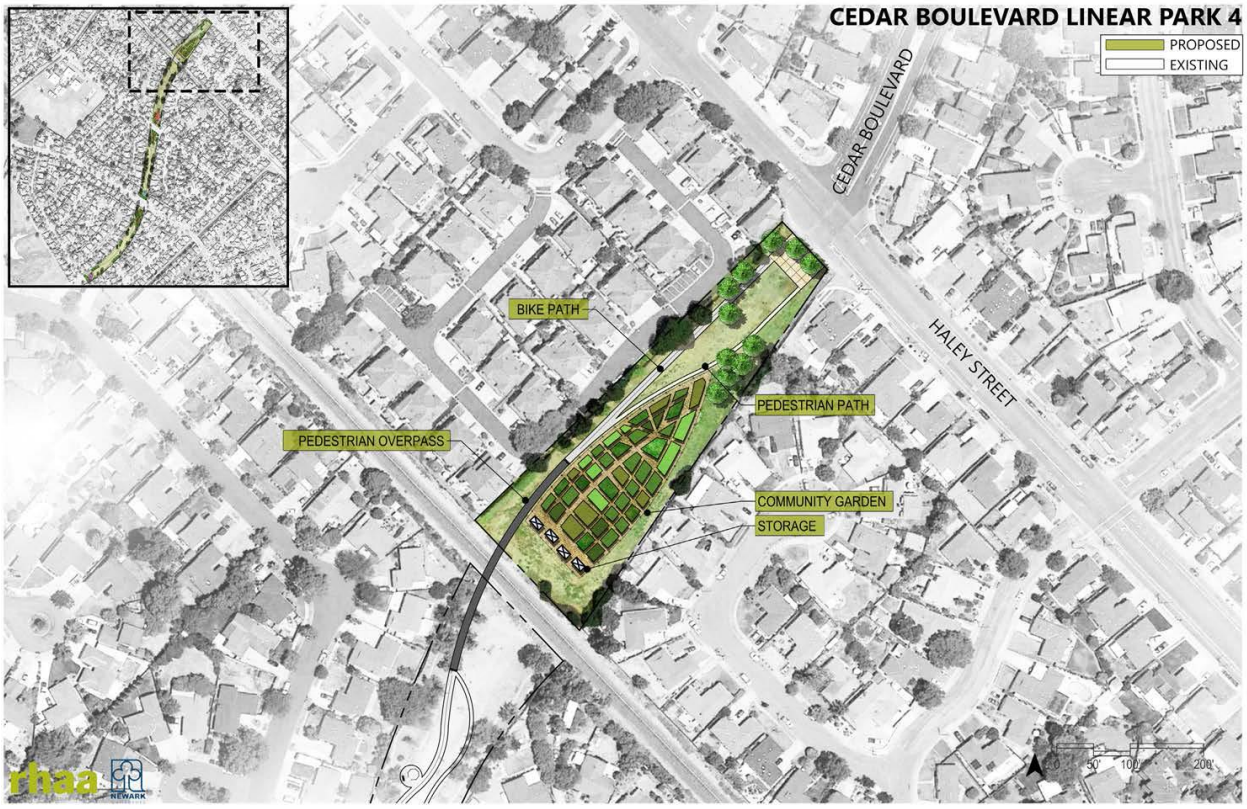


Figure 7b. Views of proposed layout for the Cedar Boulevard Linear Park, revitalizing approximately 9.25 acres of unimproved Cedar Boulevard into usable public space.

Maps of Planned and Potential Projects

The maps included in Appendix A, show the locations of the potential green stormwater infrastructure projects listed on the Short List of High Priority Projects as well as other prioritized green infrastructure projects. Maps of planned and potential projects may be updated, as needed, to provide necessary information relative to the identification of funding options and consideration for potential inclusion in the City of Newark's capital improvement projects list.

2.3 Impervious Surface Retrofit Targets

The City of Newark has identified targets for the amount of impervious surface, from public and private projects within its jurisdiction (including redevelopment projects regulated under Provision C.3.b of the MRP), to be retrofitted by 2020, 2030, and 2040. The targets are presented in Table 2-1. The time schedules shown in this table are consistent with the timeframes for assessing load reductions for mercury and PCBs specified in Provisions C.11 and C.12 of the MRP. The City of Newark is currently participating in a regional effort to perform a Reasonable Assurance Analysis that demonstrates how green infrastructure will be implemented to achieve PCB and mercury load reductions. To the extent that the implementation of this Green Infrastructure Plan may support load reductions for mercury and PCBs, as outputs from the Regional Assurance Analysis become available, The City of Newark may consider modifying the targets presented in Table 2-1. Due to uncertainties related to the funding of public green infrastructure projects and the reliability of projections for private development projects, The City of Newark will track the progress toward achieving the targets presented in Table 2-1, identify any challenges that arise in achieving these targets, and propose solutions, in coordination with other MRP Permittees.

Table 2-2: Target Amounts of Existing Impervious Surface to be Retrofitted by 2020, 2030 and 2040

Future Year	Approximate Target Amount of Existing Impervious Surface to be Retrofitted for Stormwater Treatment with GSI (acres)
2020	170
2030	225
2040	265

Notes:

1. Amounts shown in the table represent areas of impervious surface existing within The City of Newark as of July 1, 2002, that are anticipated to be retrofitted by the target years as a result of both public and private projects.
2. Projections of existing impervious surface to be retrofitted are based on anticipated results of actions described in Section 2.4, Prioritized Projects for Alternative Compliance Program or Early Implementation; local knowledge of planned future development; anticipated availability of funding; and future development scenarios generated with the Bay Area UrbanSim model used by the Metropolitan Transportation Commission.

2.4 Prioritized Projects for Early Implementation

The City of Newark has identified prioritized projects as part of Early Implementation in accordance with MRP Provision C.3.j.iii. Provision C.3.j.iii. states, in part, that, "Each permittee shall: 1. Prepare and maintain a list of green infrastructure projects…that are already planned for

implementation during the permit term that have potential for green infrastructure measures." Further, Provision C.3.j.iii. details that each permittee shall evaluate public projects for green infrastructure potential and with the goal of incorporating green infrastructure to the maximum extent practicable. As part of this early implementation evaluation process, collectively known as "No Missed Opportunities," the City of Newark has identified the following two projects for early implementation as planned during the current permit term:

- Lindsay Tract: This street greening project was evaluated for grading and drainage improvement sbefore the current permit term. The project was included in the 2018-2020 Capital Improvement Plan as a funded project. Planning for implementation began in early 2019.
- The Historic Newark District Streetscape Project: Planning for implementation has spanned multiple planning phases with the most recent phase commencing in early 2019.

Additional details regarding the above-listed projects is provided in Appendix B, Workplan for Completing Prioritized Projects.

3. Tracking and Mapping Completed GI Projects

The process for tracking and mapping completed GI projects, both public and private, and making the information publicly available, as required by Provision C.3.j.i.(2)(d), is described below. This process was developed by the ACCWP, which participated in regional coordination with BASMAA, to comply with the requirement in Provision C.3.j.iv.(1) that "Permittees shall, individually or collectively, develop and implement regionally-consistent methods to track and report implementation of green infrastructure measures including treated area and connected and disconnected impervious area on both public and private parcels within their jurisdictions."

3.1 Project Tracking and Load Reduction Accounting Tool

As a member agency of the ACCWP, the City of Newark uses an ArcGIS online (AGOL) web application-based tool, the C3 Project Tracking and Load Reduction Accounting Tool ("AGOL Tool"), which ACCWP developed in cooperation with the Contra Costa Clean Water Program to assist its member agencies in meeting the requirements described above. Detailed information and instructions on the tool can be found in the C3 Project Tracking and Load Reduction Accounting Tool Guidance Document (ACCWP 2017).

The general process for entering GI projects into the AGOL Tool involves logging in to the ArcGIS online web application, opening the tool, and entering data. There are two methods for entering data, but, in general both involve: locating the project area, drawing the project boundary, entering project attributes, drawing the stormwater treatment facility(ies), and entering facility attributes. Project attributes include fields such as jurisdiction, location description, type of project, project name, and additional optional fields that can be populated if the information is known. Facility attributes include hydraulic sizing criterion, project ID, facility type, treatment, and percent of project area treated by the facility.

The City of Newark has incorporated the use of the AGOL Tool into its processes for reviewing, approving and reporting C.3 Regulated Projects and non-C.3 Regulated projects that include green infrastructure – encompassing both public and private projects. The tool includes a feature for generating tables of C.3 Regulated Projects and GI projects that include MRP-required project data for annual reporting purposes.

3.2 Making Information Publicly Available

As required by the MRP, the process for tracking and mapping completed projects (public and private) includes making the information generated by the tool publicly available. Information from the tool will be made publicly available as follows.

- On an annual basis, include in the Annual Report for the City of Newark's Stormwater Program information from the tool in the form of (1) a list of GI projects (public and private) that are planned for implementation during the permit term as required in Provision C.3.j.ii, and (2) a list of Regulated Projects approved during the fiscal year reporting period as required in MRP Provision C.3.b.iv.

- Coordinate with ACCWP to develop a viewable version of the AGOL tool, which is anticipated to be embedded on ACCWP's public website and may also be accessible via the City of Newark's website.

4. Summary of General Guidelines for GI Projects

General Guidelines are presented in Appendix C to guide the City in designing a project that has a unified, complete design that implements the range of functions associated with GI projects, and in providing for appropriate coordination of projects and project elements. The General Guidelines include hydraulic sizing guidance and typical designs for GI projects. Additional information about the General Guidelines is summarized below.

4.1 Implementing Projects with a Unified, Complete Design

The General Guidelines presented in Appendix C focus on designing and coordinating projects that implement a range of functions appropriate to the type of project. For example, the guidelines for designing street projects address a range of functions including pedestrian travel; use as public space, for bicycle, transit, and vehicle movement; and locations for urban forestry. The guidelines for coordination identify measures for implementation during construction to minimize conflicts that may impact green infrastructure.

4.2 Hydraulic Sizing Requirements

Provision C.3.j.i.(2)(g) of the MRP states that GI projects are required to meet the treatment and hydromodification management (HM) sizing requirements included in Provisions C.3.c and C.3.d of the MRP. However, an exception to this requirement is provided in Provision C.3.j.i.(2)(g) for street projects that are not Regulated Projects under Provision C.3.b ("non-Regulated Projects").

The General Guidelines in Appendix C provide hydraulic sizing guidance for GI projects, addressing the hydraulic sizing criteria in MRP Provisions C.3.c and C.3.d, as well as the alternate sizing approach for constrained street projects developed by the Bay Area Stormwater Management Agencies Association. These guidelines do not address Regulated Projects as defined in Provision C.3.b of the MRP.

Please note that some non-Regulated Projects are required to implement site design measures in accordance with Provision C.3.i of the MRP. Appendix L of the C.3 Technical Guidance explains how to determine whether Provision C.3.i applies to your project, and how to incorporate applicable site design measures, if required. Appendix L has been included as Attachment C-8 as part of Appendix C.

Table 4-1 presents a summary of where to find hydraulic sizing guidance, and other applicable guidance, for different types of projects.

Table 4-1: Where to Find Hydraulic Sizing Guidance and Other Guidance - by Project Type

Type of Project	Where to Find Guidance	
	Provision C.3.i or HM Guidance, if Applicable	**Hydraulic Sizing Guidance**
Non-Regulated Green Infrastructure Project (public or private project) that is NOT subject to Provision C.3.i[3]	Not applicable	Appendix C – General Guidelines for GI Projects
Non-Regulated Green Infrastructure Project (public or private project) that IS subject to Provision C.3.i	ACCWP C.3 Technical Guidance (Appendix L, Site Design Requirements for Small Projects)	
Regulated Project that is NOT a Hydromodification Management (HM) Project[4]	Not applicable	ACCWP C.3 Technical Guidance (Section 5.1, Hydraulic Sizing Criteria)
Regulated Project that IS an HM Project	ACCWP C.3 Technical Guidance (Chapter 7, Hydromodification Management Measures)	

4.3 Typical Designs

Appendix C of this GI Plan includes typical design drawings for GI projects, which address various types of land-use, transportation, and site characteristics. GI projects may also utilize design guidance provided in Chapter 6 of the C.3 Technical Guidance manual (ACCWP 2017b) for other types of low impact development storm water treatment facilities, subject to municipal staff approval.

[3] MRP Provision C.3.i applies to projects that create and/or replace at least 2,500 but less than 10,000 square feet of impervious surface; and Individual single family home projects that create and/or replace 2,500 square feet or more of impervious surface.

[4] An HM Project is a Regulated Project that creates and/or replaces one acre or more of impervious surface, will increase impervious surface over pre-project conditions, and is located in a susceptible area, as shown on the ACCWP default susceptibility map.

5. GI Requirements in Other Planning Documents

In compliance with Provision C.3.j.i.(2)(h), the City of Newark has updated planning documents that may affect the future alignment, configuration, or design of impervious surfaces within the Permittee's jurisdiction, including, but not limited to, streets, alleys, parking lots, sidewalks, plazas, roofs, and drainage infrastructure. The updated documents are listed and summarized below.

- City of Newark 5-Year Strategic Plan; Biennial Budget 2018-2020
- City of Newark Pedestrian and Bicycle Master Plan
- City of Newark Clean Bay Blueprint
- City of Newark Stormwater Requirements Checklist

The above-listed planning documents were updated to include an overview and definition of green infrastructure; a discussion of various types of opportunities for potentially incorporating green infrastructure in public and private development and redevelopment projects; requirements to consider incorporating green infrastructure in projects that are not Regulated Projects under Provision C.3.b of the MRP; and a discussion of how the Green Infrastructure Plan will guide the identification, implementation, tracking, and reporting of green infrastructure projects.

5.1 Anticipated Updates of Additional Planning Documents

The City of Newark has identified additional planning documents as being in need of updates to incorporate GI requirements, as listed in Table 5-1. Updates to these planning documents have not yet been made for the reasons identified in the table.

Table 5-1: Planning Documents to Be Updated to Include GI Requirements

Name of Planning Document	Reason for Deferral of Document Update
City of Newark General Plan	The City of Newark General Plan is scheduled to open in 2022 for element updates.
Historic Newark District Specific Plan	The specific plan for the Historic Newark District Streetscape Project is currently under development and expected to be completed in 2020.

6. Evaluation of Funding Options

Provision C.3.j.i.(2)(k) of the reissued Municipal Regional Stormwater Permit (MRP 2) requires the Green Infrastructure (GI) Plans prepared in compliance with Provision C.3.j to include "[a]n 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 document has been prepared to meet this requirement. In view of the potential need to shift some existing funds to green infrastructure activities, some funding options are considered that may be appropriate for aspects of the Stormwater Program other than green infrastructure. The implementation of such options may potentially allow the use of some existing funds for green infrastructure activities.

6.1 Identification of Options and Evaluation Criteria

The options for funding GI planning and implementation activities, discussed in Section 3, were identified based primarily on previous stormwater funding studies conducted by Hilton Farnkopf & Hobson, LLC for the Clean Water Program (ACCWP 2002) and the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP 2008), as well as a funding study conducted for the City of Berkeley by MWH (City of Berkeley 2016). Independent research by City of Newark staff of grant opportunities remains an ongoing process as grant funds become available via different regional, State, or other agencies.

The following criteria were used to evaluate the identified funding options.

- **Ballot approval** – This criterion considers whether approval by voters is needed to implement the funding option.
- **Reliability** – Considers the extent to which the funding option, once implemented, could be relied upon in the future.
- **Cost to implement** – Considers the resources needed to implement the funding option.
- **Obstacles** – Considers barriers to implementing the funding option.

The following funding options are considered: existing resources, in-lieu fees (single jurisdiction or multi-jurisdictional), wastewater fees, refuse collection (solid waste) fees, water fees, regulatory fees and fees for service, development impact fees and capital contributions, stormwater fee, taxes and assessments, and grants. For each funding option, an evaluation is provided, based on the criteria described in this section. A selection of the listed funding options is described in the following sections. Further options are discussed in Appendix D.

6.2 In-Lieu Fees (Single Jurisdictional)

Provision C.3.e.i.(2) of MRP 2 allows development projects that are Regulated Projects under Provision C.3.b to meet the C.3 requirements for stormwater treatment by paying an in-lieu fee to a Regional Project that achieves a net environmental benefit, in addition to treating a portion of the runoff from the project onsite. Additionally, MRP 2 requires that the Regional Project be completed within three years after the end of construction of the Regulated Project, with an

extension of up to five years, with prior approval of the Executive Officer of the Regional Water Quality Control Board. In this option, the agency would implement an in-lieu fee as a single jurisdiction.

- **Ballot approval** -- In-lieu fees are not classified as a tax or special assessment, and therefore do not require voter approval to be enacted.
- **Reliability** – Amount of funding would fluctuate, due to the linkage to development projects.
- **Cost to implement** – Costs include initiating the planning phase of a regional project in preparation to receive contributions, setting up administrative procedures to manage the contributions, and carrying the Regional Project through to completion per the required timeframe.
- **Obstacles**
    - Predicting sufficient level of contributions to warrant start-up costs.
    - Ensuring sufficient level of contributions to complete one or more regional projects.
- **Example of Implementation** City of Portland, Oregon – Portland allows projects, under special circumstances, to pay a fee in lieu of constructing on-site stormwater management facilities. The fee is based on an average unit cost of onsite facilities where such facilities would be effective, and allows for the establishment of the calculation method and fee by rule (City of Portland 2016b). Section 1.5 of Portland's Stormwater Management Manual (Portland, Oregon 2016a) describes the collection of the stormwater offsite management fee, which is placed in a mitigation account to be used to mitigate the impacts of offsite discharge of stormwater runoff. The Bureau of Environmental Services determines whether all or a portion of the stormwater management obligations of a project may be fulfilled by paying an offsite management fee, based on information provided by the applicant. The current fee is listed with the current fiscal year's Sewer and Drainage Rates and Charges.

6.3 In-Lieu Fees (Multi-Jurisdictional)

This option is based on Provision C.3.e.i.(2) of MRP 2 and is similar to the In-Lieu Fee (Single Jurisdiction) option, except that the agency would not be solely responsible for the in-lieu program. Instead, the agency would participate in a multi-jurisdictional program, which could be managed by one of the participating jurisdictions, or by another entity. Provision C.3.e.i.(2) does not require Regional Projects to be located in the same watershed as the Regulated Project, which would allow for the implementation of an in-lieu fee program on a multi-jurisdictional basis, potentially including the entire county, or San Francisco Bay region. Provision C.3.e.i.(2) of MRP 2 allows development projects that are Regulated Projects under Provision C.3.b to meet the C.3 requirements for stormwater treatment by paying an in-lieu fee to a Regional Project that achieves a net environmental benefit, in addition to treating a portion of the runoff from the project onsite. See Section 6.2, In-Lieu Fees (Single Jurisdiction) for a discussion of the required timeframe for completion of Regional Projects.

- **Ballot approval** -- In-lieu fees are not classified as a tax or special assessment, and therefore do not require voter approval to be enacted.
- **Reliability** – Amount of funding would fluctuate, due to the linkage to development projects.
- **Cost to implement** – Costs would be shared across the participating jurisdictions, including the up-front costs of planning and implementing Regional Projects, the ongoing administrative costs to operate the program, and financial exposure with regard to the need to complete projects within required time frames for all contributing Regulated Projects.
- **Obstacles** – While the agency could potentially influence the development of a multi-jurisdictional in-lieu fee option, the viability of this option would be dependent upon decisions and actions by others, including the establishment of agreements and cost-sharing approaches with other jurisdictions or another entity that may be identified to manage the program.
- **Example of Implementation** The Construction Industry Coalition on Water Quality prepared a framework for the development of a model alternative compliance program that would apply to various locations covered by municipal stormwater permits in the San Diego region, Orange County, Riverside County, and San Bernardino County. The framework consists of four key elements: (1) analysis of legal/regulatory issues, (2) analysis of institutional framework considerations, (3) integrate an analysis of project opportunities with a benefit-cost analysis, and (4) conduct case study and pilot project to test the programmatic and decision selection framework (Grey 2014).

6.4 Wastewater Fees

The use of revenue from wastewater fees to fund stormwater programs does not require voter or property owner approval, but it must be in compliance with Proposition 218's majority-protest public hearing process. The amount of funding must be clearly related to the benefits received by wastewater rate payers. The basis for transferring revenue from sanitary sewer service charges to stormwater programs is the benefit that is accrued to sanitary sewer customers by flood control and drainage maintenance projects that reduce the inflow or infiltration (I&I) of stormwater into sanitary sewers (SMCWPPP 2008, City of Berkeley 2016). In the context of sanitary sewer systems, infiltration means stormwater or groundwater that seeps into the sewer system through cracks and other vulnerable locations in the pipes and joints; inflow is the introduction of stormwater into the sanitary sewer system via specific storm connections, either deliberate or inadvertent (USEPA 2014). Inputs of I&I into sanitary sewers produces much higher than average flows at wastewater treatment facilities during wet weather episodes. Wastewater facilities must be designed to temporarily store wet weather flows so that they can be treated and safely discharged.

In order to use revenue from wastewater fees to implement GI plans, the agency would need to identify the I&I reduction that is anticipated to result from the construction and maintenance of projects included in its GI plan. The manner in which applicable costs for stormwater capital and maintenance projects can be incorporated into the sewer rate structure should maintain proportionality, which has presumably been established already in the sewer rate design if it

conforms to industry rate-making practices. Sanitary sewage flow contributions, numbers of accounts, equivalent dwelling units, or strength factors are all common in sewer rate structures that distribute stormwater costs equitably (SMCWPPP 2008).

- **Ballot approval** -- Wastewater fees do not require voter or property owner approval to be enacted.
- **Reliability** – Amount of funding would be relatively steady, once established.
- **Cost to implement** – Costs to implement this option would include the analysis of GI projects to quantify I&I reduction benefits and develop the required documentation to incorporate into the wastewater fee structure.
- **Obstacles** –Estimating the I&I reductions that would result from activities proposed in the GI plan, and establishing a clear nexus between the fee and the costs incurred, and the proportionality to the user.
- **Examples of Implementation:**
    - City of Oakland funds part of its stormwater program from revenue from sewer service charges, capped at 5% of the sewer revenue requirements. This funding mechanism pre-dates Proposition 218 (SMCWPPP 2008).
    - City of Belmont has provided funding from sewer service charges to its stormwater program since 2000. The Sewer Fund provides funding for 55% of the stormwater program budget based on those activities in the stormwater program – both O&M and capital improvements – that reduce I&I. The transfer from the Sewer Fund to the Stormwater Program represents 10% of the Sewer Fund's budget (SMCWPPP 2008).
    - City of Petaluma included its stormwater program within the Sewer Fund in 2002 because the stormwater program consisted primarily of O&M activities that resulted in reducing I&I into the sanitary sewers. The stormwater program represents 5% of the
      Sewer Fund's budget (SMCWPPP 2008).
    - City of Lodi - For many years, Lodi has funded its stormwater O&M costs within the Sewer Fund and capital costs from the Public Works budget. The stormwater O&M expenses represent 7% of the Sewer Fund's budget (SMCWPPP 2008).

6.5 Refuse Collection (Solid-Waste) Fees

Both stormwater and solid waste programs have close associations with street maintenance programs. Streets convey stormwater and also collect litter and other wastes that must be removed or swept away. It is a common practice for cities to include street sweeping services within their solid waste services (SMCWPPP 2008).

In addition, streets provide garbage vehicles access to waste sources, transfer stations, and disposal sites. When streets are poorly maintained, they pose both drainage and sweeping problems, and the debris on poorly-maintained streets contributes stormwater pollutants. Solid waste customers benefit from street sweeping, as well as street repair and maintenance. Garbage trucks exert more wear and tear on streets than any other vehicle. They are the

heaviest vehicles that regularly travel streets, particularly in residential area, which are vulnerable because they have often not been designed to standards that can withstand the weight of garbage vehicles. Clean streets drain properly, which reduces flooding and promotes vehicle access (SMCWPPP 2008). Roadway maintenance and repair activities, such as asphalt overlay, may be linked to the wear and tear of streets resulting from garbage trucks, particularly on residential streets, and could potentially be funded, in part, from refuse collection fees. There may be cost savings to install GI in concert with roadway maintenance projects such as asphalt overlay.

Additionally, it could be argued that the solid waste utility bears responsibility, at least in part, for the litter that needs to be cleared from storm drains, because activities such as street sweeping benefit both street maintenance and storm drain maintenance (City of Berkeley 2016).

- **Ballot approval** – Refuse collection fees do not require voter or property owner approval to be enacted.
- **Reliability** – The amount of funding would be relatively steady, once established.
- **Cost to implement** – Costs to implement this option would include the analysis of the cost of applicable projects to develop the required documentation to incorporate into the refuse collection fee structure.
- **Obstacles** – A clear nexus must be established between the fee and the costs incurred, and the proportionality to the user.
- **Example of Implementation:**

City of Petaluma moved street sweeping to solid waste services, which allowed the City to fund street sweeping from solid waste rates. Prior to this move, the streets had been damaged to the point where street sweeping could not be performed. With the necessary funding, pavement repair was possible, after which the City was able to resume street sweeping in compliance with its NPDES requirements (SMCWPPP 2008).

6.6 Further Funding Options

Further discussion of other funding options is included in Appendix D.

7. References

Alameda Countywide Clean Water Program. 2017. C3 Project Tracking and Load Reduction Accounting Tool Guidance Document.

Alameda Countywide Clean Water Program. 2017b. C.3 Technical Guidance Manual, Version 6.

City of Dublin, California. 2018. Typical Green Infrastructure Designs and Standard Specifications.

Geosyntec. 2017. Alameda Countywide Stormwater Resource Plan Screening and Prioritization using Multi-Benefit Metrics Technical Memorandum. December 13.

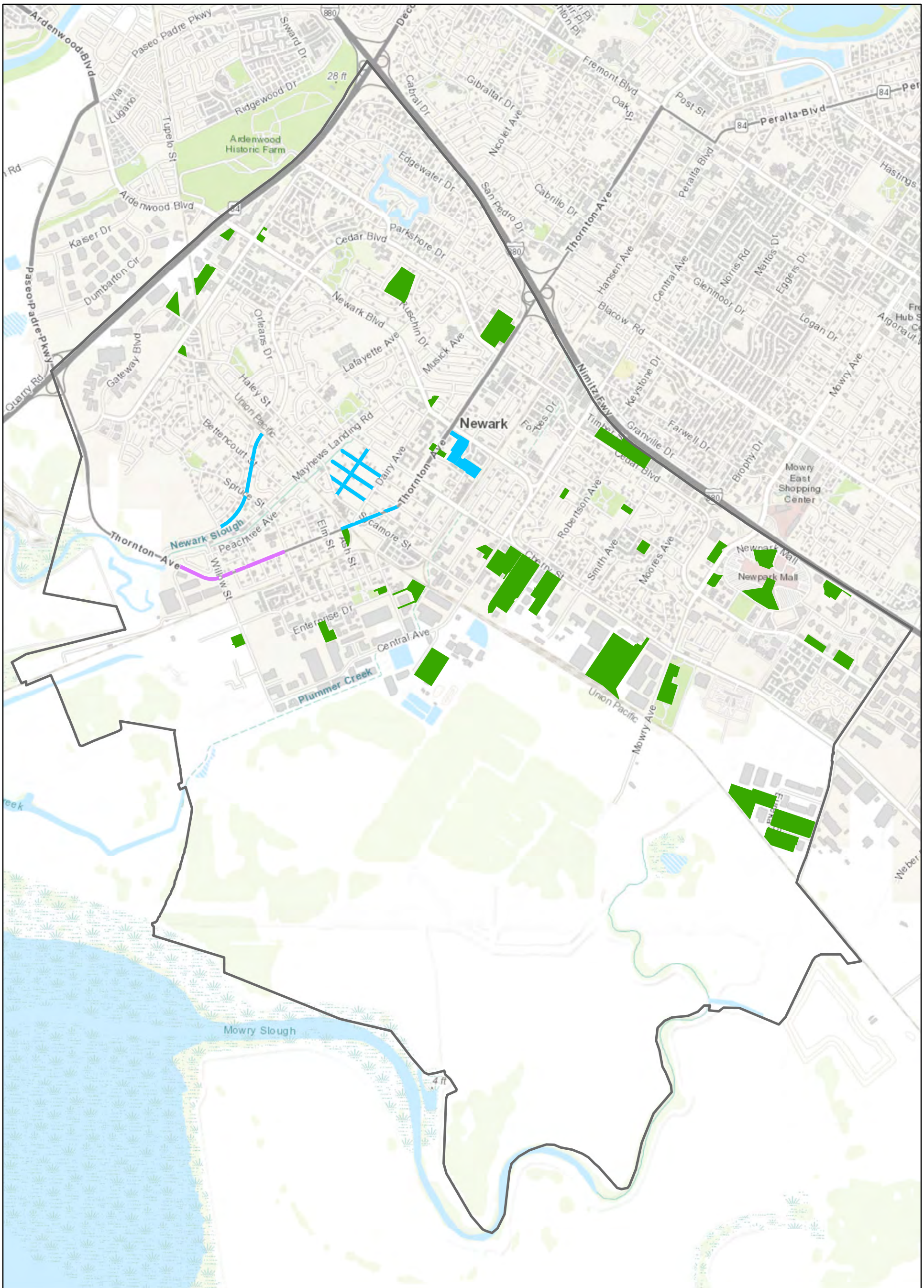
National Association of City Transportation Officials. 2017. Urban Street Stormwater Guide.

San Francisco Bay Regional Water Quality Control Board. 2015. Order No. R2-2015-0049, Municipal Regional Stormwater Permit (MRP).

San Mateo Countywide Water Pollution Prevention Program. 2009. San Mateo County Sustainable Green Streets and Parking Lots Design Guidebook.

Appendix A. Maps of Prioritized Projects

Maps contained in Appendix A consist of a mapping of a comprehensive overview inclusive of all public right-of-way segments and regional parcels as evaluated by GIS analysis, as well as specific mapping of implemented C.3 projects and projects under the City of Newark's Short List of High Priority Projects. These maps are included in the following pages.



CITY OF NEWARK Existing, Planned and Potential Green Infrastructure

- Existing C.3.b Project
- Existing Green Street/Retrofit
- 2030 Estimated Public Green Projects
- 2040 Estimated Public Green Projects
- Agency Boundary

N

0 0.2 0.4 0.8 Miles

Estimated Impervious Acres Treated

2003-2020		2003-2030		2003-2040	
Public	Private	Public	Private*	Public	Private*
3.6	166.2	20.2	213.0	24.1	239.4

*The acres treated estimates for private projects by 2030 and by 2040 are derived from the ACCWP UrbanSim modeling project. The estimated private projects are not displayed on the map.

Information contained on these maps is for the sole purpose of the Alameda County Clean Water Program. Accuracy of the data is not guaranteed. Map Created By ACCWP GIS

cleanwater PROGRAM alameda county

8/21/2019

Potential Public and Regional Opportunities for the City of Newark

Representative heat mapping of comprehensive right-of-way list as generated by GIS analysis. A metrics based evaluation was used to classify opportunities in a potential range from 0 to 24. Metrics by which opportunities were ranked include: area, location slope, infiltration coefficient, Hg/PCB yield classification of drainage area, regional facility status, stormwater pollutant load, water supply augmentation, flood control benefits, natural drainage benefits, open-space benefits, recreational or public-use benefits, and trash capture co-benefits. The comprehensive list of opportunities by ID number was included in the Countywide Stormwater Resources Project Prioritization Plan for future planning and funding opportunities.

Appendix B. Workplan for Completing Prioritized Projects

Workplan for Completing Prioritized GI Projects

City of Newark

September 12, 2019

1. Statement of Purpose

The purpose of this workplan is to identify the scheduled timeframes and other key information for implementing prioritized green infrastructure (GI) projects identified as part of a Provision C.3.e Alternative Compliance program or as part of Provision C3J Early Implementation.

2. Schedule, Budget, and Responsible Party

The following table identifies milestones for the implementation of prioritized projects, as well as the budget, funding source, and responsible party for each project.

	Schedule								Budget	Funding source	Responsible Party
	Planning		Preliminary Design		Final Design		Construction				
Name of Project	Start	Finish	Start	Finish	Start	Finish	Start	Finish			
Lindsay Tract	JULY 2019	DEC 2019	DEC 2019	MARCH 2020	MARCH 2020	MARCH 2021	MARCH 2021	OCT 2021	$3.5M	General fund SB 1 Measure B/BB Area Improvement District Funds	Trang Tran
Historic Newark District Streetscape	JAN 2019	MAY 2022	MAY 2022	NOV 2022	NOV 2022	NOV 2023	NOV 2023	MAY 2025	Planning: $350K Construction: Unapproved	General Fund CIP Budget	Art Interiano

Appendix C. General Guidelines for GI Projects

Appendix C. General Guidelines for GI Projects

These General Guidelines have been developed to guide the City of Newark in designing a project that has a unified, complete design that implements the range of functions associated with GI projects, and in providing for appropriate coordination of projects and project elements. The guidelines apply to projects that incorporate GI into an existing roadway segment or a previously developed public parcel and are **not** Regulated Projects as defined in Provision C.3.b of the MRP. The guidelines are organized as follows.

Section C.1 Functions Associated with GI
Section C.2 Guidelines for GI Retrofits of Existing Streets
Section C.3 Guidelines for GI Retrofits of Public Parcels
Section C.4 Guidelines for Coordination of Projects
Attachment C-1 Hydraulic Sizing Requirements
Attachment C-2 Worksheet for Calculating the Combination Flow and Volume Method
Attachment C-3 Mean Annual Precipitation Map of Alameda County
Attachment C-4 Typical Designs
Attachment C-5 Model Sign-off Form for Capital Improvement Projects
Attachment C-6 BASMAA Guidance for Sizing Green Infrastructure Facilities
Attachment C-7 ACCWP C.3. Technical Guidance Appendix C: Example Scenarios and Spreadsheet Tools for Sizing Stormwater Treatment Measures
Attachment C-8 ACCWP C.3. Technical Guidance Appendix L: Site Design Requirements for Small Projects

C.1 Functions Associated with GI

The functions associated with GI retrofits of existing streets and GI retrofits of public parcels are identified below.

C.1.1 Functions Associated with GI Retrofits of Existing Streets

The following functions are associated with GI retrofits of existing streets:

- Street use for stormwater management, including treatment;
- Safe pedestrian travel;
- Use as public space for bicycle, transit, and vehicle movement/parking; and
- Use as locations for urban forestry.

C.1.2 Functions Associated with GI Retrofits of Public Parcels

Existing facilities on public parcels may be retrofitted with GI. Although there are potentially a wide range of public uses that could occur on various parcels, key issues are associated with the outdoor use of public parcels for landscaping and parking. The following functions are associated with GI retrofits of public parcels:

- Site use for stormwater management and landscaping
- Circulation and parking within the site

C.2 Guidelines for GI Retrofits of Existing Streets

Streets must perform the range of functions described in Section C.1.1. The following guidelines provide general guidelines for designing and constructing GI facilities within the right-of-way of existing streets, to address the full range of functions. Additional design guidance for GI facilities, which are also referred to as low impact development (LID) stormwater treatment facilities, is provided in Chapters 5 and 6 of the Alameda Countywide Clean Water Program's C.3 Technical Guidance, which may be downloaded at, www.cleanwaterprogram.org (click Businesses, then Development).

C.2.1 Guidelines Addressing Street Use for Stormwater Management

The GI guidelines to support street functionality for stormwater management are organized around the following objectives:

- Convey stormwater to GI facilities,
- Identify the appropriate GI typical designs for the project, and
- Convey stormwater away from transportation facilities.

Convey Stormwater to GI Facilities

GI retrofits of existing streets must be designed to convey stormwater runoff from the roadway surface to the proposed GI facilities. Key issues include working with the street profile, working with the existing drainage system, and considering conveyance facilities where needed.

Work with the Existing Street Profile

Modifying the profile of an existing street is costly. Therefore, the designs of GI street retrofits should generally maintain the existing street profile where feasible. The street profile affects how stormwater runoff flows off of a street, and is considered in the design of GI facilities. The most common street profile is crowned, although some streets may be reverse crowned, or may drain to one side, as illustrated in Figures C-1 through C-3. Occasionally, a street may have a flat profile, such as the example shown in Figure C-4 in which a street is designed to drain into pervious pavement. Unless pervious pavement is used for the full width of the street, GI facilities would be located downslope from the roadway surface. In a crowned street, this may allow for GI facilities on both sides of the street. In a reverse crowned street, GI facilities may be considered in the median; and in a side-sloping street, GI facilities would be located on the downslope side.

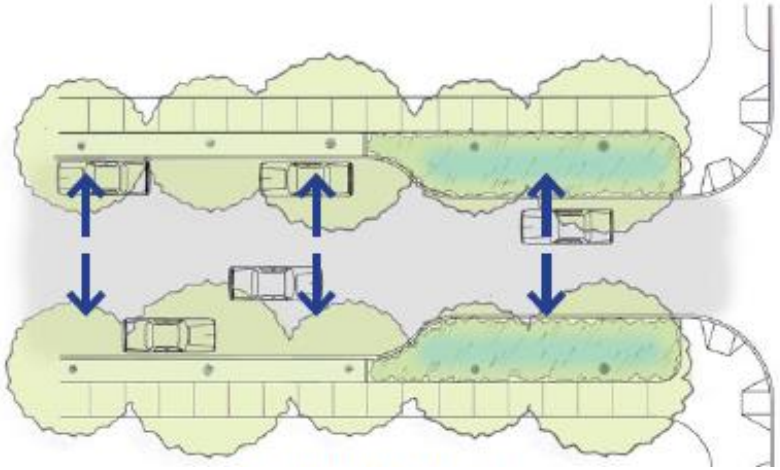


Figure C-1. Crowned Street Profile. A crowned street is designed so that the highest elevation is in the middle of the street, such that stormwater runoff drains to the sides of the street. GI facilities may be located on either side of the street.

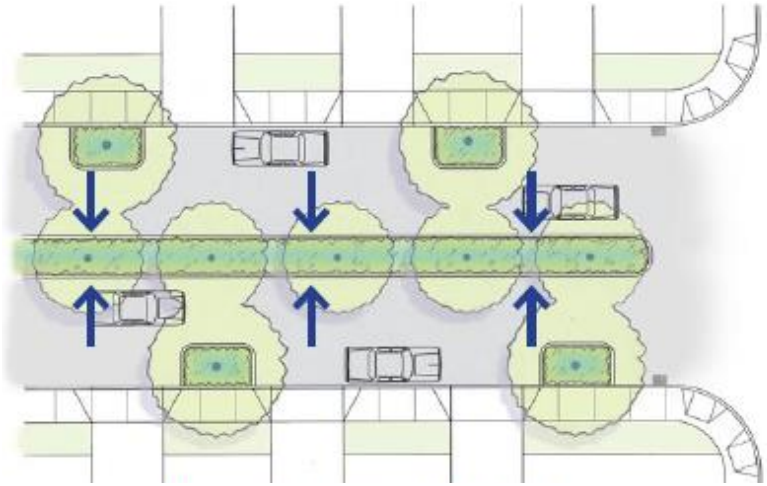


Figure C-2. Reverse Crowned Street Profile. A reversed crowned street is the opposite of a crowned street and directs runoff to the center line of the street. GI facilities may be considered in the median.

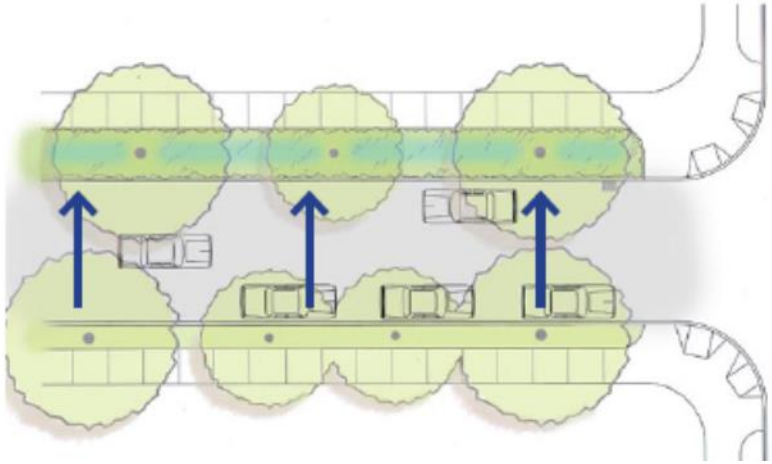


Figure C-3. Side Shed Street Profile. Side shed streets are designed to shed all water to one side of the street. GI facilities would be located on the downslope side.

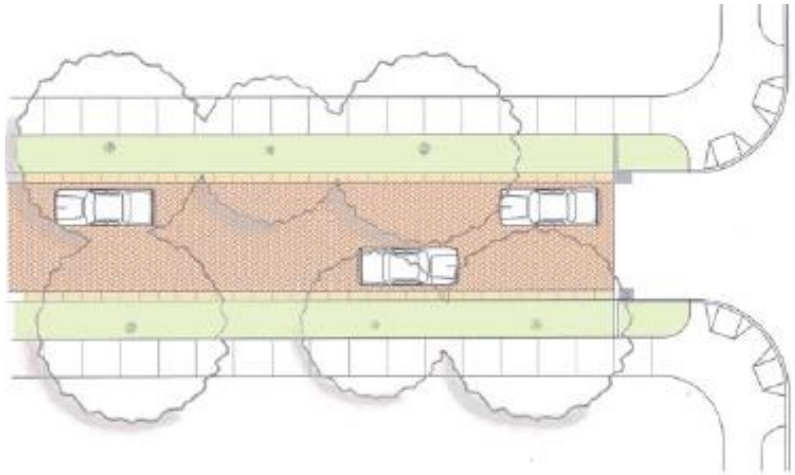


Figure C-4. Flat Street Profile. Flat streets are designed to drain through pervious paving. While these facilities do not have a marked slope, they may be graded slightly so that they drain to the sides or center of the street when there is too much water.

Source: San Mateo Countywide Water Pollution Prevention Program/Nevue Ngan

Work with the Existing Drainage System

If an underdrain will be included in the GI facility design, a street retrofit site should have an existing storm drain line, to which the underdrain may be connected. If there is no existing storm drain line, subject to municipal approval, in lieu of an underdrain, sites with poorly draining soils may potentially be designed with an oversized reservoir layer of rock below the GI facility. The rock layer would be sized to hold the amount of runoff identified in Section 6, Hydraulic Sizing Requirements. This approach was used in the City of Burlingame's Donnelly Street green street project (Figure C-5), because there was no available storm drain line.

Figure C-5. Donnelly Street Green Street Project. The Donnelly Street Green Street Project includes a rain garden, pictured at right, which captures runoff from the adjacent commercial buildings and parking lot. The rain garden was designed with no underdrain and an enlarged subsurface layer of rock, which serves as a reservoir and allows runoff to slowly infiltrate to the underlying soil. The system was designed for onsite management of flows that exceed the 30-year storm. An overflow to the curb is provided for a 50- to 100-year event scenario.
Source: City of Burlingame

Consider Conveyance Facilities

In some cases, a street retrofit project may be located near an appropriate site for a larger stormwater facility than can be accommodated in the typical street right-of-way. For example, a street retrofit project may be designed to convey stormwater runoff to a bioretention facility that will be constructed on an adjacent park or greenway. This approach is illustrated by the City of El Cerrito's Ohlone Greenway Natural Area and Rain Garden project's incorporation of a rain garden (Figure C-6) that captures and treats stormwater runoff from an adjacent segment of Fairmont Boulevard. Various methods may be considered for conveying runoff to nearby GI facilities, including trench drains (Figure C-7) and vegetated swales or vegetated channels (Figure C-8).

Figure C-6. Ohlone Greenway Natural Area and Rain Garden. This rain garden captures and treats runoff from an adjacent segment of Fairmont Boulevard. In this instance, the rain garden location provided an opportunity to convey and treat stormwater outside the street right-of-way.
Source: PlaceWorks

Figure C-7. Trench Drain. A trench drain can be used to convey runoff to GI facilities.

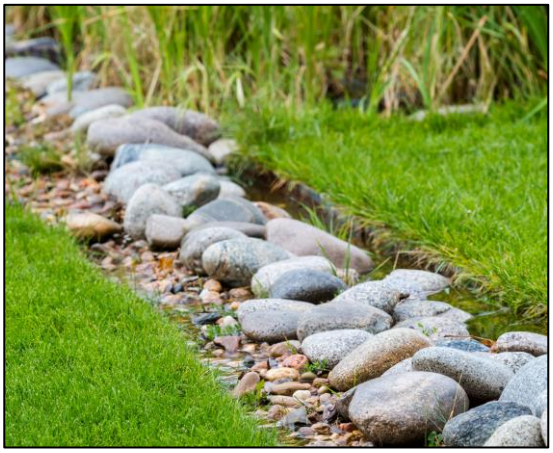


Figure C-8. Pervious Drainage Channel. Pervious, unlined drainage channels can be designed to convey runoff to GI facilities.

Identify the Appropriate Typical Design for Street Project Site

Refer to Attachment C-4 of this appendix to identify appropriate typical design drawings for the project. Typical designs have been developed for various conditions that may occur at a project site. GI projects may also utilize design guidance provided in Chapter 6 of the C.3 Technical Guidance manual for other types of low impact development storm water treatment facilities, subject to municipal staff approval.

Apply the Appropriate Hydraulic Sizing Criteria

Refer to Attachment C-1 for guidance on identifying and using the appropriate hydraulic sizing criteria for the proposed project.

Convey Stormwater away from Transportation Facilities

To manage the risk of flooding, adequate drainage facilities must be provided for all segments of roadway, in accordance with the City of Newark's storm drainage design standards, including design criteria, standards, policies, and procedures for storm drainage improvements. All storm drainage facilities must be designed in accordance with the applicable standards and accepted engineering principles, as directed by City of Newark Department of Public Works

C.2.2 Guidelines Addressing Pedestrian Travel within Street Right of Way

To help reduce pollution from automobiles, the City of Newark has a goal to improve and expand transportation choices, including the pedestrian mode of travel. As part of meeting this goal, the design of GI retrofits of existing streets should incorporate measures that seek to enhance the safety and attractiveness for pedestrians. The following measures may be considered:

- Incorporate into project intersections curb extensions, also referred to as bulbouts, which reduce the street width at intersections and shorten the length of street crossings for pedestrians, while also providing space for GI facilities (see Figure C-9).
- Provide attractive landscaping designs that enhance the sense of place for pedestrians and may potentially include amenities such as shade trees and seating areas.
- Locate the GI facility between the sidewalk and vehicle travel lanes, in order to enhance pedestrian safety by providing protected sidewalks.

Figure C-9. Curb Extension. In addition to reducing the street width and shortening the length of street crossings for pedestrians, curb extensions, or "bulbouts," such as this example in Albany, also provide space for GI facilities.
Source: bluegreenbldg.com

C.2.3 Guidelines Addressing Street Use for Bicycle, Transit, and Vehicle Movement/Parking

Complete streets balance the needs of pedestrian, bicycle, automobile, and public transit modes of travel. To meet the goal of improving and expanding transportation choices, described in Section C.2.2, in addition to pedestrian transportation, GI retrofits of existing streets must also be designed to accommodate bicycles, motor vehicles, and, where appropriate, public transit. The design and construction of each GI project should incorporate appropriate measures to enhance transportation safety and help improve the attractiveness of alternative modes of travel. The following measures may be considered:

<u>Bicycle-Friendly Measures</u>

- Include bicycle lanes in GI retrofits of existing streets.
- Provide a protected bicycle lane by locating a GI facility or other landscaped area, or a lane of parking, between a bicycle lane and lanes of motor vehicle travel.
- Include bicycle racks in GI street retrofit projects.

<u>Public Transit-Friendly Measures</u>

- Enhance the comfort of public transit users by providing shelter, shade, and greenscape at bus stops and other public transit stops.
- Integrate GI into transit facilities, such as boarding bulbs and islands, or rooftops of transit shelters.
- Provide bicycle racks at public transit stops.

Motor Vehicle-Friendly Measures

- Implement GI with geometric changes that reduce vehicle speed and/or improve visibility. This may include "road diet" projects that reduce the number of lanes of travel, or traffic calming projects that incorporate areas of landscaping, such as traffic islands, as visual cues to help slow down traffic.
- Provide visual cues to help slow down traffic and alert drivers to the presence of GI facilities, to help prevent motor vehicles from driving into a stormwater facility. Visual cues may include curbs and landscaping that is readily visible to drivers.

C.2.4 Guidelines Addressing Urban Forestry in Public Right of Way

Increasing the planting of street trees in the City of Newark is anticipated to benefit local water quality, air quality, energy efficiency, and property values. GI projects should incorporate measures to preserve existing street trees and promote the planting of new street trees. The following measures should be incorporated, as appropriate:

- Prioritize the preservation of existing mature trees.
- Replace any mature trees that are removed by the project.
- Maximize the planting of new trees in accordance with the requirements of the City of Newark Department of Public Works.
- The planting of trees within a GI facility should follow guidance, including the identification of appropriate species, provided in Appendix B of the ACCWP C.3 Technical Guidance, which may be downloaded at www.cleanwaterprogram.org (click Businesses, then Development).

C.3 Guidelines for GI Retrofits of Public Parcels

Public parcels must perform the range of functions described in Section C.1. The following guidelines provide general guidelines for GI retrofitting of public parcels, to address the full range of functions. Additional design guidance for GI facilities, which are also referred to as low impact development (LID) storm water treatment facilities, is provided in Chapters 5 and 6 of the ACCWP C.3 Technical Guidance, which may be downloaded at, www.cleanwaterprogram.org (click Businesses, then Development).

C.3.1 Guidelines to Address Parking Lot Use for Landscaping and Stormwater Management

Parking lots often contain excess parking spots and oversized parking spaces and drive aisles. GI retrofits of public parcels should consider options to reduce any unnecessary parking areas, in order to provide space for landscaping, stormwater management, and pedestrian walkways. The following measures may be considered:

Maximize Space for GI and other Landscaping

To allow more space for GI and other landscaping, shorten parking stall lengths to 17 feet, contributing the reduction of 2 feet into adjacent landscape planters, and drive/back-up aisle widths to 24 feet, subject to municipal approval. Parking should be designed to meet "average day" needs and utilize pervious overflow parking zones to meet peak parking needs.

Consider Specifying Pervious Paving Pervious paving may be used in parking lot designs. Where pervious paving is underlain with pervious soil or pervious storage material sufficient to hold the Municipal Stormwater Regional Permit Provision C.3.d volume of rainfall runoff, it is not considered impervious and can function as a self-treating area. Please see Section 6.6 of the C.3 Technical Guidance for further design guidance for pervious pavement installations.

Convey Stormwater to GI Facilities

GI retrofits of existing sites must be designed to convey stormwater runoff from impervious surfaces (roofs and/or parking lots) to the proposed GI facilities. Key issues include working with the existing drainage system, and considering conveyance facilities where needed.

Work with the Existing Drainage System

If an underdrain will be included in the GI facility design, the site should have access to an existing storm drain line, to which the underdrain may be connected. If there is no existing storm drain line, subject to municipal approval, in lieu of an underdrain, sites with poorly draining soils may potentially be designed with an oversized reservoir layer of rock below the GI facility. The rock layer would be sized to hold the amount of runoff identified in Section 6, Hydraulic Sizing Requirements. This approach was used in the City of Burlingame's Donnelly Street green street project (Figure C-5), because there was no available storm drain line.

Consider Conveyance Facilities

Various methods may be considered for conveying runoff from impervious surfaces to GI facilities, including trench drains (Figure C-7) and vegetated swales or vegetated channels (Figure C-8). In parking lots that include speed bumps, consider using speed bumps to help direct stormwater runoff to GI facilities.

Identify the Appropriate Typical Design for the Project Site

Refer to Attachment C-4, included in this appendix, to identify appropriate typical design drawings for the project. Typical designs have been developed for various conditions that may occur at a project site. GI projects may also utilize design guidance provided in Chapter 6 of the C.3 Technical Guidance manual for other types of low impact development storm water treatment facilities, subject to municipal staff approval.

Apply the Hydraulic Sizing Criteria Identified in Provisions C.3.c and C.3.d

Refer to Attachment C-1 for guidance on using the appropriate hydraulic sizing criteria in MRP Provisions C.3.c and C.3.d as applicable to design GI projects that are not regulated by Provision C.3.b ("non-Regulated Projects).

Prioritize Tree Preservation and Planting

In order to benefit local water quality, air quality, energy efficiency, and property values, GI projects on public parcels should incorporate measures to preserve existing street trees and promote the planting of new trees. The following measures should be incorporated, as appropriate:

- Prioritize the preservation of existing mature trees.
- Replace any mature trees that are removed by the project.
- Maximize the planting of new trees in accordance with the requirements of City of Newark Department of Public Works.
- Incorporate trees in landscaped areas within parking lots – which serves to shade vehicles and paved surfaces, improve air and water quality, intercept stormwater in the tree canopy, and take up stormwater through the root system.
- The planting of trees within a GI facility should follow guidance, including the identification of appropriate species, provided in Appendix B of the ACCWP C.3 Technical Guidance, which may be downloaded at www.cleanwaterprogram.org (click Businesses, then Development).

C.3.2 Guidelines to Address Parking Lot Use for Vehicular Parking

GI retrofits of public parcels should provide for adequate motor vehicle and bicycle parking for the proposed public use. The following measures may be considered:

- Include bicycle parking facilities.
- Provide pedestrian walkways within parking lots, including bridged walkways across GI facilities.
- Provide safe pedestrian access to and directional signage for adjacent public transit stops.
- Consider other improvements to enhance existing pedestrian circulation and safety.
- Depending on the type of use, larger public parcel retrofits should consider providing bicycle storage, changing rooms, and preferred parking for carpooling

C.4 Guidelines for Coordination of Projects

Installing GI components at a project prior to the completion of that project, or the construction of an adjacent project, has the potential to degrade the functioning of the GI facility. Street improvement or other infrastructure projects, the development of public parcels, and other public and private projects should therefore include coordination of construction schedules to minimize impacts to GI.

The following measures shall be implemented in all GI projects to protect investments in GI:

1. GI facilities shall not be used as temporary sediment basins during construction.
2. Erosion control plans shall include protections for GI; erosion control plans are subject to the Engineering Review during all phases of design as well as through construction as per MRP Provision C.6.
3. Installed GI facilities shall be protected from construction runoff and kept offline until the contributing drainage area is stabilized.

Contractors are encouraged to construct GI facilities at the end of a project, to help protect the facilities from construction-related impacts.

Attachment C-1: Hydraulic Sizing Criteria

This provides guidance on the following topics:

- Hydraulic sizing criteria in MRP Provisions C.3.c and C.3.d as applicable to GI projects that are not regulated by Provision C.3.b ("non-Regulated Projects)
- Alternate sizing approach for constrained street projects

C1.1 Hydraulic Sizing Criteria in MRP Provisions C.3.c and C.3.d

Provision C.3.c requires the use of low impact development (LID) stormwater controls. To meet the MRP definition of LID, bioretention facilities must have a surface area no smaller than what is required to accommodate a 5 inches/hour stormwater runoff surface loading rate, and infiltrate runoff through biotreatment soil media at a minimum of 5 inches per hour.

Provision C.3.d of the MRP includes volume-based, flow-based, and the combination volume- and flow-based hydraulic sizing criteria. Bioretention areas may be sized using a simplified flow-based hydraulic sizing method, known as the "4 percent method," in which the surface area of the bioretention area is 4 percent of the effective impervious surface area that is treated. However, by using a combination volume- and flow-based hydraulic sizing approach, it may be possible to provide a bioretention area that is less than 4 percent of the effective impervious surface area, which can help reduce costs. Step-by-step instructions for using the 4 percent method and the volume-based sizing criteria are provided in Section 5.1 of the C.3 Technical Guidance. Guidance for using the combination flow and volume criteria from Section 5.1 of the C.3 Technical Guidance document are copied below. The worksheet for using this method is provided in Attachment C-2.

The implementation of LID stormwater treatment facilities designed in accordance with Provisions C.3.c and C.3.d of the MRP will provide hydromodification management benefits by infiltrating and detaining stormwater runoff.

Step-by-Step Guidance for Combination Flow and Volume Method

To apply the combination flow and volume approach, use the following steps, which may be performed using the combination flow and volume sizing criteria Excel worksheet provided in Attachment C-2 of this appendix.

1. **Mean Annual Precipitation**
    - Determine the mean annual precipitation (MAP) for the project site using the Mean Annual Precipitation Map of Alameda County (Attachment C-3). Use the Oakland Airport unit basin storage volume values from Table C1-1(below) if the project location's mean annual precipitation is 16.4 inches or greater and the San Jose values if it is less than 16.4 inches.

- In order to account for the difference between MAP of the project site and the two rainfall locations shown, calculate the ***MAP adjustment factor*** by dividing the project MAP by the MAP for the applicable rain gauge, as shown below: MAP adjustment factor = (project location mean annual precipitation

$$Map\ adjustment\ factor = \frac{(project\ location\ mean\ annual\ precipitation)}{(18.35\ or\ 14.4, as\ appropriate)}$$

2. Effective Impervious Area for the Drainage Management Area

- Based on the topography of the site and configuration of buildings, divide the site into drainage management areas (DMAs), each of which will drain to a treatment measure. Implement the steps below for each DMA with a volume-based treatment measure.
- Minimize the amount of landscaping or pervious pavement that will contribute runoff to the treatment measures. Refer to Sections 4.1 and 4.2 of the C.3 Stormwater Technical Guidance to design areas of landscaping or pervious pavement as "self-treating areas" or "self-retaining areas," so that they do not contribute runoff to the LID treatment measure and may be excluded from the DMAs for the treatment measures.
- For each DMA in which the area that will contribute runoff to the treatment measure includes pervious surfaces (landscaping or properly designed pervious paving), multiply the area of pervious surface by a factor of 0.1.
- For applicable DMAs, add the product obtained in the previous step to the area of impervious surface, to obtain the "***effective impervious area***." (For DMAs that are 100% impervious, use the entire DMA area.)

3. Unit Basin Storage Volume

- The effective impervious area of a DMA has a runoff coefficient of 1.0. Refer to Table C1-1 to obtain the ***unit basin storage volume*** that corresponds to your rain gauge area. For example, using the Oakland Airport gauge, the unit basin storage volume would be 0.67 inches. Adjust the unit basin storage volume for the site by multiplying the unit basin storage volume value by the MAP adjustment factor calculated in Step 1.
- Calculate the ***required capture volume*** by multiplying the effective impervious area of the DMA calculated in Step 2 by the adjusted unit basin storage volume. Due to the mixed units that result, such as acre-inches, it is recommended that the resulting volume be converted to cubic feet for use during design. For example, say you determined the adjusted unit basin storage volume to be 0.5 inches, and the effective impervious area draining to the bioretention facility is 7,000 square feet. Then the required capture volume would be:

$$Required\ capture\ volume = 0.5\ inches\ \times \left(\frac{1\ foot}{12\ inches}\right) \times 7{,}000\ feet^2 = 292\ cubic\ feet$$

Table C1-1. Unit Basin Storage Volume (Inches) for 80 Percent Capture with 48-Hour Drawdown Time		
		Unit Basin Storage Volume for Effective Impervious Area of Drainage Management Area
Location	**Mean Annual Precipitation (inches)**	**Coefficient of 1.00**
Oakland Airport	18.35	0.67
San Jose	14.4	0.56
Source: CASQA 2003, cited in Table 6-2 of the C.3 Technical Guidance.		

4. Depth of Infiltration Trench or Pervious Paving Base Layer

- Assume that the rain event that generates the required capture volume of runoff determined in Step 3 occurs at a constant rainfall intensity of 0.2 inches/hour from the start of the storm (i.e., assume a rectangular hydrograph). Calculate the ***duration of the rain event*** by dividing the unit basin storage volume by the intensity. In other words, determine the amount of time required for the unit basin storage volume to be achieved at a rate of 0.2 inches/hour. For example, if the unit basin storage volume is 0.5 inches, the rain event duration is 0.5 inches ÷ 0.2 inches/hour = 2.5 hours.

5. Preliminary Estimate of the Surface Area the Facility

- Make a ***preliminary estimate of the surface area*** of the bioretention facility by multiplying the DMA's impervious area (or effective impervious surface if applicable) by the 4 percent method sizing factor of 0.04. For example, a drainage area of 7,000 square feet of impervious surface × 0.04 = 280 square feet of bioretention treatment area.
- Assume a bioretention area that is about 25% smaller than the bioretention area calculated with the 4 percent method. Using the example above, 280 – (0.25 × 280) = 210 square feet.
- ***Calculate the volume of runoff that filters through the biotreatment soil*** at a rate of 5 inches per hour (the design surface loading rate for bioretention facilities), for the duration of the rain event calculated in Step 4. For example, for a bioretention treatment area of 210 square feet, with an infiltration rate of 5 inches per hour for a duration of 2.5 hours, the volume of treated runoff = 210 square feet × 5 inches/hour × (1 foot/12 inches) × 2.5 hours = 219 cubic feet. (Note: when calculating ponding depth, the mulch layer is not included in the calculation.)

6. Initial Adjustment of Depth of Surface Ponding Area

- Calculate the portion of the required capture volume ***remaining after treatment is accomplished by filtering*** through the treatment soil. The result is the amount that must be stored in the ponding area above the reduced bioretention area assumed in Step 6. For example, the amount remaining to be stored comparing Step 3 and Step 5 is 292 cubic feet – 219 cubic feet = 73 cubic feet. If this volume

is stored over a surface area of 210 square feet, the ***average ponding depth*** would be 73 cubic feet ÷210 square feet = 0.35 feet or 4.2 inches.

- Check to see if the ***average ponding depth is between 6 and 12 inches***, which is the recommended allowance for ponding in a bioretention facility or flow-through planter.

7. **Optimize the Size of the Treatment Measure**
    - If the ponding depth is greater than 12 inches, a larger surface area will be required. (In the above example, the optimal size of the bioretention area is 190 square feet with a ponding depth of 6 inches.) In order to build conservatism into this sizing method, the Countywide Program recommends that municipalities not approve the design of any bioretention areas or rain gardens that have a surface area that is less than 3 percent of the effective impervious area within the DMA.

Please note that Appendix C of the C.3 Stormwater Technical Guidance includes an example of sizing bioretention areas using the combination flow- and volume-based method.

C1.2 Alternate Sizing Approach for Constrained Street Projects

Provision C.3.j.i.(2)(g) of the MRP allows the jurisdictions subject to the MRP (MRP Permittees) to develop an alternate sizing approach for street projects that are not subject to Provision C.3.b.ii. (non-Regulated Projects) in which project constraints preclude fully meeting the C.3.d sizing requirements. This approach, developed by the Bay Area Stormwater Management Agencies Association, is described as follows.

The Guidance for Sizing Green Infrastructure Facilities in Street Projects, provided by BASMAA and included as Attachment C-6, states that bioretention facilities in street projects should be sized as large as feasible and meet the Provision C.3.d. sizing criteria where possible. It further states that 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, and provides guidance that may be applied to those circumstances.

Attachment C-2: Worksheet for Calculating the Combination Flow and Volume Method

The worksheet for calculating the combination flow and volume method is provided on the following pages.

Worksheet for Calculating the Combination Flow and Volume Method

Instructions: After completing Section 1, make a copy of this Excel file for each Drainage Management Area within the project. Enter information specific to the project and DMA in the cells shaded in yellow. Cells shaded in light blue contain formulas and values that will be automatically calculated.

1.0 Project Information

1-1	Project Name:	
1-2	City application ID:	
1-3	Site Address or APN:	
1-4	Tract or Parcel Map No:	
1-5	Rainfall Region	
1-6	Region Mean Annual Precipitation (MAP)	#N/A
1-7	Site Mean Annual Precipitation (MAP)	

The calculations presented here are based on the **combination flow and volume sizing method** provided in the Countywide Program's C.3 Technical Guidance, Version 4.0. The steps presented below are explained in Section 5.1 of the Guidance, applicable portions of which are included in this file, in the sheet named "Guidance from Chapter 5".

Click here for map

1-8 ***MAP adjustment factor is automatically calculated as:***

(The "Site Mean Annual Precipitation (MAP)" is divided by the MAP for the applicable rain gauge, showin in Table 5-3, below.)
Refer to the map in Appendix C of the C.3 Technical Guidance to identify the Rainfall Region for the site.

2.0 Calculate Percentage of Impervious Surface for Drainage Management Area (DMA)

2-1 Name of DMA:

For items 2-2 and 2-3, enter the areas in square feet for each type of surface within the DMA.

	Type of Surface	Area of surface type within DMA (Sq. Ft.)	Adjust Pervious Surface	Effective Impervious Area
2-2	Impervious surface		1.0	0
2-3	Pervious surface		0.1	0
	Total DMA Area (square feet) =	0		

2-4 ***Total Effective Impervious Area (EIA)*** 0 **Square feet**

3.0 Calculate Unit Basin Storage Volume in Inches

Table 5-3. Unit Basin Storage Volumes in Inches for 80 Percent Capture Using 48-Hour Drawdowns, based on runoff coefficient

Region	Station, and Mean Annual Precipitation (Inches)	Runoff Coefficient of 1.0
1	Boulder Creek, 55.9"	2.04"
2	La Honda, 24.4"	0.86"
3	Half Moon Bay, 25.92"	0.82"
4	Palo Alto, 14.6"	0.64"
5	San Francisco, 21.0"	0.73"
6	San Francisco airport, 20.1"	0.85"
7	San Francisco Oceanside, 19.3"	0.72"

3-1 ***Unit basin storage volume from Table 5-3:*** #N/A

(The coefficient for this method is always 1.0, due to the conversion of any landscaping to effective impervious area.)

3-2 ***Adjusted unit basin storage volume:*** #N/A **Inches**

(The unit basin storage volume [Item 3-1] is adjusted by applying the MAP adjustment factor [Item 1-8].)

3-3 ***Required Capture Volume (in cubic feet):*** #N/A **Cubic feet**

(The adjusted unit basin sizing volume [Item 3-2] is multiplied by the DMA EIA [Item 2-4] and converted to cubic feet)

4.0 Calculate the Duration of the Rain Event

4-1	Rainfall intensity	0.2	**Inches per hour**
4-2	Divide Item 3-2 by Item 4-1	#N/A	**Hours of Rain Event Duration**

5.0 Preliminary Estimate of Surface Area of Treatment Measure

5-1	4% of DMA EIA (Item 2-4)	-	**Square feet**
5-2	Area 25% smaller than Item 5-1 (i.e., 3% of DMA EIA)	-	**Square feet**
5-3	Volume of treated runoff for area in Item 5-2	#N/A	**Cubic feet** (Item 5-2 * 5 inches per hour * 1/12 * Item 4-2)

6.0 Initial Adjustment of Depth of Surface Ponding Area

6-1	Subtract Item 5-3 from Item 3-3	#N/A	**Cubic feet** (Amount of runoff to be stored in ponding area)
6-2	Divide Item 6-1 by Item 5-2	---	**Feet** (Depth of stored runoff in surface ponding area)
6-3	Convert Item 6-2 from feet to inches	---	**Inches** (Depth of stored runoff in surface ponding area)

6-4 If ponding depth in Item 6-3 meets your target depth (recommend 6"), skip to Item 8-1. If not, continue to Step 7-1.
(Note: Overflow outlet elevation should be set based on the calculated ponding depth.)

Note: Ponding depth in Item 6-3 does not meet target depth, continue to Step 7-1.

7.0 Optimize Size of Treatment Measure

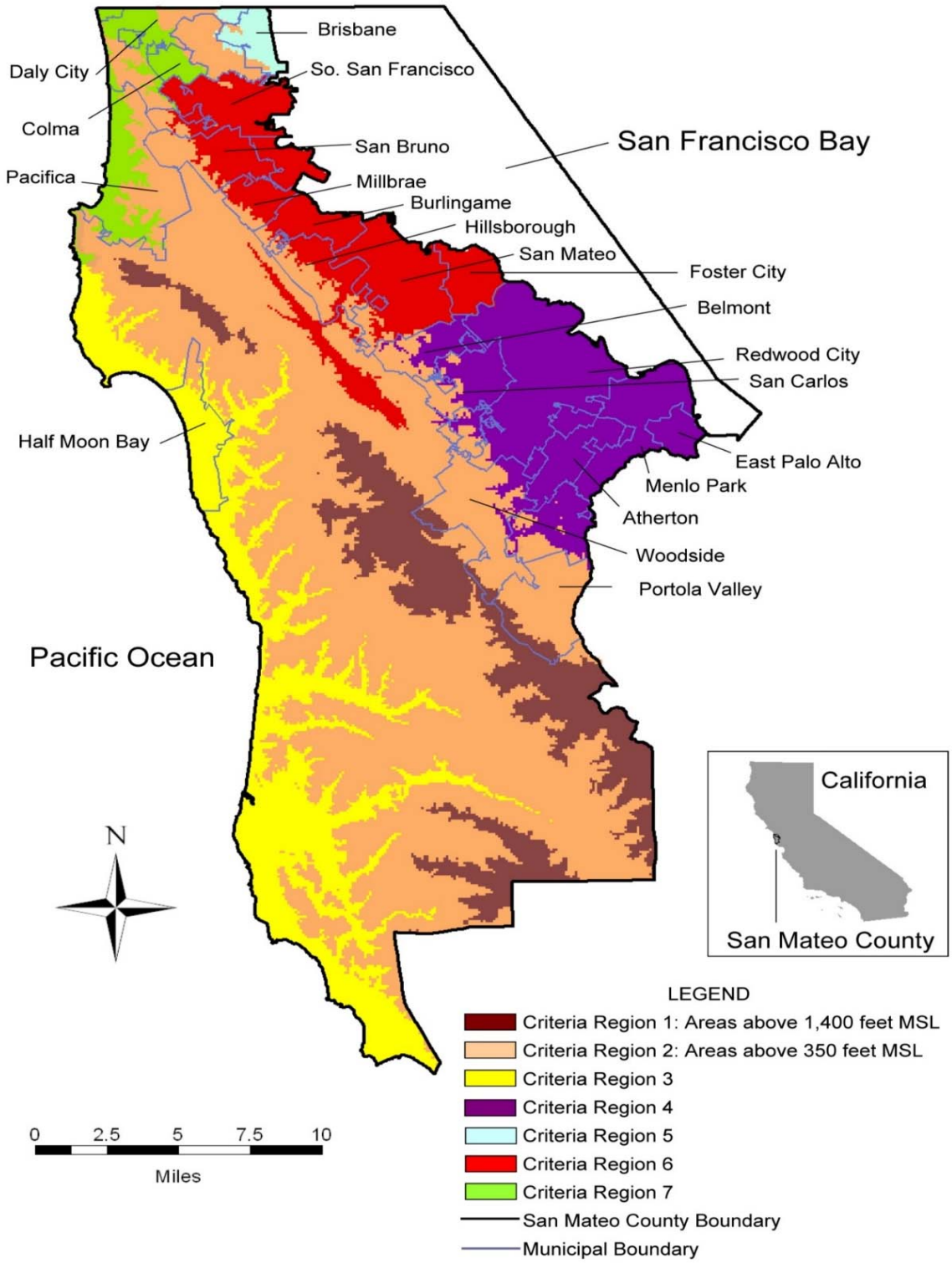
7-1	Enter an area larger than Item 5-2		**Sq.ft.** (enter larger area if you need less ponding depth.)
7-2	Volume of treated runoff for area in Item 7-1	**#N/A**	**Cubic feet** (Item 7-1 * 5 inches per hour * 1/12 * Item 4-2)
7-3	Subtract Item 7-2 from Item 3-3		**Cubic feet** (Amount of runoff to be stored in ponding area)
7-4	Divide Item 7-3 by Item 7-1	---	**Feet** (Depth of stored runoff in surface ponding area)
7-5	Convert Item 7-4 from ft. to inches	---	**Inches** (Depth of stored runoff in surface ponding area)

7-6 If the ponding depth in Item 7-5 meets target, stop here. If not, repeat Steps 7-1 through 7-5 until you obtain target depth.
(Note: Overflow outlet elevation should be set based on the calculated ponding depth.)

8.0 Surface Area of Treatment Measure for DMA

8-1	Final surface area of treatment	**0**	**Square feet** (Either Item 5-2 or final amount in Item 7-1)

Figure 1
BMP Design Criteria Regions for San Mateo County



Combination Flow and Volume Sizing Approach

Step by Step Guidance

(Excerpt from Chapter 5, Section 5.1 of the C.3 Technical Guidance, Version 4.1)

To apply the combination flow and volume approach, use the following steps, which may be performed using the combination flow and volume sizing criteria in this Excel worksheet.

1. Identify Rainfall Region

- Determine which rainfall region the project site is located in using the figure in Appendix C. San Mateo County has been divided in to seven different regions based on local rainfall patterns.

2. Determine the Effective Impervious Area for Each Drainage Management Area

- Based on the topography of the site and configuration of buildings, divide the site into drainage management areas (DMAs), each of which will drain to a treatment measure. Implement the steps below for each DMA with a volume-based treatment measure.
- Minimize the amount of landscaping or pervious pavement that will contribute runoff to the treatment measures. Refer to Sections 4.2 and 4.3 to design areas of landscaping or pervious pavement as "self-treating areas" or "self-retaining areas," so that they do not contribute runoff to the LID treatment measure and may be excluded from the DMAs for the treatment measures.
- For each DMA in which 5 percent or more of the area that will contribute runoff to the treatment measure includes pervious surfaces (landscaping or properly designed pervious paving), multiply the area of pervious surface by a factor of 0.1. Then add the product obtained in the previous step to the area of impervious surface, to obtain the "effective impervious area". For DMAs with less than 5 percent pervious area, use the entire DMA area as the effective impervious area.

3. Unit Basin Storage Volume

- Determine the ***unit basin storage volume*** from Table 5-2 based on the composite effective impervious area runoff coefficient of 1.0 and the rain gauge area.
- Adjust the unit basin storage volume to the appropriate value for your project site by applying the following correction factor based on the ratio of the mean annual precipitation (MAP) of the project site to the MAP of the reference rain gage:

  Correction factor = $MAP_{site} \div MAP_{gage}$

  For example, if the MAP of the site is 23 inches, and the site is in Region 5 (San Francisco) with a reference gage MAP of 21 inches, the correction factor would be 23/21 inches, or 1.095.

  Multiply the unit basin storage volume by the correction factor to get the adjusted unit basin storage volume.
- Calculate the ***water quality design volume ("C.3.d volume")*** by multiplying the effective impervious area of the DMA, calculated in step 2, by the adjusted unit basin storage volume (in units of inches converted to feet). For example, say you determined the adjusted unit basin storage volume to be 0.5 inches, and the effective impervious area draining to the bioretention facility is 7,000 square feet. Then the required capture volume would be 0.5 inches × (1 foot/12 inches) × 7,000 square feet = 292 cubic feet.

4. Estimate the Duration of the Rain Event

- Assume that the rain event that generates the required design volume of runoff determined in Step 3 occurs at a constant rainfall intensity of 0.2 inches/hour from the start of the storm (i.e., assume a rectangular hydrograph). Calculate the ***duration of the rain event*** by dividing the adjusted unit basin storage volume by the intensity. In other words, determine the amount of time required for the unit basin storage volume to be achieved at a rate of 0.2 inches/hour. For example, if the unit basin storage volume is 0.5 inches, the rain event duration is 0.5 inches ÷ 0.2 inches/hour = 2.5 hours.

5. ***Make a Preliminary Estimate of the Surface Area of the Facility***

- Make a ***preliminary estimate of the surface area*** of the bioretention facility by multiplying the DMA's area of impervious surface (or equivalent impervious surface from step 4, if applicable) by the 4 percent method sizing factor of 0.04. For example, a drainage area of 7,000 square feet of impervious surface × 0.04 = 280 square feet of bioretention treatment area.
- Assume a bioretention area that is about 25% smaller than the bioretention area calculated with the 4 percent standard. Using the example above, 280 – (0.25 × 280) = 210 square feet.
- ***Calculate the volume of runoff that filters through the treatment soil at a rate of*** 5 inches per hour (the design surface loading rate for bioretention facilities), for the duration of the rain event calculated in Step 5. For example, for a bioretention surface area of 210 square feet, with an infiltration rate of 5 inches per hour for a duration of 2.5 hours, the volume of treated runoff = 210 square feet × 5 inches/hour × (1 foot/12 inches) × 2.5 hours = 219 cubic feet.

6. ***Initial Adjustment of Depth of Surface Ponding Area***

- Calculate the portion of the water quality design volume ***remaining after treatment is accomplished by filtering*** through the treatment soil. The result is the amount that must be stored in the ponding area above the reduced bioretention area assumed in Step 6. For example, the amount remaining to be stored comparing Step 6 and Step 9 is 292 cubic feet – 219 cubic feet = 73 cubic feet. If this volume is stored over a surface area of 210 square feet, the average ponding depth would be 73 cubic feet ÷210 square feet = 0.35 feet or 4.2 inches.
- Check to see if the ***average ponding depth is between 6 and 12 inches***, which is the recommended range for ponding in a bioretention facility or flow-through planter.

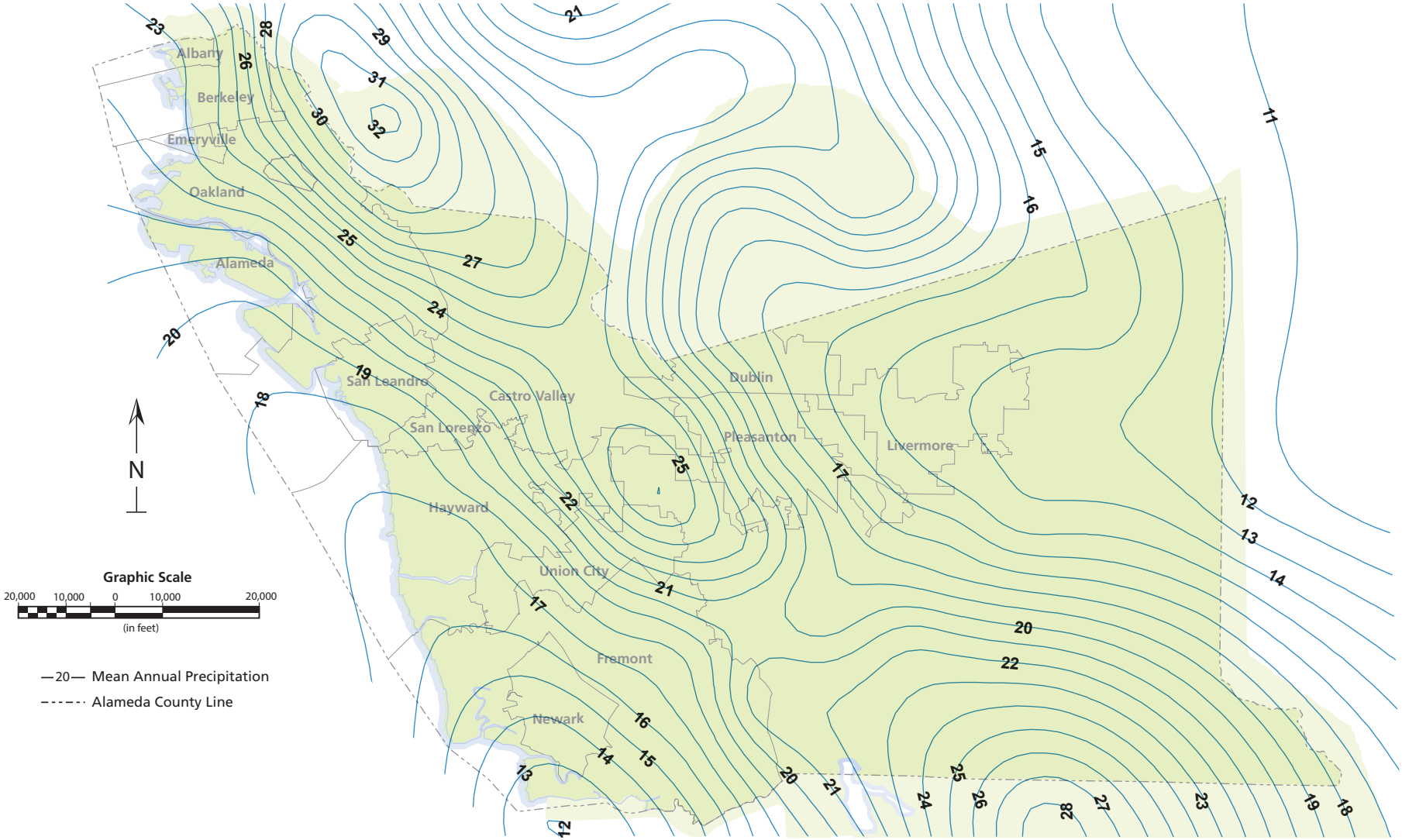
7. ***Optimize the Size of the Treatment Measure***

- If the ponding depth is less than 6 inches, the bioretention design can be optimized with a smaller surface area (i.e., repeat Steps 6 and 7 with a smaller area). If the ponding depth is greater than 12 inches, a larger surface area will be required. (In the above example, the recommended size of the bioretention area is 190 square feet with a ponding depth of 6 inches.)

Rainfall Region	M.A.P.	25% impervious	50% impervious	75% impervious	100% impervious
1	55.9	0.51	1.02	1.53	2.04
2	24.4	0.21	0.42	0.64	0.86
3	25.9	0.2	0.41	0.6	0.82
4	14.6	0.16	0.32	0.49	0.64
5	21	0.18	0.36	0.54	0.73
6	20.1	0.21	0.42	0.63	0.85
7	19.3	0.18	0.35	0.53	0.72

Attachment C-3: Mean Annual Precipitation Map

The Mean Annual Precipitation Map for Alameda County is provided on the following page.



This map is Attachment 6 of the Alameda County Hydrology & Hydraulics Manual and may be downloaded as a GIS file from the Alameda County Flood Control District website.

(District 2011)

Flood Control & Water Conservation DISTRICT

Mean Annual Precipitation

Attachment C-4: Typical Designs

Typical design drawings for GSI projects are provided on the following pages.

Table C4-1: GI Typical Designs

Sheet No.	Title of Drawing/Standard Specifications	Site Characteristics		
		Land Use	Street Classification	Other
GI-2A	Bioretention area: Plan view with street parking	Commercial, industrial, or residential	Arterial, collector, or local streets	Parking lane
GI-2B	Bioretention area: Bulbout plan view	Commercial, industrial, or residential	Arterial, collector, or local streets	Intersection with sidewalks
GI-2C	Bioretention area: Street median	Commercial, industrial, or residential	Arterial, collector, or local streets	Median
GI-3A	Bioretention Area: Sloped Sides Cross Section	Commercial, industrial, or residential	Arterial, collector, or local streets	Sidewalk
GI-3B	Bioretention Area: Vertical Side Wall Cross Section	Commercial, industrial, or residential	Arterial, collector, or local streets	Parking lane and sidewalk
GI-4	Bioretention Components: Outlet Detail	Commercial, industrial, or residential	Arterial, collector, or local streets	--
GI-5	Bioretention Components: Edge Treatment Detail	Commercial, industrial, or residential	Arterial, collector, or local streets	No parking
GI-6A	Bioretention Components: Gutter Curb Cut Inlet Detail	Commercial, industrial, or residential	Arterial, collector, or local streets	--
GI-6B	Bioretention Components: Trench Drain Curb Cut Inlet Detail	Commercial, industrial, or residential	Arterial, collector, or local streets	Parking lane and sidewalk
GI-6C	Bioretention Components: Curb Cut At Bulbout Inlet Detail	Commercial, industrial, or residential	Arterial, collector, or local streets	Intersection with Sidewalks
GI-7	Bioretention Components: Check Dam Detail	Commercial, industrial, or residential	Arterial, collector, or local streets	Slope requiring check dams
GI-8	Bioretention Components: With Bike Lane Plan View	Commercial, industrial, or residential	Arterial, collector, or local streets	Bike Lane

Source: City of Dublin, 2018

PURPOSE:

PROVISION C.3 OF THE MUNICIPAL REGIONAL STORMWATER NPDES PERMIT (MRP) REQUIRES TREATMENT OF IMPERVIOUS SURFACES USING GREEN INFRASTRUCTURE FOR BOTH PUBLIC AND PRIVATE DEVELOPMENT PROJECTS. BIORETENTION AREAS ARE EXPECTED TO BE THE MOST COMMON GREEN INFRASTRUCTURE APPLICATION IN PUBLIC RIGHT-OF-WAY (ROW). THE PURPOSE OF THE BIORETENTION AREA IS TO IMPROVE WATER QUALITY BY FILTRATION THROUGH THE BIOTREATMENT SOIL AND TO CONTROL RUNOFF PEAK FLOW RATES AND VOLUMES THROUGH STORAGE AND INFILTRATION.

NOTES & GUIDELINES:

1. THE ENGINEER SHALL ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. BIORETENTION AREA SHALL BE SIZED TO MEET THE REQUIREMENTS OF MRP PROVISION C.3 SIZING.
3. 48 HOUR MAXIMUM FACILITY DRAWDOWN TIME (TIME FOR MAXIMUM SURFACE PONDING TO DRAIN THROUGH THE BIOTREATMENT SOIL AFTER THE END OF A STORM). REFER TO C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR DRAINAGE CONSIDERATIONS.
4. A STORAGE LAYER OF CALTRANS STANDARD CLASS II PERMEABLE MATERIAL IS REQUIRED UNDER THE BIOTREATMENT SOIL. REFER TO C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR SPECIFICATIONS.
5. CHECK DAMS SHALL BE USED TO TERRACE FACILITIES TO PROVIDE SUFFICIENT PONDING FOR SLOPED INSTALLATIONS. ENGINEER SHALL SPECIFY CHECK DAM HEIGHT AND SPACING. REFER TO DETAIL **GI-7** FOR GUIDANCE ON CHECK DAM DESIGN.
6. DEPENDING ON THE DEPTH OF THE BIORETENTION AREA, ADDITIONAL STRUCTURAL CONSIDERATIONS MAY BE REQUIRED TO ADDRESS HORIZONTAL LOADING. REFER TO DETAIL **GI-5** FOR GUIDANCE ON EDGE TREATMENTS.
7. WHEN FACILITY CONSTRUCTION IMPACTS EXISTING SIDEWALK, ALL SAW CUTS SHALL ADHERE TO LOCAL JURISDICTION STANDARDS. SAW CUTS SHALL BE ALONG SCORE LINES OR ALONG CONSTRUCTION JOINTS, AS DETERMINED BY THE CITY ENGINEER, AND ANY DISTURBED SIDEWALK FLAGS SHALL BE REPLACED IN THEIR ENTIRETY.
8. BIORETENTION AREAS IN PUBLIC RIGHT OF WAY SHALL BE DESIGNED WITH AN EMERGENCY OVERFLOW. IN THE EVENT THE BIORETENTION AREA OVERFLOW DRAIN IS OBSTRUCTED OR CLOGGED, THE INUNDATION AREA SHALL BE CONTAINED WITHIN THE STREET AND SHALL NOT BE WITHIN ADJACENT PRIVATE PROPERTIES.
9. BIORETENTION AREA VEGETATION SHALL BE SPECIFIED BY LANDSCAPE DESIGN PROFESSIONAL. SEE C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR PLANT LIST AND VEGETATION GUIDANCE.
10. THE ENGINEER SHALL EVALUATE THE NEED FOR EROSION PROTECTION AT ALL INLET LOCATIONS. ALL COBBLES USED FOR ENERGY DISSIPATION SHALL BE GROUTED. ENGINEER TO CONSIDER MAINTENANCE REQUIREMENTS TO FACILITATE EASY SEDIMENT REMOVAL AND ADEQUATE VECTOR CONTROL.
11. THE PROJECT PLANS SHALL SHOW ALL EXISTING UTILITIES AND INDICATE POTENTIAL UTILITY CROSSINGS OR CONFLICTS.
12. CHECK WITH LOCAL JURISDICTION FOR UTILITY CROSSING PROVISIONS.
13. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES SHALL CONFORM TO CURRENT LOCAL JURISDICTION STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS.
14. VERTICAL SIDEWALLS EXTENDING INTO EXISTING STORM DRAIN PIPE TRENCH BACKFILL SHALL BE DESIGNED WITH A CONCRETE BACKFILL ACCEPTABLE TO THE CITY ENGINEER.
15. OVERFLOW RISER MUST BE FORMED SUCH THAT IT IS A MINIMUM OF 6" ABOVE THE BOTTOM OF THE SYSTEM INLET, OR AS DESIGNED. PLACE STRUCTURE ADJACENT TO PEDESTRIAN EDGE TO ALLOW FOR MONITORING ACCESS.
16. DETAILS WERE ADAPTED FROM SFPUC GREEN INFRASTRUCTURE TYPICAL DETAILS AND SPECIFICATIONS.
17. DETAILS WERE DEVELOPED BY GEOSYNTEC CONSULTANTS.

ENGINEER CHECKLIST (SHALL SPECIFY, AS APPLICABLE):

- ☐ BIORETENTION AREA WIDTH AND LENGTH
- ☐ DEPTH OF PONDING
- ☐ AMOUNT OF FREEBOARD PROVIDED
- ☐ DEPTH OF BIOTREATMENT SOIL (18" MIN)
- ☐ UNDERDRAIN SPECIFICATIONS AND LOCATION (IF FACILITY IS LINED PLACE UNDERDRAIN AT BOTTOM OF FACILITY)
- ☐ BIORETENTION SURFACE ELEVATION (TOP OF BIOTREATMENT SOIL) AT UPSLOPE AND DOWNSLOPE ENDS OF FACILITY
- ☐ CONTROL POINTS AT EVERY BIORETENTION WALL CORNER AND POINT OF TANGENCY
- ☐ DIMENSIONS AND DISTANCE TO EVERY INLET, OUTLET, CHECK DAM, SIDEWALK NOTCH, ETC.
- ☐ ELEVATIONS OF EVERY INLET, OVERFLOW RISER, STRUCTURE RIM AND INVERT CHECK DAM, BIORETENTION AREA WALL CORNER, AND SIDEWALK NOTCH
- ☐ TYPE AND DESIGN OF BIORETENTION AREA COMPONENTS (E.G., EDGE TREATMENTS, INLETS/GUTTER MODIFICATIONS, UTILITY CROSSINGS, LINER, AND PLANTING DETAILS)
- ☐ DEPTH AND TYPE OF MULCH (NON-FLOATING; ORGANICALLY-DERIVED; NOT BARK OR GORILLA HAIR; 3" MIN)

RELATED TECHNICAL GUIDANCE	SOURCE
BIORETENTION: - BIOTREATMENT SOIL MIX - CALTRANS CLASS II PERM LAYER STORAGE - PERFORATED UNDERDRAIN - NON-FLOATING MULCH	C.3 TECHNICAL GUIDANCE MANUAL (ACCWP)

NOT FOR CONSTRUCTION

cleanwater PROGRAM

BIORETENTION AREA: NOTES

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

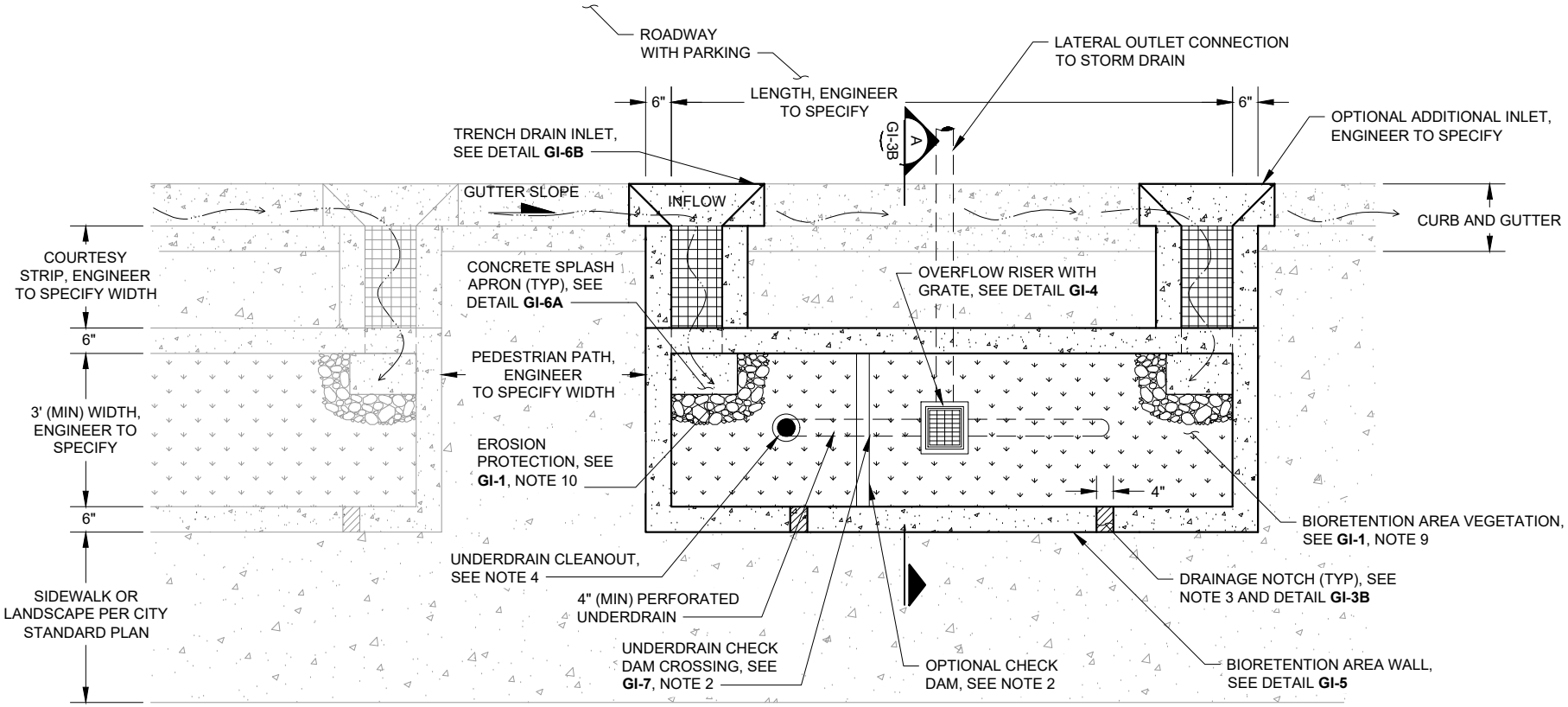
SCALE: NOT TO SCALE

DATE: MAY 11, 2018 REVISED: JUNE 11, 2019

DRAWN BY: K. K. REVISED BY: E. F.

CHECKED BY: A. R.

GI-1



NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN (SEE DETAIL **GI-7**).
3. LAY OUT DRAINAGE NOTCHES AS APPLICABLE TO PREVENT PONDING BEHIND BIORETENTION AREA WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE UNDERDRAIN CLEANOUT PER BIORETENTION AREA (MIN). CLEANOUT REQUIRED AT UPSTREAM END AND PIPE ANGLE POINTS EXCEEDING 45 DEGREES. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% (MIN).

NOT FOR CONSTRUCTION

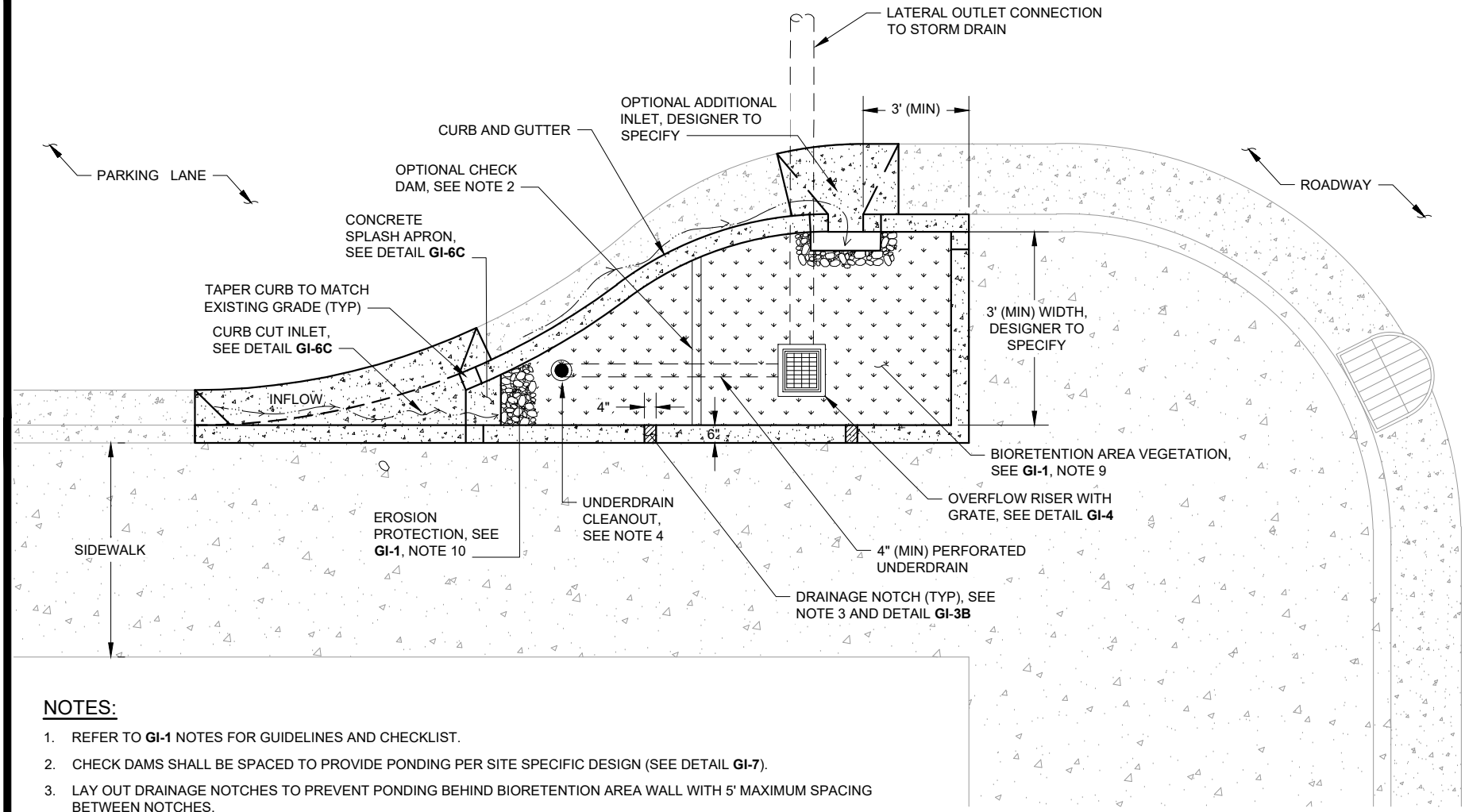
BIORETENTION AREA: PLAN VIEW WITH STREET PARKING

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K	REVISED BY: E. F.
CHECKED BY: A. R.	

GI-2A



NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN (SEE DETAIL **GI-7**).
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND BIORETENTION AREA WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE UNDERDRAIN CLEANOUT PER BIORETENTION AREA (MIN). CLEANOUT REQUIRED AT UPSTREAM END AND PIPE ANGLE POINTS EXCEEDING 45 DEGREES. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% (MIN).

NOT FOR CONSTRUCTION

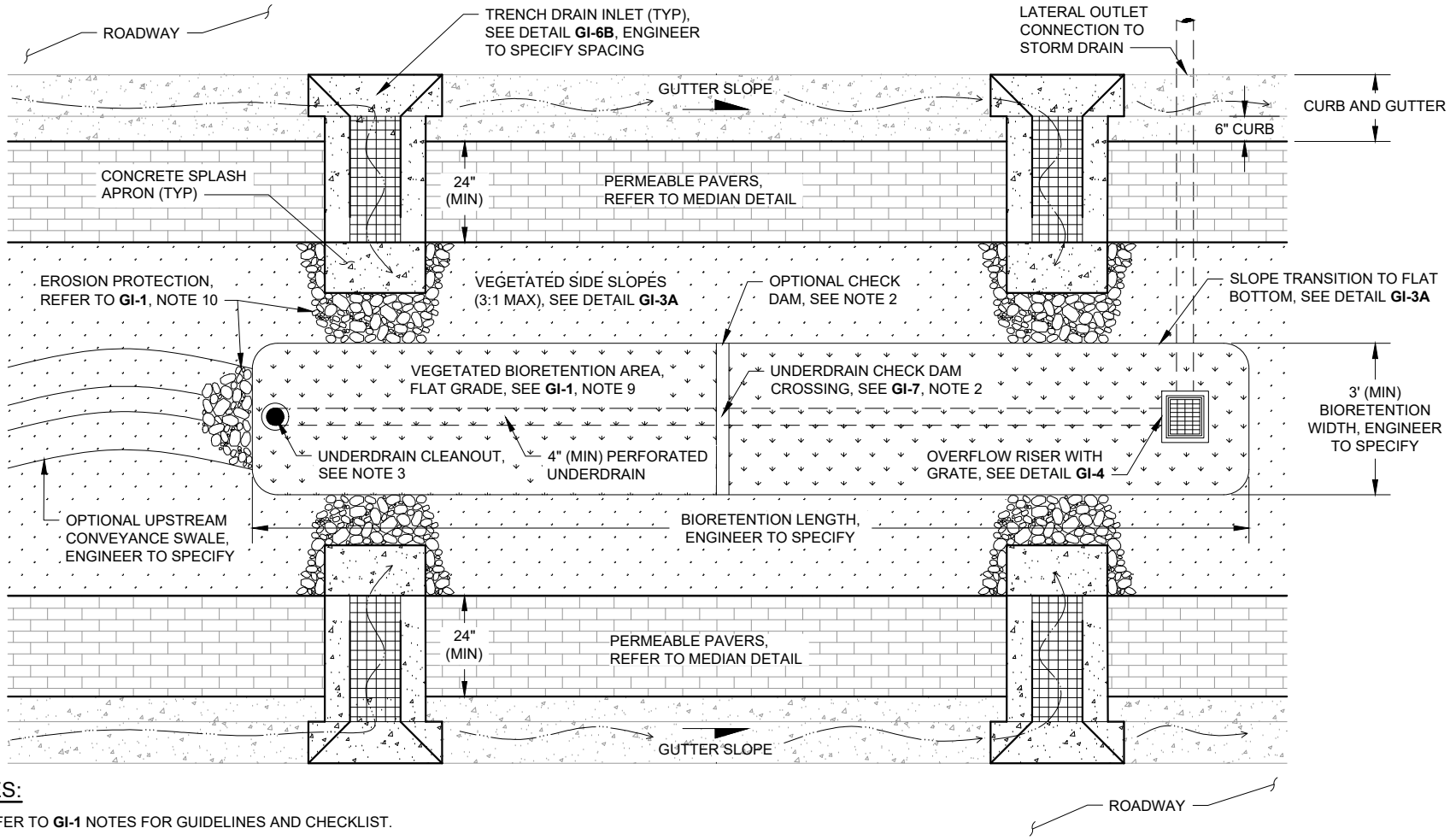
BIORETENTION AREA: BULBOUT PLAN VIEW

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E. F.
CHECKED BY: A. R.	

GI-2B



NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN (SEE DETAIL **GI-7**).
3. PROVIDE ONE UNDERDRAIN CLEANOUT PER BIORETENTION AREA (MIN). CLEANOUT REQUIRED AT UPSTREAM END AND PIPE ANGLE POINTS EXCEEDING 45 DEGREES. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% (MIN).
4. DESIGNERS TO REFERENCE AASHTO ROADSIDE SAFETY DESIGN REQUIREMENTS AND CONSIDER USE OF MEDIAN BIORETENTION AREAS IN RELATION TO STREET CLASSIFICATION AND STREET SPEEDS.
5. A STORAGE VOLUME SAFETY FACTOR OF 1.5 SHALL BE INCLUDED IN THE DESIGN OF MEDIAN BIORETENTION AREAS TO PREVENT FLOODING.
6. SLOPED SIDES (**GI-3A**) DEPICTED IN PLAN VIEW ABOVE, REFER TO **GI-3B** IF VERTICAL SIDE WALLS ARE USED.

NOT FOR CONSTRUCTION

BIORETENTION AREA: STREET MEDIAN

GREEN INFRASTRUCTURE EXAMPLE DETAILS

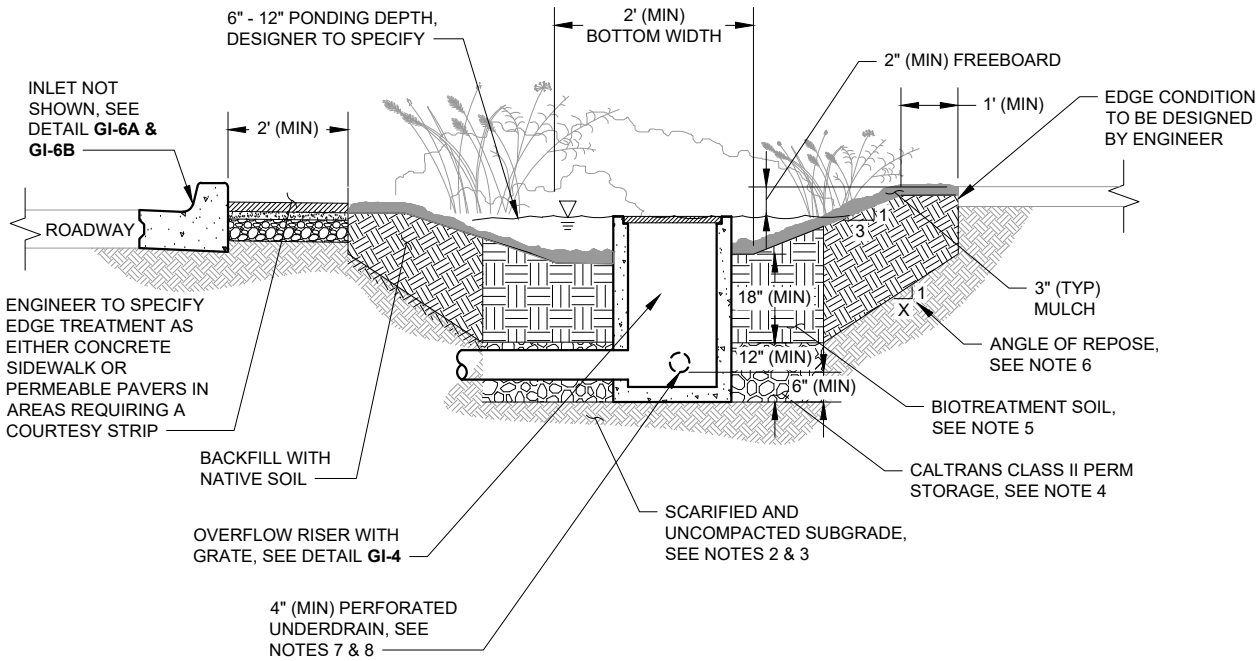
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E. F.
CHECKED BY: A. R.	

GI-2C

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. AVOID UNNECESSARY COMPACTION OF EXISTING SUBGRADE BELOW AREA.
3. SCARIFY SUBGRADE TO A DEPTH OF 3" (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF CALTRANS CLASS 2 PERMEABLE MATERIAL STORAGE LAYER AND BIOTREATMENT SOIL MATERIALS.
4. AGGREGATE STORAGE LAYER COMPRISED OF 12" MIN CALTRANS CLASS 2 PERMEABLE MATERIAL.
5. REFER TO C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR BIOTREATMENT SOIL MIX SPECIFICATIONS. INSTALL BIOTREATMENT SOIL AT 85% COMPACTION FOLLOWING BASMAA INSTALLATION GUIDANCE.
6. ANGLE OF REPOSE VARIES PER GEOTECHNICAL ENGINEER RECOMMENDATIONS.
7. UNDERDRAIN AND CLEAN OUT PIPE (1 MIN PER FACILITY) REQUIRED, REFER TO C.3 TECHNICAL GUIDANCE MANUAL (ACCWP) FOR DESIGN CONSIDERATIONS. UNDERDRAINS SHOULD BE ELEVATED 6" (MIN) WITHIN THE CALTRANS CLASS 2 PERMEABLE MATERIAL STORAGE LAYER TO PROMOTE INFILTRATION. IN FACILITIES WITH AN IMPERMEABLE LINER, THE UNDERDRAIN SHOULD BE PLACED AT THE BOTTOM OF THE CALTRANS CLASS 2 PERMEABLE MATERIAL STORAGE LAYER. PERFORATED/SLOT DRAINS SHOULD BE DOWNWARD FACING TO FACILITATE BETTER STORAGE IN THE GRAVEL LAYER.
8. THE UNDERDRAIN IN ALL FACILITIES LOCATED IN THE PUBLIC RIGHT-OF-WAY SHALL BE VIDEO RECORDED AND PROVIDED TO THE CITY FOR REVIEW PRIOR TO PROJECT ACCEPTANCE.
9. REFER TO LOCAL JURISDICTION STANDARDS FOR CURB AND SIDEWALK DETAILS.



NOT FOR CONSTRUCTION

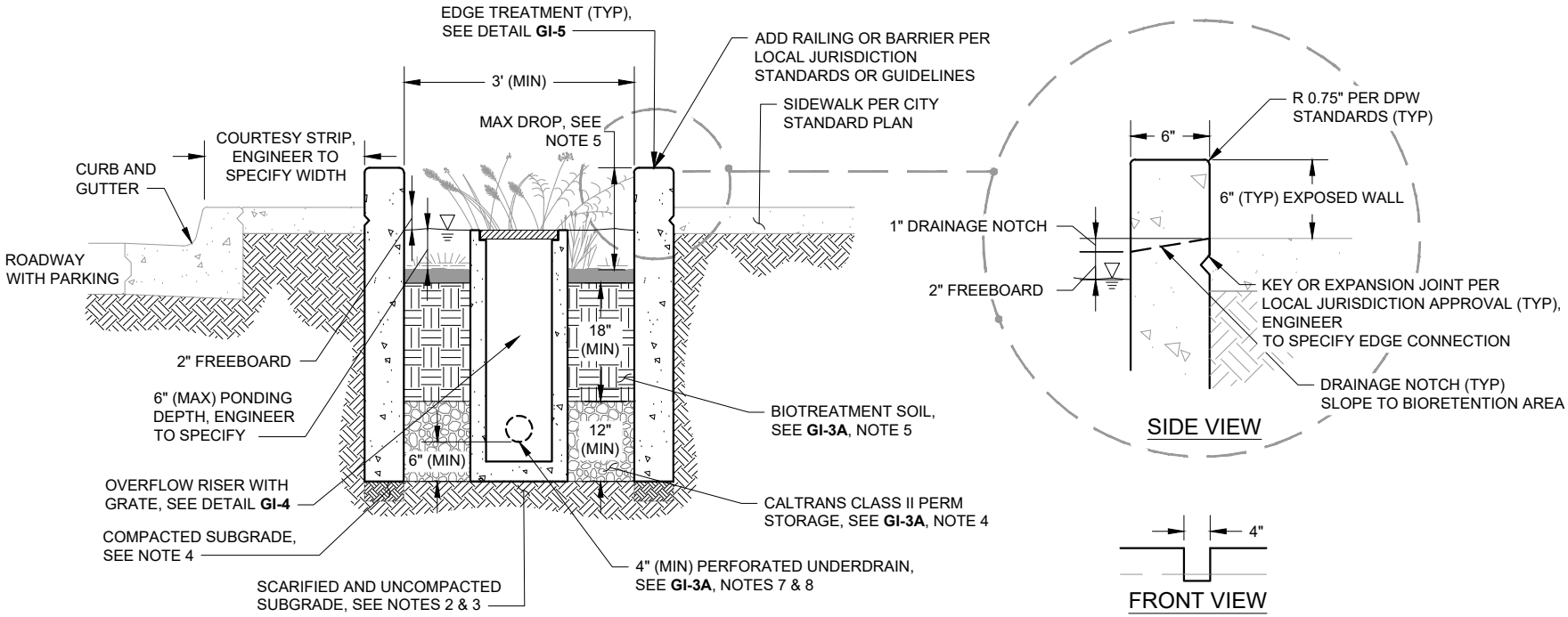
BIORETENTION AREA: SLOPED SIDES CROSS SECTION

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E. F.
CHECKED BY: A. R.	

GI-3A



BIORETENTION AREA WITH VERTICAL SIDE WALLS

DRAINAGE NOTCH DETAIL

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. AVOID UNNECESSARY COMPACTION OF EXISTING SUBGRADE BELOW BIORETENTION AREA.
3. SCARIFY SUBGRADE TO A DEPTH OF 3" (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIOTREATMENT SOIL MATERIAL.
4. FOR STRUCTURAL SUPPORT, SUBGRADE UNDER WALLS ONLY COMPACTED PER ENGINEER SPECIFICATIONS.
5. MAXIMUM DROP, PER LOCAL BUILDING CODE, FROM TOP OF CURB TO TOP OF BIOTREATMENT SOIL SHALL INCLUDE CONSIDERATIONS FOR BIOTREATMENT SOIL SETTLEMENT. THE DROP IS THE SUM OF PONDING DEPTH (6" TYP), FREEBOARD (2" TYP), AND CURB HEIGHT (6" TYP).
6. REFER TO LOCAL JURISDICTION STANDARDS FOR CURB AND SIDEWALK DETAILS.

NOT FOR CONSTRUCTION

cleanwater PROGRAM

BIORETENTION AREA: VERTICAL SIDE WALL CROSS SECTION

GREEN INFRASTRUCTURE EXAMPLE DETAILS

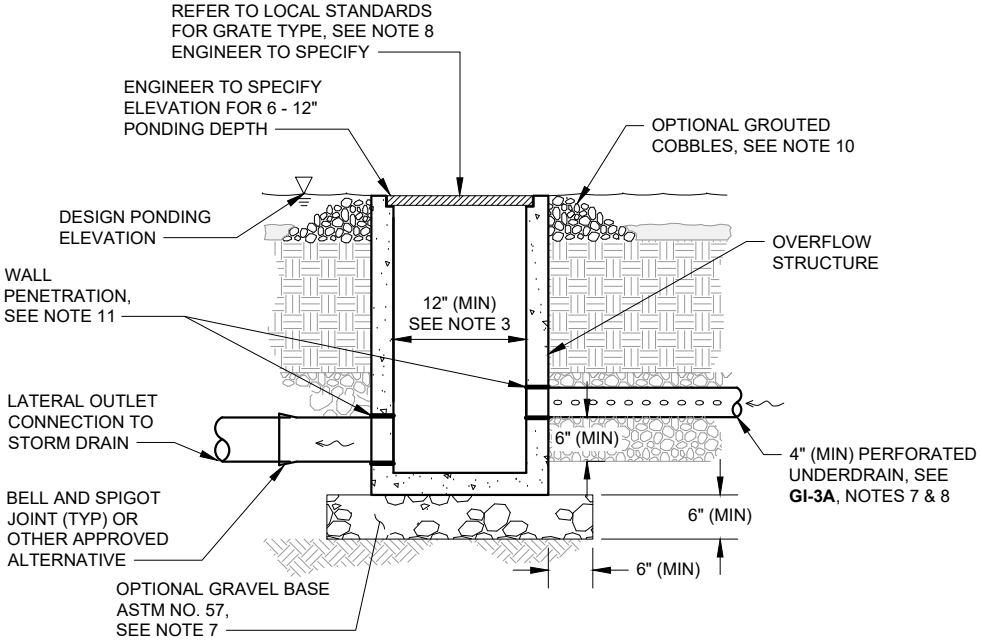
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E. F.
CHECKED BY: A. R.	

GI-3B

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. ALL MATERIAL AND WORKMANSHIP FOR OVERFLOW STRUCTURES SHALL CONFORM TO LOCAL JURISDICTION STANDARDS.
3. DESIGN OVERFLOW WEIR AND OUTLET PIPE TO CONVEY 10-YR, 24-HR STORM FLOW OR DESIGN INLET TO DIVERT FLOWS LARGER THAN THE DESIGN STORM DIRECTLY TO THE STORM DRAIN. LOCATE ALL OVERFLOW PIPES AT AN ELEVATION HIGHER THAN THE STORM SEWER HYDRAULIC GRADE LINE TO PREVENT BACKFLOW INTO THE BIORETENTION FACILITY.
4. STORM DRAIN OUTLET PIPES SHALL BE SIZED TO MEET HYDRAULIC REQUIREMENTS WITH APPROPRIATE COVER DEPTH AND PIPE MATERIAL.
5. PERFORATED UNDERDRAINS WITH CLEANOUT PIPES ARE REQUIRED. PERFORATED/SLOT DRAINS SHOULD BE DOWNWARD FACING TO FACILITATE BETTER STORAGE IN THE GRAVEL LAYER.
6. MAINTENANCE ACCESS IS REQUIRED FOR ALL OUTLET STRUCTURES AND CLEANOUT FACILITIES. 12" (MIN) CLEARANCE WITHIN OVERFLOW STRUCTURE SHALL BE PROVIDED FOR MAINTENANCE ACCESS.
7. ENGINEER SHALL REFER TO LOCAL JURISDICTION STANDARDS AND/OR ASSESS NEED FOR GRAVEL BASE. ENGINEER SHALL EVALUATE BUOYANCY OF STRUCTURES FOR SITE SPECIFIC APPLICATION AND SPECIFY THICKENED OR EXTENDED BASE / ANTI-FLOATATION COLLAR, AS NECESSARY.
8. SIZE OF GRATE SHALL MATCH SIZE OF RISER SPECIFIED IN PLANS, SHALL BE REMOVABLE TO PROVIDE MAINTENANCE ACCESS, AND SHALL BE BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM. MAXIMUM GRATE OPENING SHALL BE 2".
9. IF INTERIOR DEPTH OF OVERFLOW STRUCTURE EXCEEDS 5', A PERMANENT BOLTED LADDER AND MINIMUM CLEAR SPACE OF 30" BY 30" SHALL BE PROVIDED FOR MAINTENANCE ACCESS.
10. MINIMUM DIAMETER OF OPTIONAL GROUTED COBBLES SHALL BE LARGER THAN MAXIMUM GRATE OPENING.
11. GROUT ALL PENETRATIONS, CRACKS, SEAMS, AND JOINTS WITH CLASS "C" MORTAR.



NOT FOR CONSTRUCTION

BIORETENTION COMPONENTS: OUTLET DETAIL

GREEN INFRASTRUCTURE EXAMPLE DETAILS

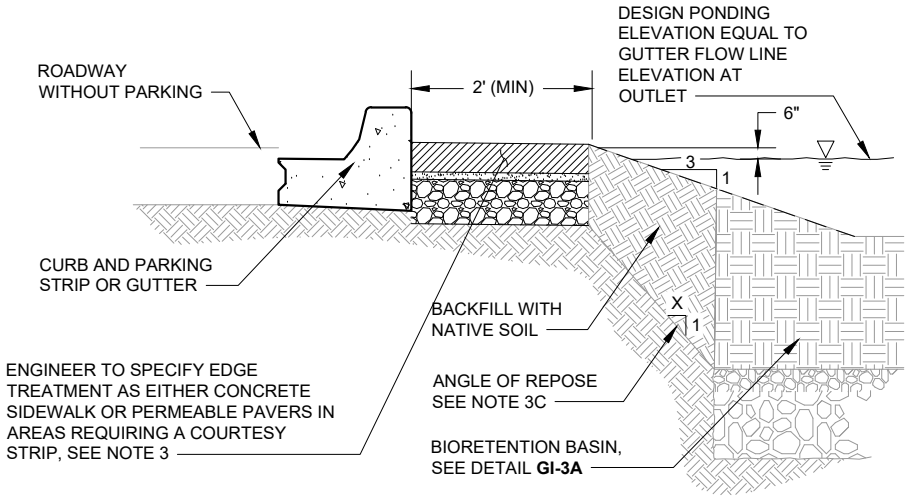
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E. F.
CHECKED BY: A. R.	

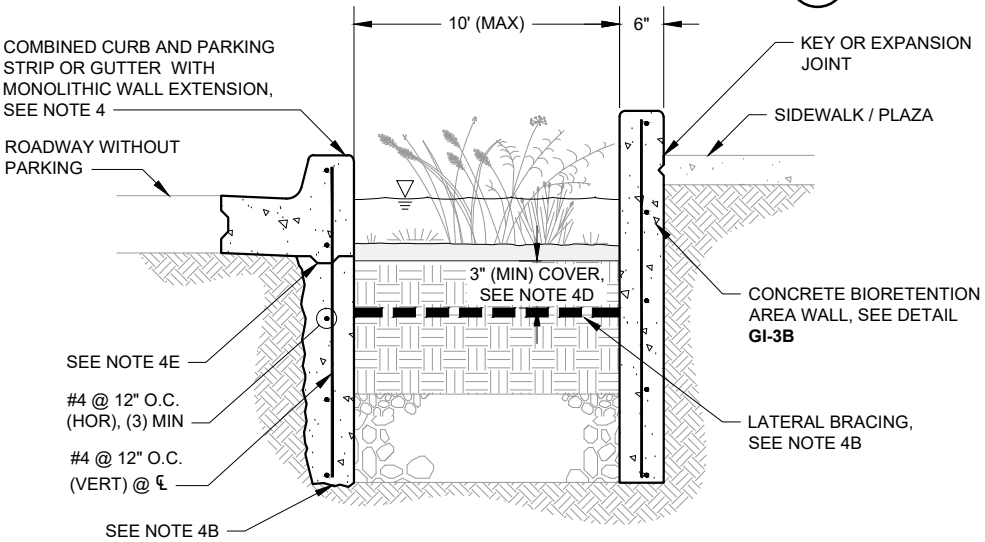
GI-4

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. THE ENGINEER SHALL ADAPT EDGE TREATMENT DESIGN TO ADDRESS SITE SPECIFIC CONSTRAINTS TO EFFECTIVELY STABILIZE ADJACENT PAVEMENT AND MINIMIZE LATERAL MOVEMENT OF WATER.
3. STANDARD CURB EDGE (WHEN SPACE AVAILABLE):
   - A. REFER TO LOCAL JURISDICTION STANDARDS FOR CURB AND SIDEWALK DETAILS.
   - B. ANGLE OF REPOSE VARIES PER GEOTECHNICAL ENGINEERS RECOMMENDATIONS.
4. VERTICAL SIDE WALLS (WHEN SPACE LIMITED):
   - A. ALL BIORETENTION AREA WALLS SHALL EXTEND TO BOTTOM OF AGGREGATE STORAGE LAYER OR DEEPER. MINIMUM DEPTHS SHALL BE DESIGNED TO PREVENT LATERAL SEEPAGE INTO THE ADJACENT PAVEMENT SECTION.
   - B. FOOTING AND/OR LATERAL BRACING SHALL SHALL BE DESIGNED BY THE ENGINEER TO WITHSTAND ANTICIPATED LOADING ASSUMING NO REACTIVE FORCES FROM THE UNCOMPACTED BIOTREATMENT SOIL.
   - C. BIORETENTION AREA WALLS EXTENDING MORE THAN 36" BELOW ADJACENT LOAD-BEARING SURFACE, OR WHEN LOCATED ADJACENT TO PAVERS, SHALL HAVE FOOTING OR LATERAL BRACING. FOOTING OR LATERAL BRACING MAY BE EXCLUDED ONLY IF THE ENGINEER DEMONSTRATES THAT THE PROPOSED WALL DESIGN MEETS LOADING REQUIREMENTS. WALL SHALL NOT ENCROACH INTO TREATMENT AREA.
   - D. CONTRACTOR TO PROVIDE 3" MINIMUM COVER OVER ALL LATERAL BRACING FOR PLANT ESTABLISHMENT.
   - E. ALL CONSTRUCTION COLD JOINTS SHALL INCORPORATE EPOXY, DOWEL/TIE BAR, KEYWAY, OR WATER STOP.



STANDARD CURB EDGE AT BIORETENTION BASIN (1)



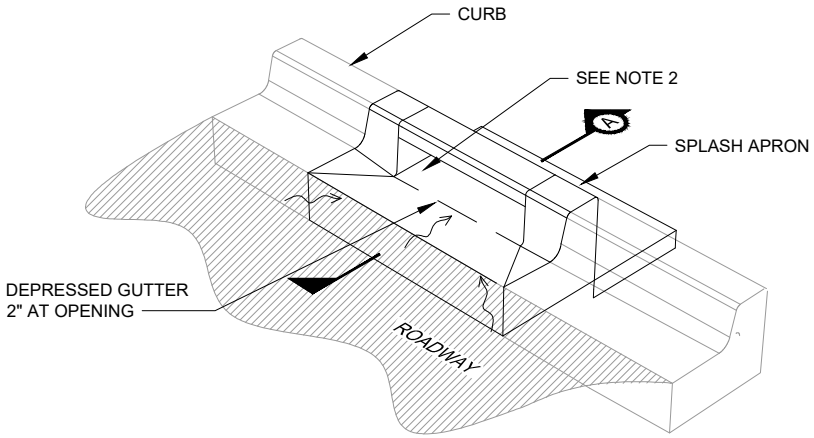
EXTENDED BIORETENTION AREA WALL WITH LATERAL BRACING (2)

NOT FOR CONSTRUCTION

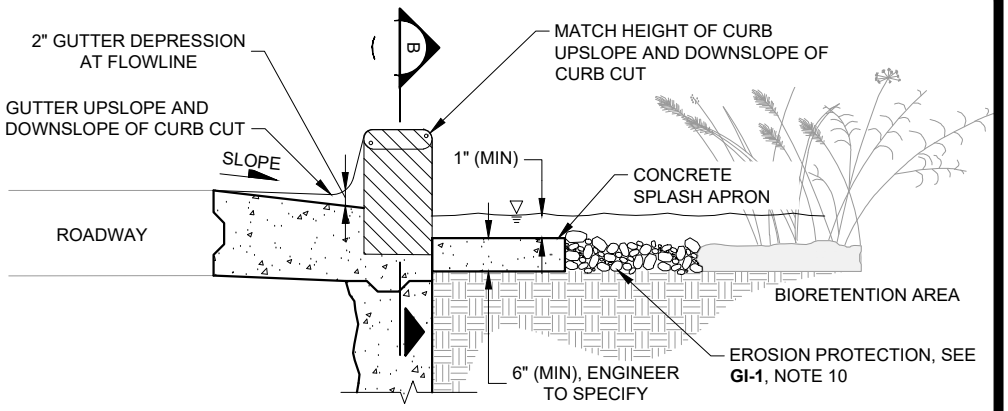
BIORETENTION COMPONENTS: EDGE TREATMENT DETAIL

GREEN INFRASTRUCTURE EXAMPLE DETAILS ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	SCALE: NOT TO SCALE	
	DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
	DRAWN BY: K. K.	REVISED BY: E. F.
	CHECKED BY: A. R.	

GI-5

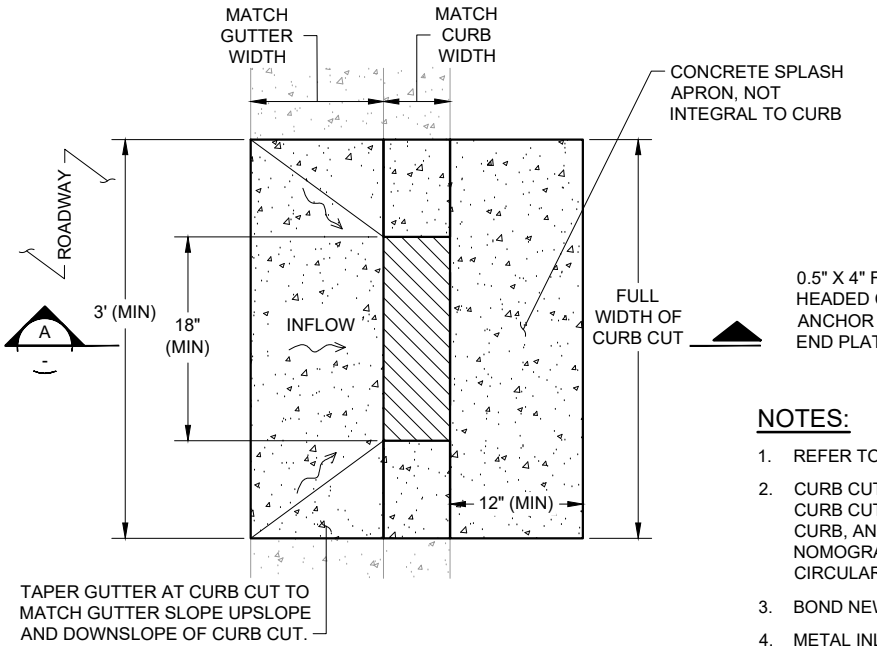


ISOMETRIC

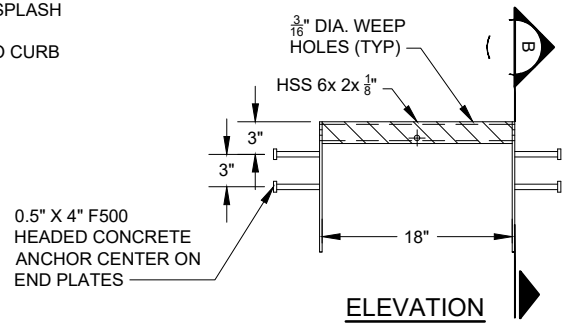


SECTION A

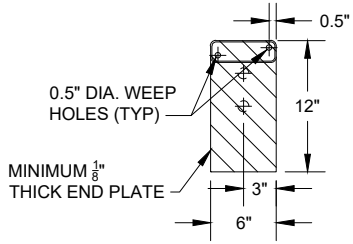
METAL INLET ASSEMBLY



PLAN



ELEVATION



SECTION B

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. CURB CUT INLETS SHALL BE ADEQUATELY SIZED, SPACED, AND SLOPED TO MEET HYDRAULIC REQUIREMENTS. THE CURB CUT OPENING WIDTH SHALL BE SIZED BASED ON THE CATCHMENT AREA, LONGITUDINAL SLOPE ALONG THE CURB, AND THE CROSS SLOPE OF THE GUTTER OR ADJACENT PAVEMENT AT THE INLET. SEE SIZING EQUATIONS AND NOMOGRAPHS FOR CURB OPENING INLETS IN THE U.S. DEPARTMENT OF TRANSPORTATION HYDRAULIC ENGINEERING CIRCULAR NO. 27.
3. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
4. METAL INLET ASSEMBLY SHALL BE HOT-DIP GALVANIZED IN ACCORDANCE WITH ASTM A-123.

NOT FOR CONSTRUCTION

cleanwater PROGRAM

BIORETENTION COMPONENTS: GUTTER CURB CUT INLET DETAIL

GREEN INFRASTRUCTURE EXAMPLE DETAILS

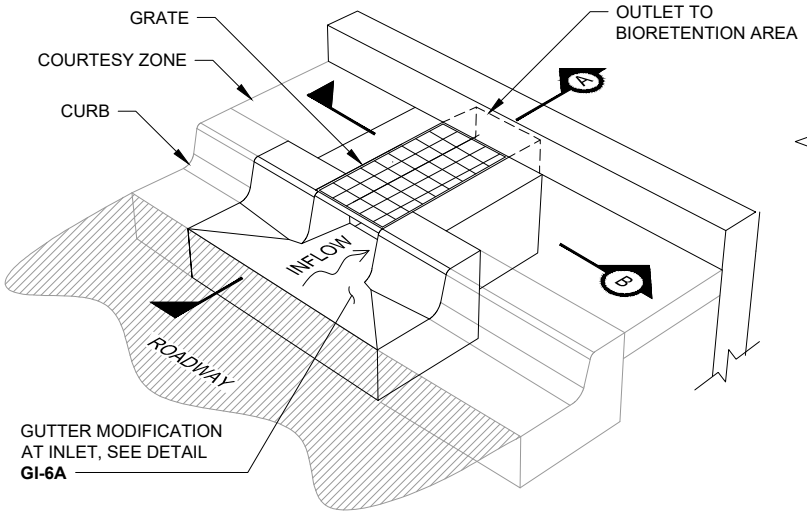
ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E.F.
CHECKED BY: A. R.	

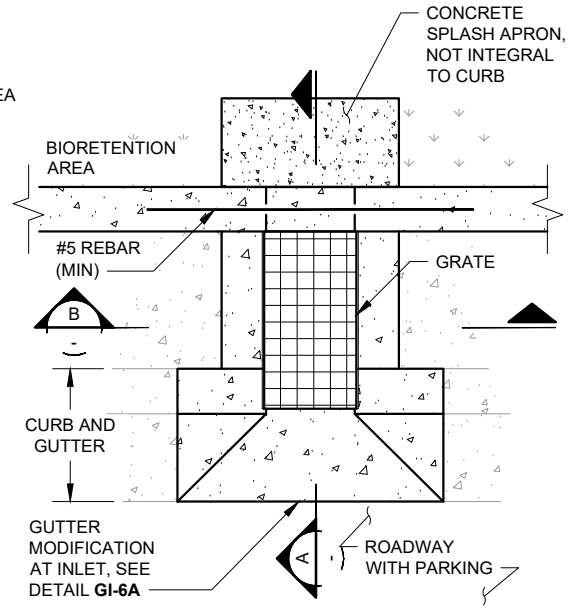
GI-6A

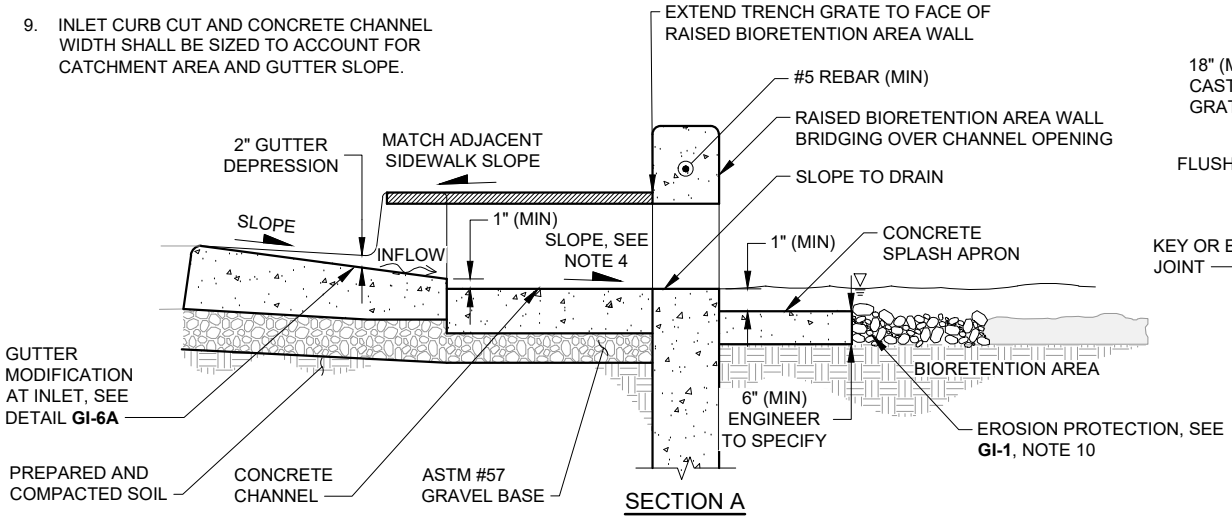
NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. ALL MATERIAL AND WORKMANSHIP FOR TRENCH DRAIN ASSEMBLY SHALL CONFORM TO LOCAL JURISDICTION STANDARDS.
3. TRENCH DRAIN INLETS SHALL BE ADEQUATELY SIZED, SPACED, AND SLOPED TO MEET HYDRAULIC REQUIREMENTS. SEE NOTE 2 DETAIL **GI-6A** FOR REFERENCE.
4. SLOPE TO PROVIDE AT LEAST 1" DROP OVER LENGTH OF CHANNEL OR A MINIMUM OF 2%, WHICHEVER IS LARGER.
5. ALL TRENCH GRATES SHALL BE REMOVABLE, RATED PER THE ANTICIPATED LOADING, AND BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM, FLUSH OR RECESSED IN GRATE.
6. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
7. HORIZONTAL CONTROL JOINTS SHALL BE PROVIDED EVERY 10' (LINEAR), OR PER MANUFACTURER'S RECOMMENDATIONS.
8. APPLY EPOXY BONDING AGENT AT ALL TRENCH DRAIN CONSTRUCTION COLD JOINTS.
9. INLET CURB CUT AND CONCRETE CHANNEL WIDTH SHALL BE SIZED TO ACCOUNT FOR CATCHMENT AREA AND GUTTER SLOPE.

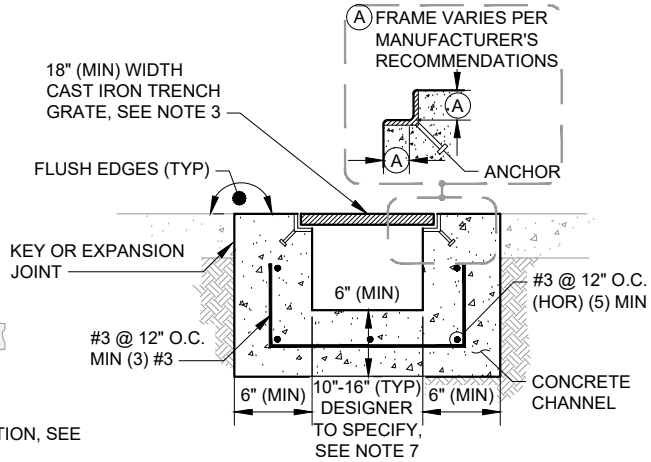


ISOMETRIC





SECTION A



SECTION B

NOT FOR CONSTRUCTION

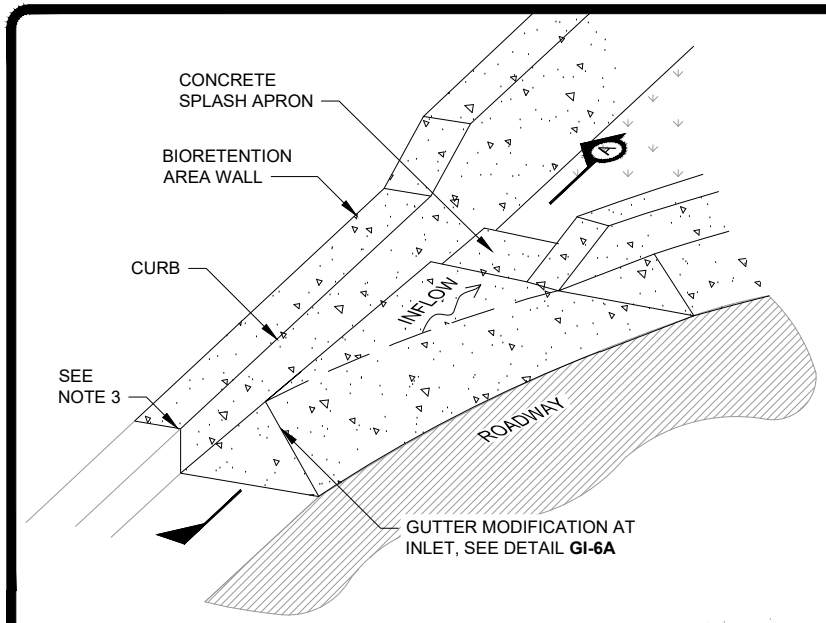
BIORETENTION COMPONENTS: TRENCH DRAIN CURB CUT INLET DETAIL

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E.F.
CHECKED BY: A. R.	

GI-6B



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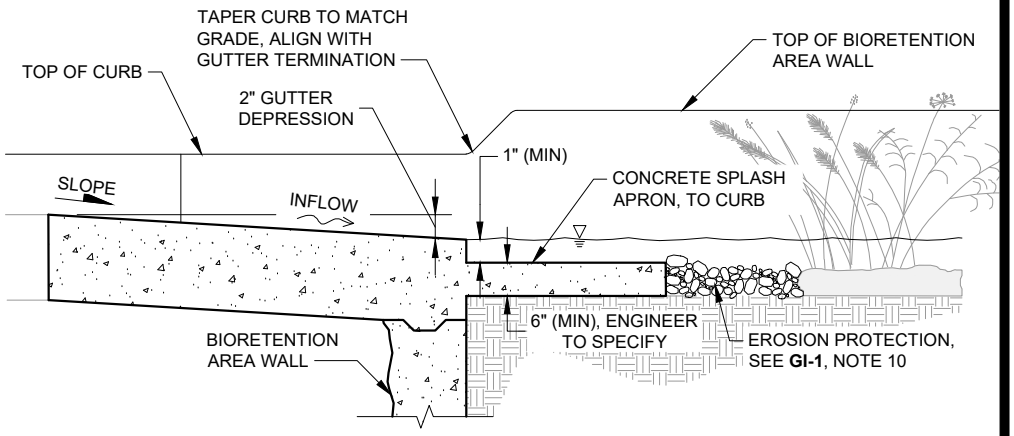
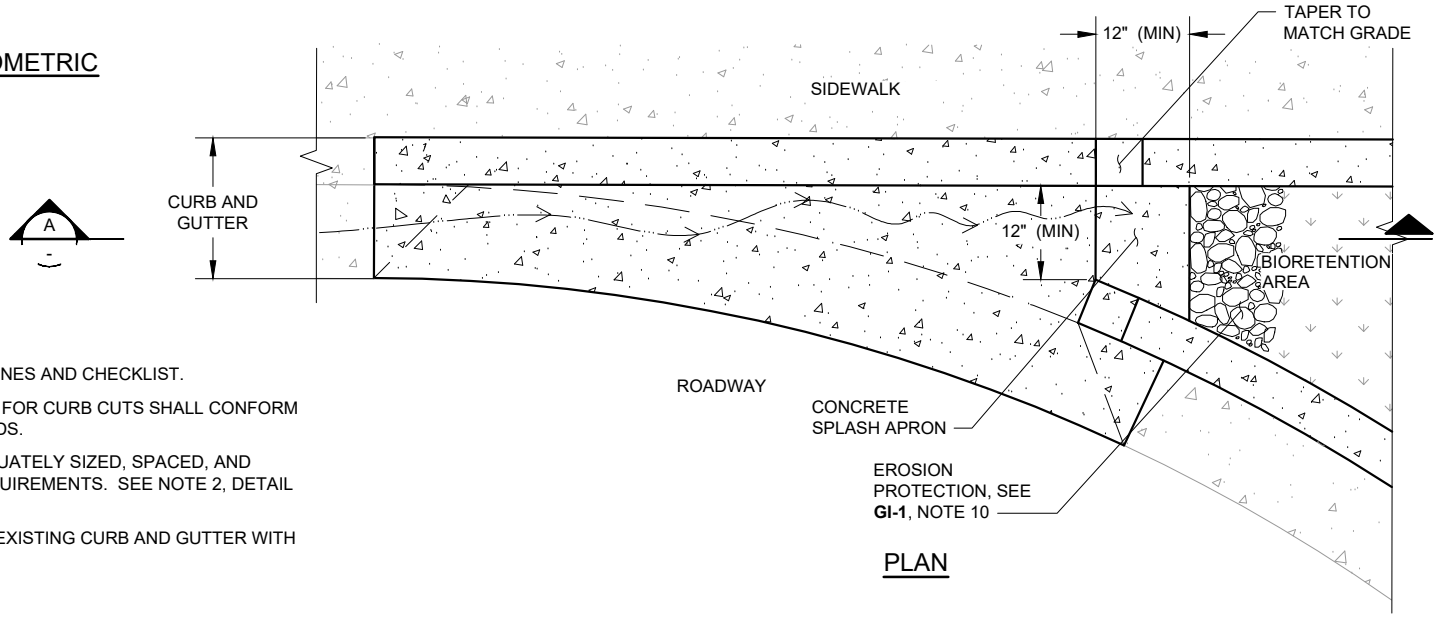


SECTION A



PLAN

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. ALL MATERIAL AND WORKMANSHIP FOR CURB CUTS SHALL CONFORM TO LOCAL JURISDICTION STANDARDS.
3. CURB CUT INLETS SHALL BE ADEQUATELY SIZED, SPACED, AND SLOPED TO MEET HYDRAULIC REQUIREMENTS. SEE NOTE 2, DETAIL **GI-6A** FOR REFERENCE.
4. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.

NOT FOR CONSTRUCTION

BIORETENTION COMPONENTS: CURB CUT AT BULBOUT INLET DETAIL

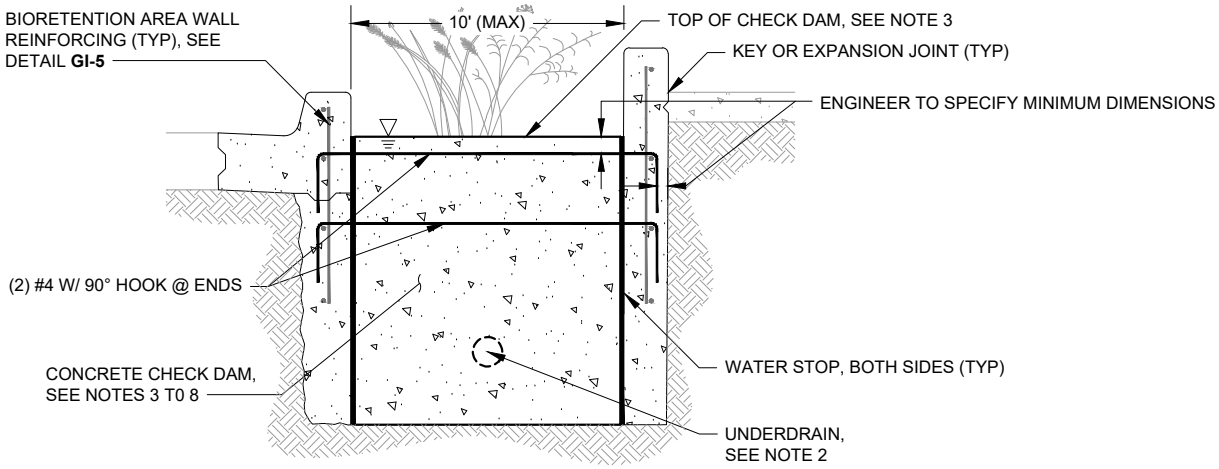
cleanwater PROGRAM

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E. F.
CHECKED BY: A. R.	

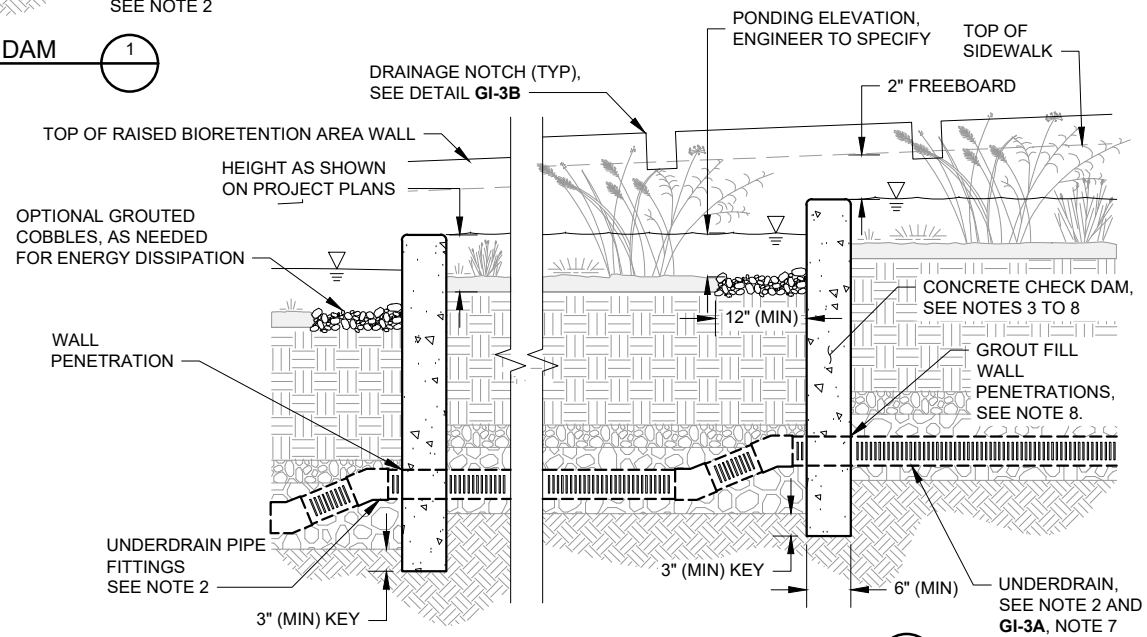
GI-6C



SECTION - CONCRETE CHECK DAM (1)

NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. UNDERDRAIN TO PASS THROUGH CHECK DAM IN NON-PERFORATED PIPE. PIPE FITTINGS SHALL BE USED TO ACCOMMODATE CHANGES IN GRADE, AS NEEDED.
3. HEIGHT AND SPACING OF CHECK DAMS SHALL BE ESTABLISHED BASED ON THE PONDING DEPTH REQUIRED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS AND THE MAXIMUM DESIRED DROP FROM THE SURROUNDING GRADE TO THE FACILITY BOTTOM.
4. ALL MATERIAL AND WORKMANSHIP FOR CHECK DAM ASSEMBLY SHALL CONFORM TO LOCAL JURISDICTION STANDARD SPECIFICATIONS.
5. CONCRETE CHECK DAM SHALL BE CONTINUOUS (NO JOINTS) AND REINFORCED WITH #4 BAR, PLACED AT 18" ON CENTER, EACH WAY.
6. CONCRETE CHECK DAM SHALL BE DESIGNED BY THE ENGINEER AND MEET STRUCTURAL REQUIREMENTS FOR LATERAL BRACING WHEN USED AS LATERAL BRACING.
7. TOP OF CHECK DAM TO BE LEVEL WITH CREST ELEVATION MATCHING PONDING ELEVATION UNLESS NOTCH SIZED TO CONVEY DESIGN FLOWS PROVIDED.
8. GROUT ALL PENETRATIONS, CRACKS, SEAMS, AND JOINTS WITH CLASS "C" MORTAR.



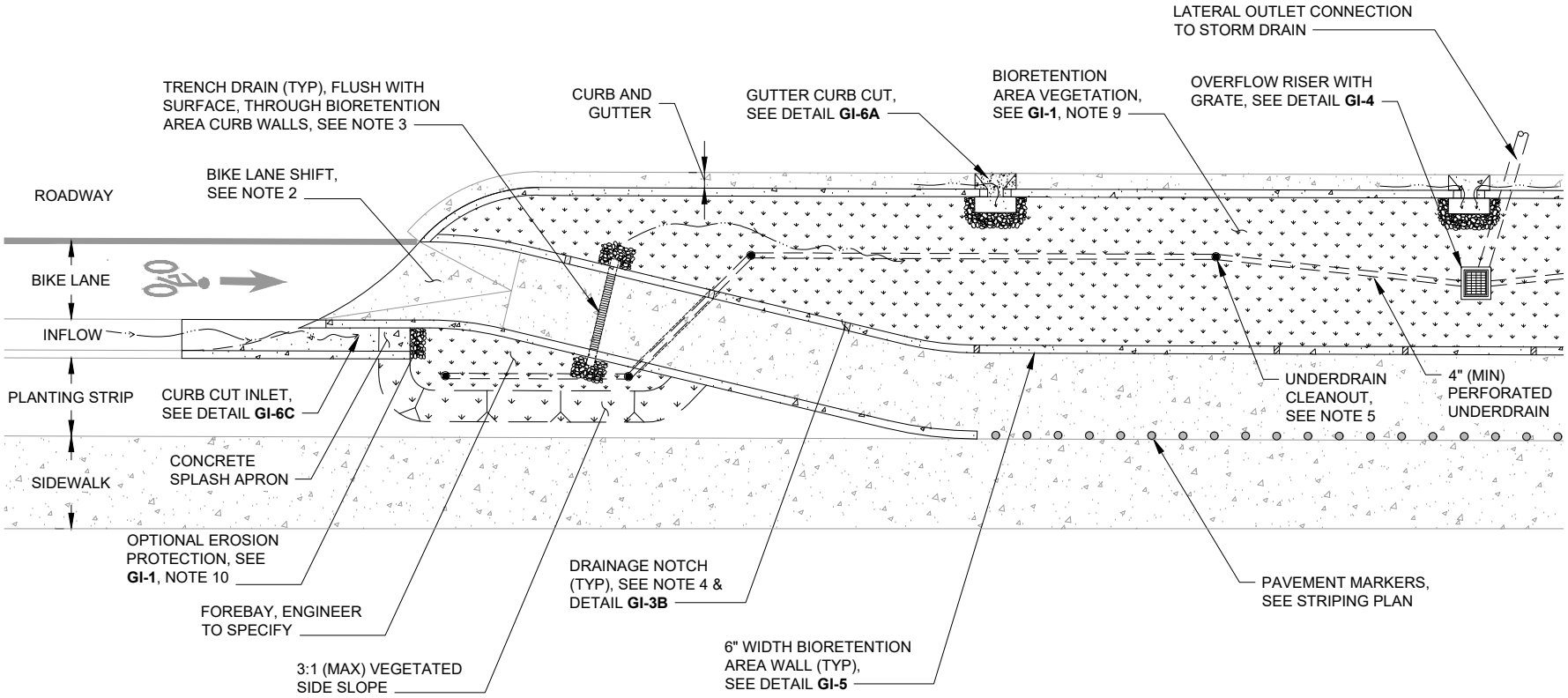
PROFILE - CONCRETE CHECK DAM (2)

NOT FOR CONSTRUCTION

BIORETENTION COMPONENTS: CHECK DAM DETAIL

GREEN INFRASTRUCTURE EXAMPLE DETAILS ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM	SCALE: NOT TO SCALE	
	DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
	DRAWN BY: K. K.	REVISED BY: E. F.
	CHECKED BY: A. R.	

GI-7



NOTES:

1. REFER TO **GI-1** NOTES FOR GUIDELINES AND CHECKLIST.
2. RAMP BIKE LANE UP ONTO BULBOUT AND SHIFT LANE OVER. MAXIMUM 1:5 HORIZONTAL TRANSITION RATE. TRANSITION GEOMETRY SHALL CONFORM TO LOCAL JURISDICTION STANDARDS.
3. HYDRAULIC CONNECTION OF SEPARATED BIORETENTION AREAS PROVIDED BY TRENCH DRAINS. ENGINEER TO SPECIFY, FOLLOWING FLOW AND STRUCTURAL REQUIREMENTS.
4. LAY OUT DRAINAGE NOTCHES AS APPLICABLE TO PREVENT PONDING BEHIND BIORETENTION AREA WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
5. PROVIDE ONE UNDERDRAIN CLEANOUT PER BIORETENTION AREA (MIN). CLEANOUT REQUIRED AT UPSTREAM END AND PIPE ANGLE POINTS EXCEEDING 45 DEGREES. LONGITUDINAL SLOPE OF PIPE SHALL BE 0.5% (MIN). PIPE SLEEVES REQUIRED FOR UNDERDRAINS TRANSITIONING BETWEEN BIORETENTION AREAS.
6. DRAWING GI-XX MODIFIED FROM THE BASMAA URBAN GREENING BAY AREA TYPICAL GI DETAILS FIGURE C-1.4.

NOT FOR CONSTRUCTION

cleanwater PROGRAM

BIORETENTION AREA: WITH BIKE LANE PLAN VIEW

GREEN INFRASTRUCTURE EXAMPLE DETAILS

ALAMEDA COUNTYWIDE CLEAN WATER PROGRAM

SCALE: NOT TO SCALE	
DATE: MAY 11, 2018	REVISED: JUNE 11, 2019
DRAWN BY: K. K.	REVISED BY: E. F.
CHECKED BY: A. R.	

GI-8

Attachment C-5: Capital Improvement Projects Sign-off Form

The Clean Water Program's Capital Improvement Projects Sign-off Form is provided on the following pages. This form is used by the agency to document whether a Regulated Project (as defined in Provision C.3.b) has complied with Provision C.3 requirements, and whether a non-Regulated Project has been evaluated for GI potential.

How to Use the

C.3 Stormwater Compliance Sign-off Form for Capital Improvement Program (CIP) Projects

Introduction

The attached checklist is for Alameda Countywide Clean Water Program (Clean Water Program) member agencies to document that capital improvement program (CIP) projects either are exempt or have complied with the requirements for C.3 Regulated Projects, as defined in Provision C.3.b of the Municipal Regional Stormwater Permit (MRP), issued by the San Francisco Bay Regional Water Quality Control Board on November 19, 2015.

Step-by-Step Instructions

1. Fill out the project information at the top of the form (Project Name, Address, etc.)

2. Review the project description and the square footage of impervious surfaces that will be created and/or replaced by the project to determine whether the project may meet any of the conditions identified in the form, under the heading, "Project is NOT a C.3 Regulated Project and the Review of GI Potential Is Documented." If the project meets any of those conditions, check the appropriate box (or boxes).
   - If one or more boxes are checked, the project is NOT a C.3 Regulated Project. Continue to Step 3.
   - If no boxes are checked, the project IS a C.3 Regulated Project. Skip to Step 4.

3. Refer to the Clean Water Program's Worksheet for Identifying GI Potential in Municipal CIP Projects[1] (or your agency's equivalent worksheet or form) to evaluate the project for the potential to include green infrastructure (GI). In the C.3 Stormwater Compliance Sign-off Form for CIP Projects, under the subheading, "Green Infrastructure Potential Review," check the box to indicate the name of the worksheet or form that was used for this review, and indicate the date on which the worksheet or form was completed.
   - Skip to Step 5.

4. Refer to the project's stormwater control plan, construction documents, and/or other project documentation, such as a completed Stormwater Requirements Checklist[2], to determine whether the requirements for C.3 Regulated Projects have been met. If all requirements have been met, including the hydromodification management (HM) requirements in Provision C.3.g (if applicable) and the documentation of operation and maintenance responsibility as required by Provision C.3.h.ii.(1), check the box to indicate the name of the applicable document(s), and write the date of the document(s).
   - Continue to Step 5.

5. Sign and date the completed C.3 Stormwater Compliance Sign-off Form for CIP Projects.

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[1] The worksheet is available on the New Development Subcommittee's members only website at: https://cleanwaterprogram.org/index.php/committees/new-development-committee.html.

[2] The checklist is available on the Clean Water Program's public website at: https://cleanwaterprogram.org/. Click on "Resources," then "Development," and scroll down to "Stormwater Requirements Checklist."

C.3 Stormwater Compliance Sign-off Form for Capital Improvement Program (CIP) Projects

This form references Provision C.3 of the Municipal Regional Stormwater Permit (MRP), issued by the San Francisco Bay Regional Water Quality Control Board on November 19, 2015.

Project Name:

Project Address: APN:

Contact Person:

Contact Phone: Contact Email:

☐ **Project is NOT a C.3 "Regulated Project" and the Review of "GI Potential" Is Documented.**

C.3 "Regulated Project" Review

The project is NOT a C.3 "Regulated Project" based on the Regulated Project definitions in Provision C.3.b as indicated below. Please check the applicable box(es):

- ☐ Project would create and/or replace less than 5,000 square feet of impervious area.
- ☐ Project would create and/or replace less than 10,000 square feet of impervious area **AND** project does not include auto service/maintenance facilities, restaurants, uncovered parking areas (stand-alone or as part of a larger project), or structures with rooftop parking.
- ☐ Project is a Road Project **AND** project would construct less than 10,000 square feet of new contiguous impervious area when the following are excluded from the calculation:[3]
  - o Sidewalks built as part of new streets or roads that direct stormwater runoff to adjacent vegetated areas.
  - o Bicycle lanes built as part of new streets or roads that are not hydraulically connected to the new streets or roads and that direct stormwater runoff to adjacent impervious areas.
  - o Impervious trails that are:
    - A. less than 10 feet wide and more than 50 feet away from the top of a creek bank.

    OR

    - B. designed to direct stormwater runoff to adjacent vegetated areas or other non-erodible permeable areas (preferably away from creeks or towards the outboard side of levees).
  - o Sidewalks, bicycle lanes, or trails constructed with permeable surfaces (pervious concrete, porous asphalt, unit pavers, or granular materials).
  - o Caltrans highway projects and associated facilities.
- ☐ Project consists of interior remodel.
- ☐ Project consists of routine maintenance and repairs (e.g., roof replacement, replacement of exterior wall surface, and/or pavement resurfacing) within the existing footprint.

[3] *When calculating the impervious area of a Road Project, include all roadway surfaces related to creation of additional traffic lanes (including, for example, passing lanes and turning pockets). Shoulders and widened portion of existing lanes may be excluded from the calculation.*

"Green Infrastructure (GI) Potential" Review

Capital improvement program (CIP) projects that are NOT C.3 Regulated Projects must be reviewed to determine whether they have green infrastructure (GI) potential, as required in Provision C.3.j.ii.(2). When conducting these reviews, agencies should follow the Bay Area Municipal Stormwater Management Agencies Association's (BASMAA) Guidance for Identifying GI Potential in Municipal CIP Projects. One way to follow this guidance is to use the Clean Water Program's Worksheet for Identifying GI Potential in Municipal CIP Projects. These documents can be downloaded from www.cleanwaterprogram.com (click "Resources," then "Development"). Please attach documentation to demonstrate that the project was reviewed for GI potential.

The non-C.3 Regulated Project has been reviewed for GI potential as shown in the following document(s):

- ☐ Worksheet for Identifying GI Potential in Municipal CIP Projects, dated: _____
- ☐ Other documentation (describe): _____

☐ **Project IS a C.3 "Regulated Project" — Compliance Documented.**

The C.3 Regulated Project has met all requirements for C.3 Regulated Projects as shown in the following documents:

- ☐ Stormwater Control Plan, dated: _____
- ☐ Construction Documents, dated: _____
- ☐ Other documentation (describe): _____

_____

Signature Date

_____

Name Title

Attachment C-6: BASMAA Guidance for Sizing Green Infrastructure Facilities in Street Projects with Analysis

The Bay Area Stormwater Management Agencies Association guidance for sizing green stormwater infrastructure facilities provided June 2019 is provided on the following pages.

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.

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[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:
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December 13, 2017

B A S M A A
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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

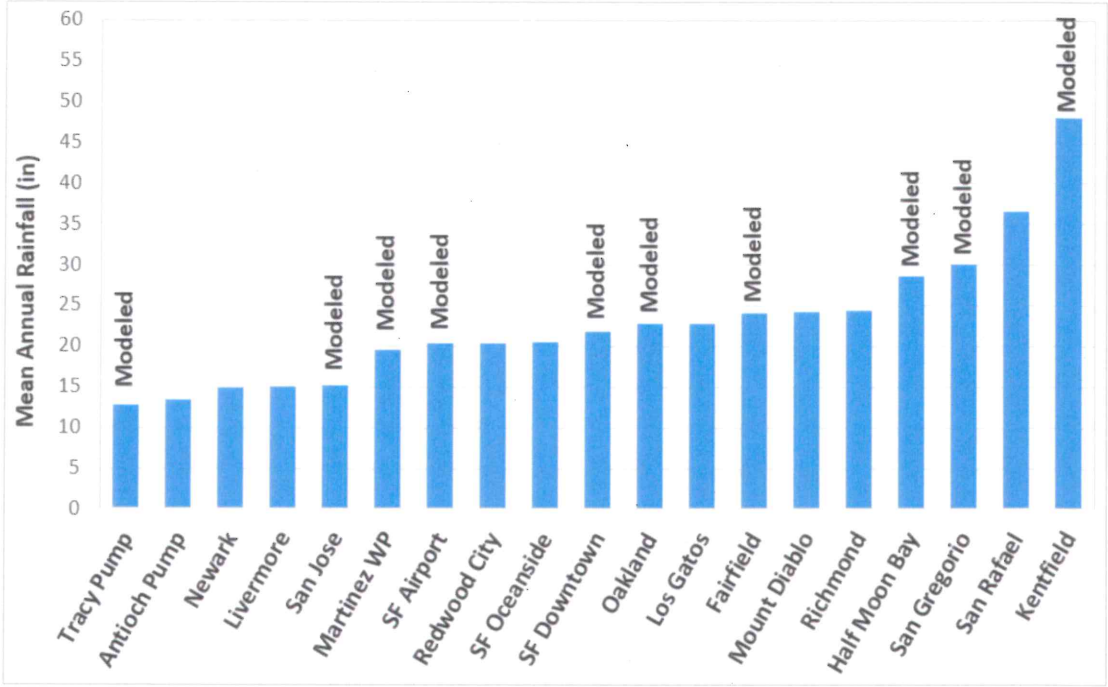
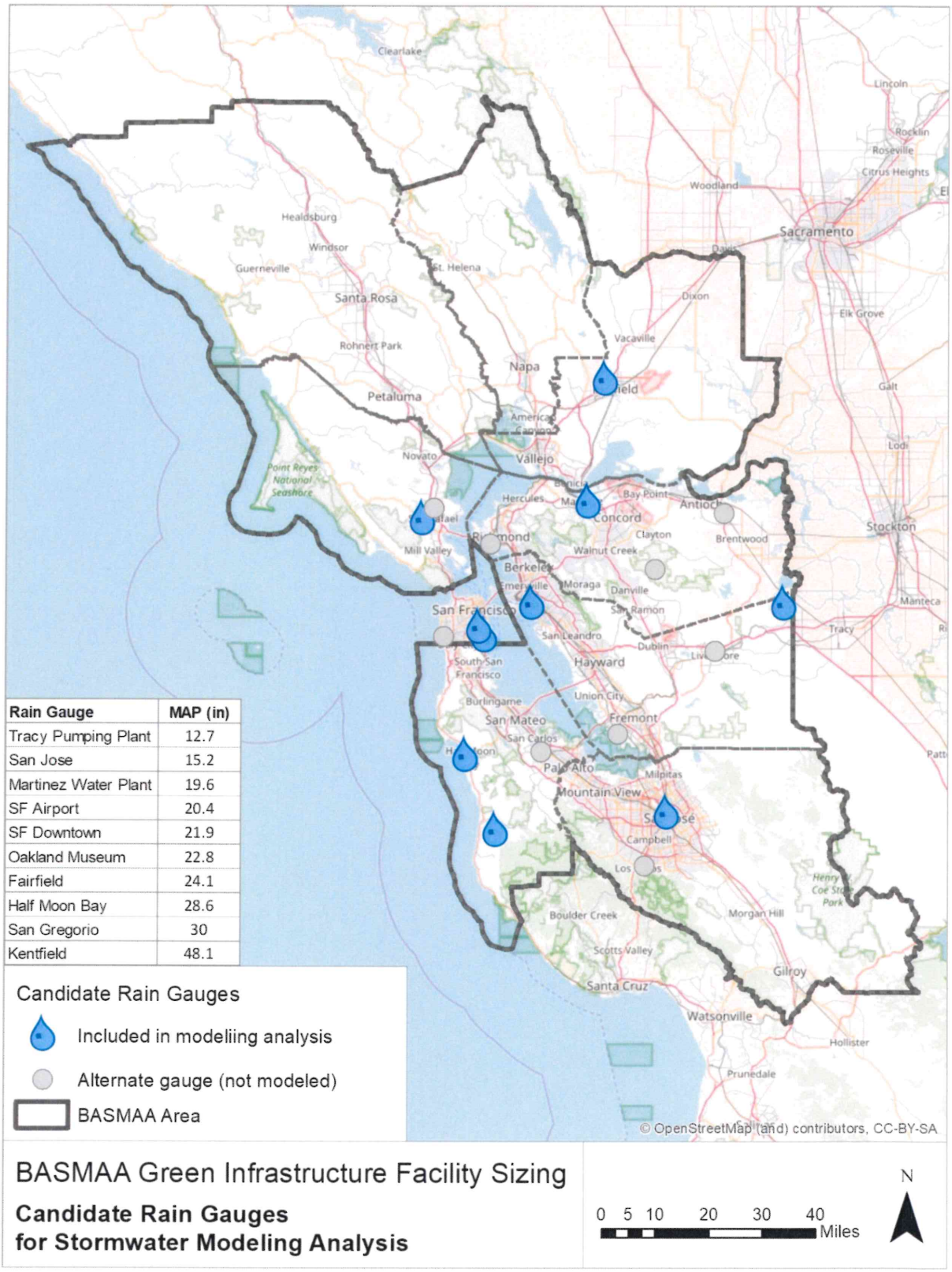


Figure 1. Candidate and selected rainfall sites with mean annual rainfall



Rain Gauge	MAP (in)
Tracy Pumping Plant	12.7
San Jose	15.2
Martinez Water Plant	19.6
SF Airport	20.4
SF Downtown	21.9
Oakland Museum	22.8
Fairfield	24.1
Half Moon Bay	28.6
San Gregorio	30
Kentfield	48.1

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.

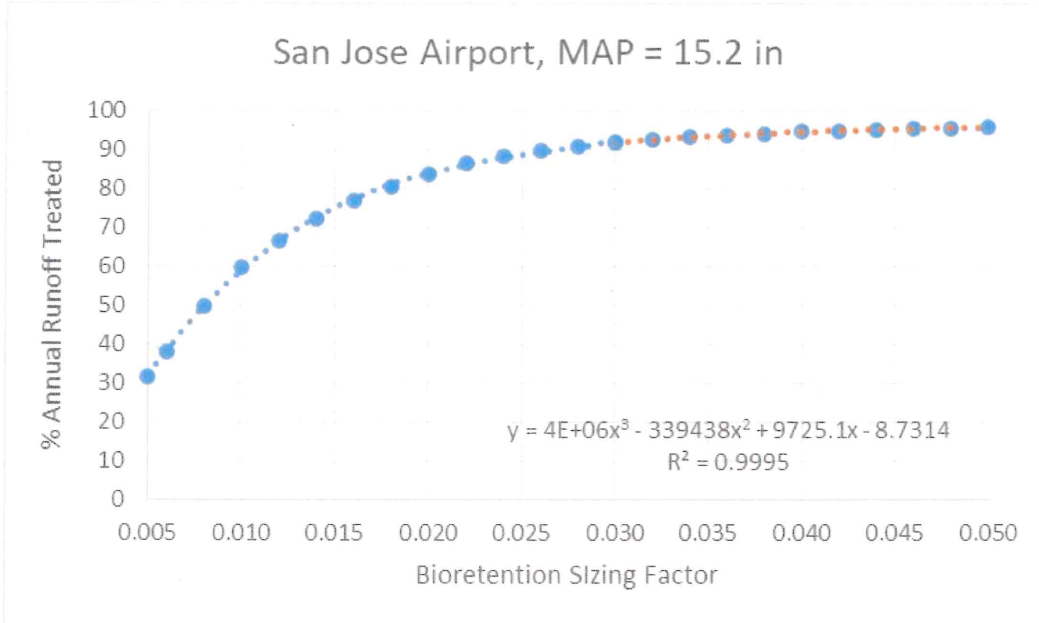


Figure 3. Percent of annual runoff treated for range of bioretention facility sizes using San Jose rain gauge

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.

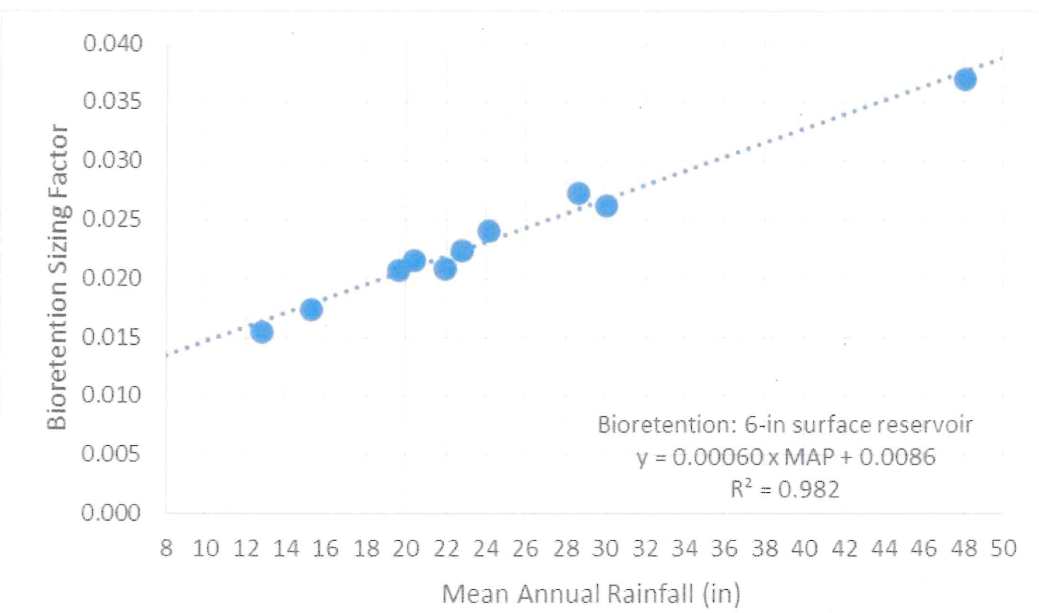


Figure 4. Bioretention size needed to provide treatment of 80 percent of annual runoff; 6-in surface reservoir

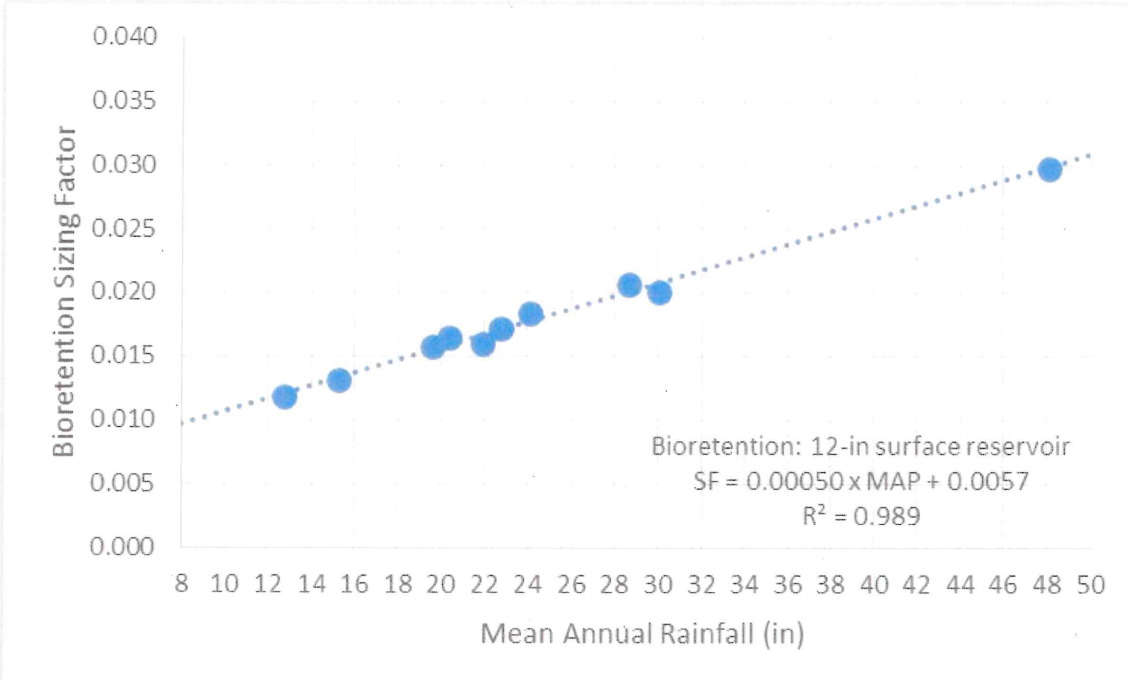


Figure 5. Bioretention size needed to provide treatment of 80 percent of annual runoff; 12-in surface reservoir

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.

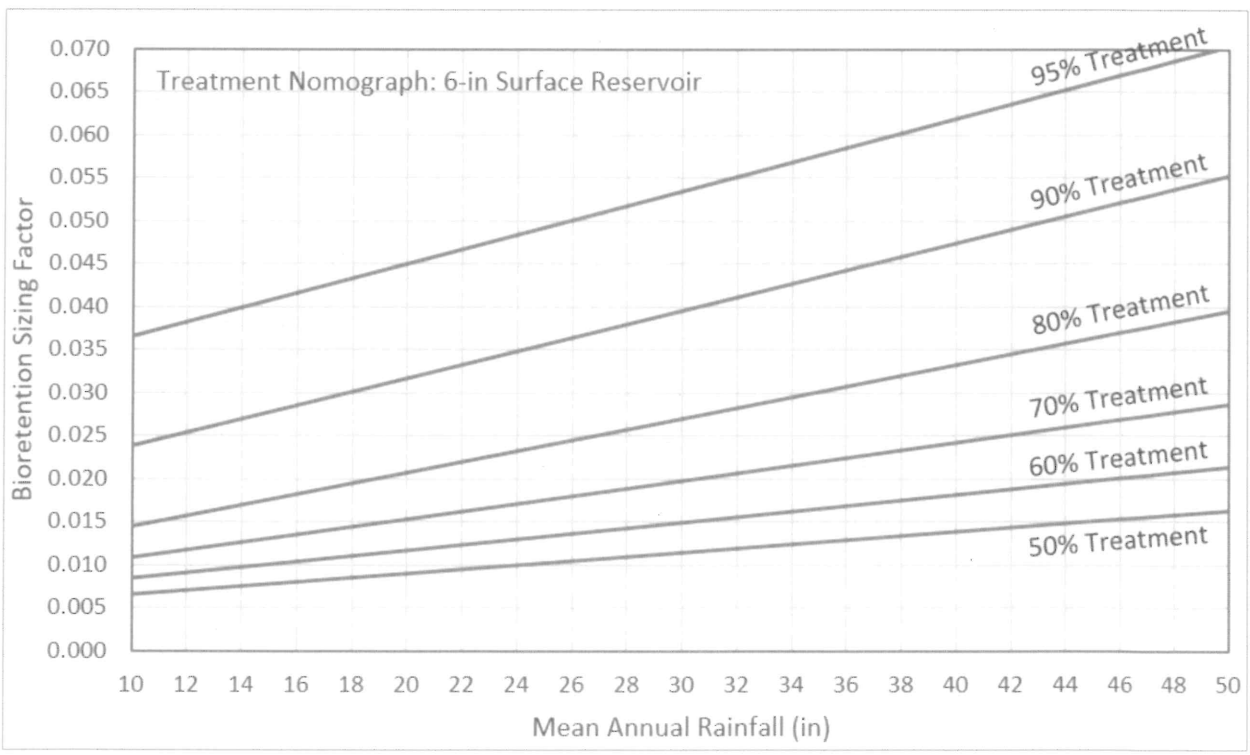


Figure 6. Percent of annual runoff treatment nomograph for bioretention facility with 6-in surface reservoir

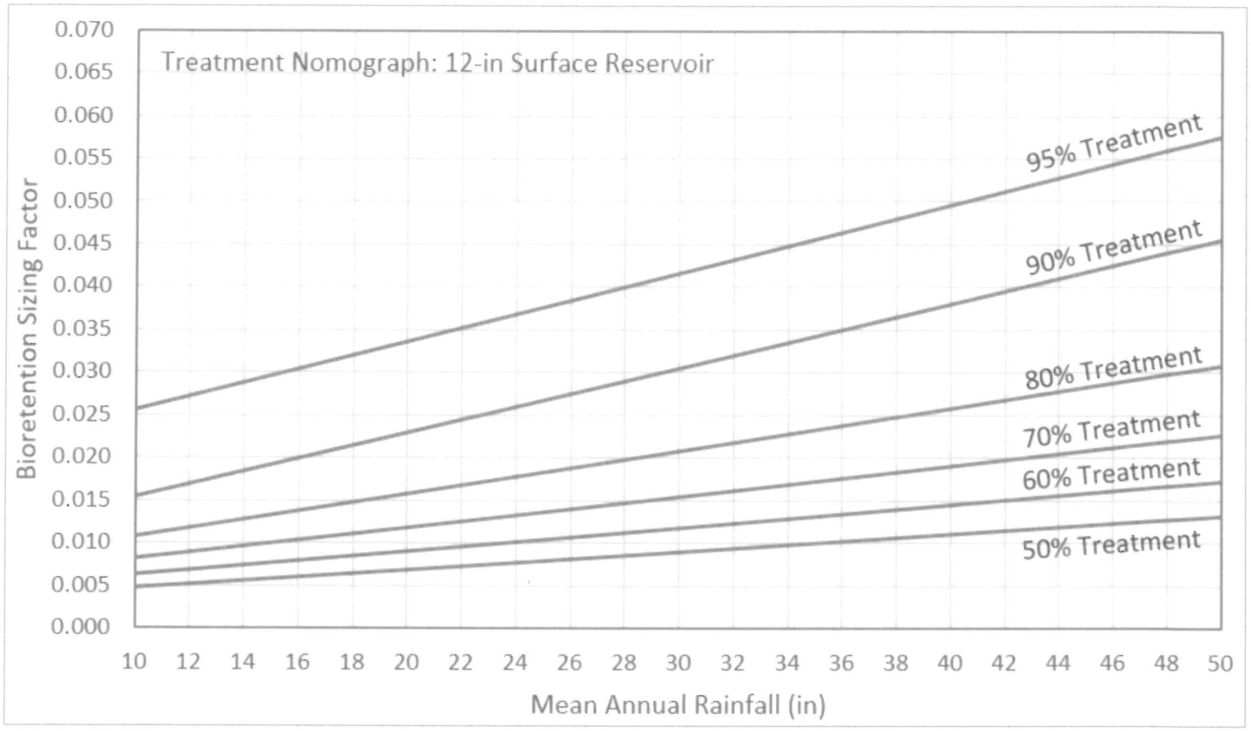


Figure 7. Percent of annual runoff treatment nomograph for bioretention facility with 12-in surface reservoir

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.

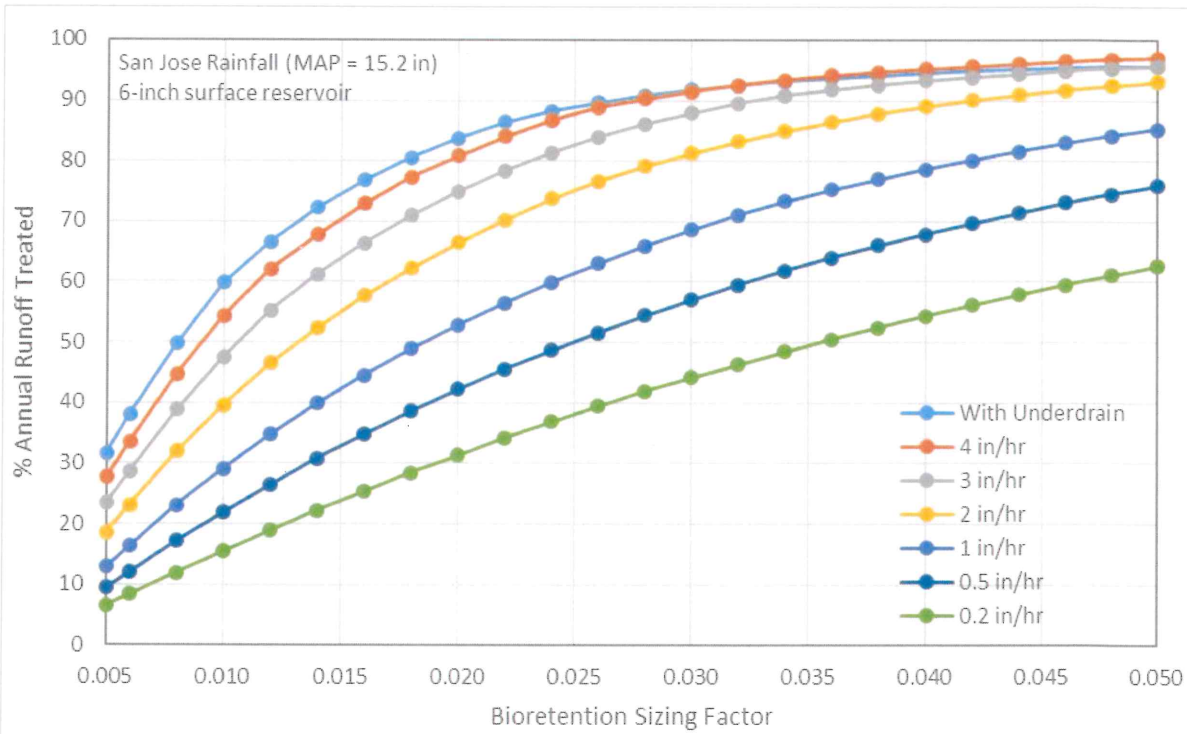


Figure 8. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in), for varying rates of permeability of surrounding soils

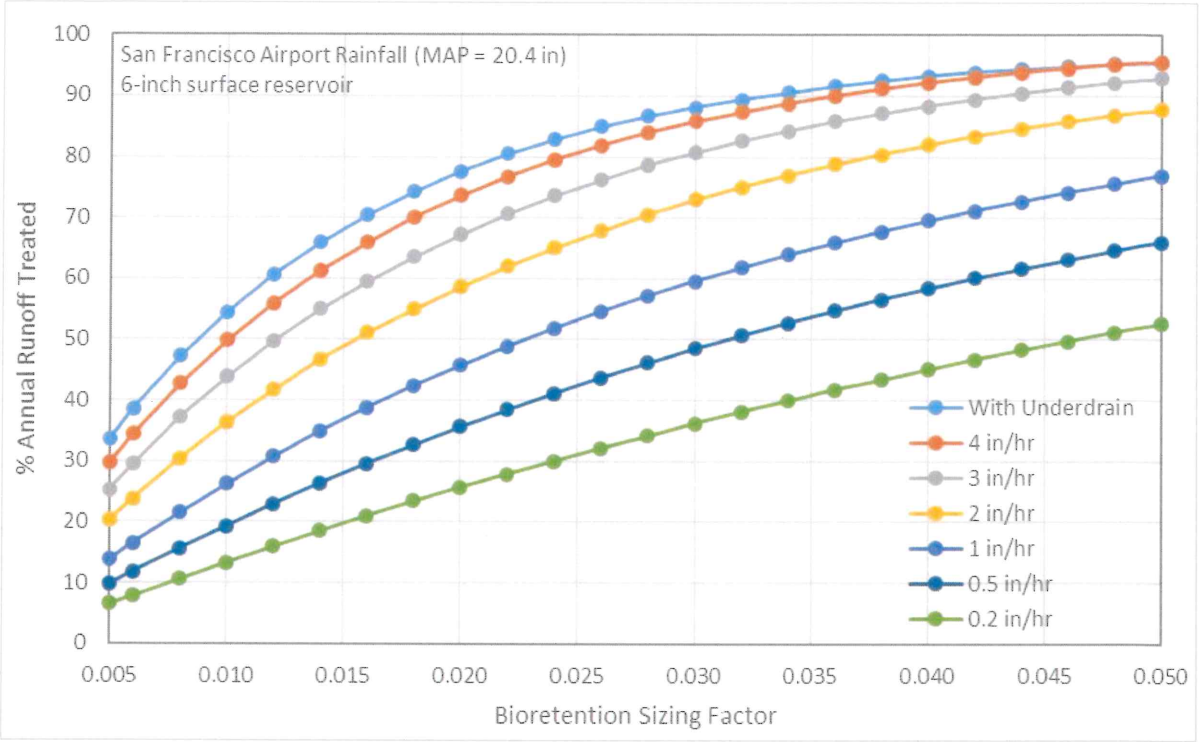


Figure 9. Treatment results for bioretention with no underdrain, San Francisco Airport gauge (MAP = 20.4 in), for varying rates of permeability of surrounding soils

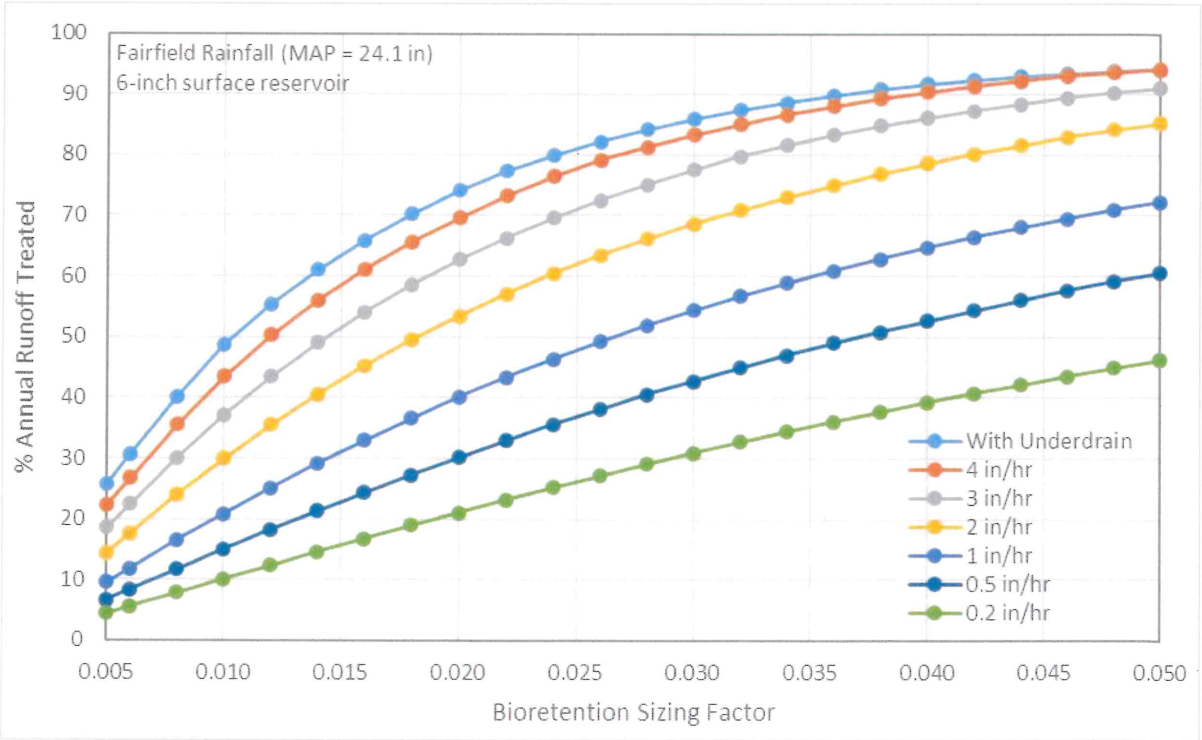


Figure 10. Treatment results for bioretention with no underdrain, Fairfield gauge (MAP = 24.1 in), for varying rates of permeability of surrounding soils

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.

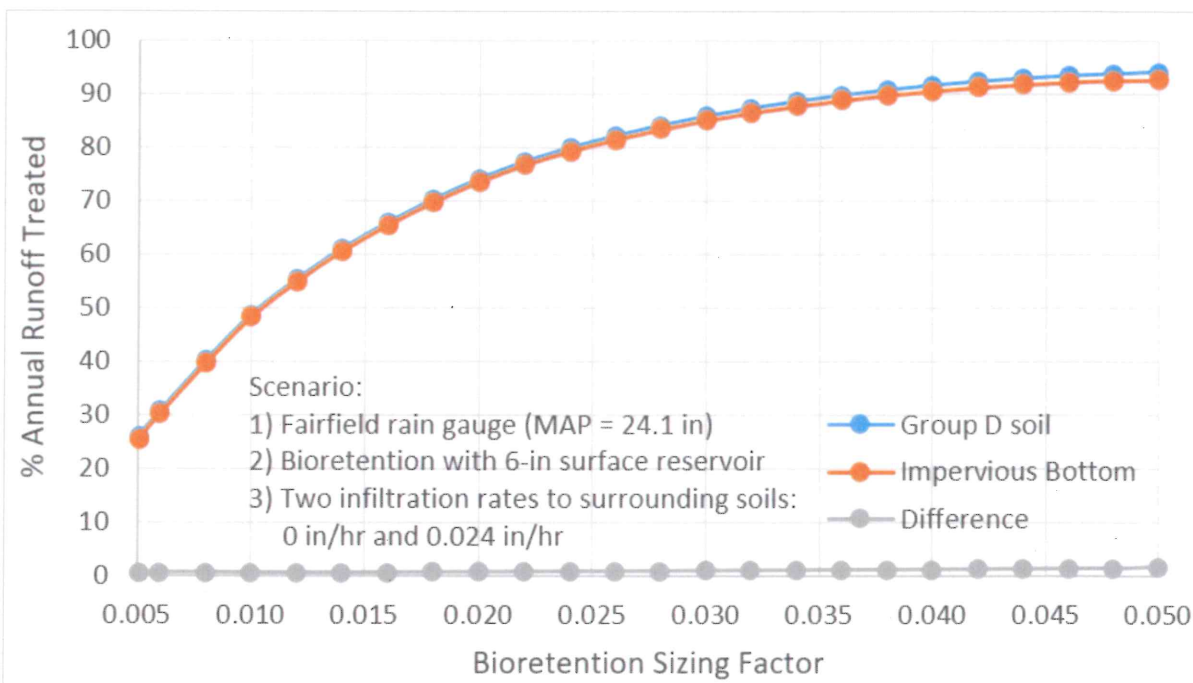


Figure 11. Comparison of model results for Group D soils and impermeable bottom scenarios

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.

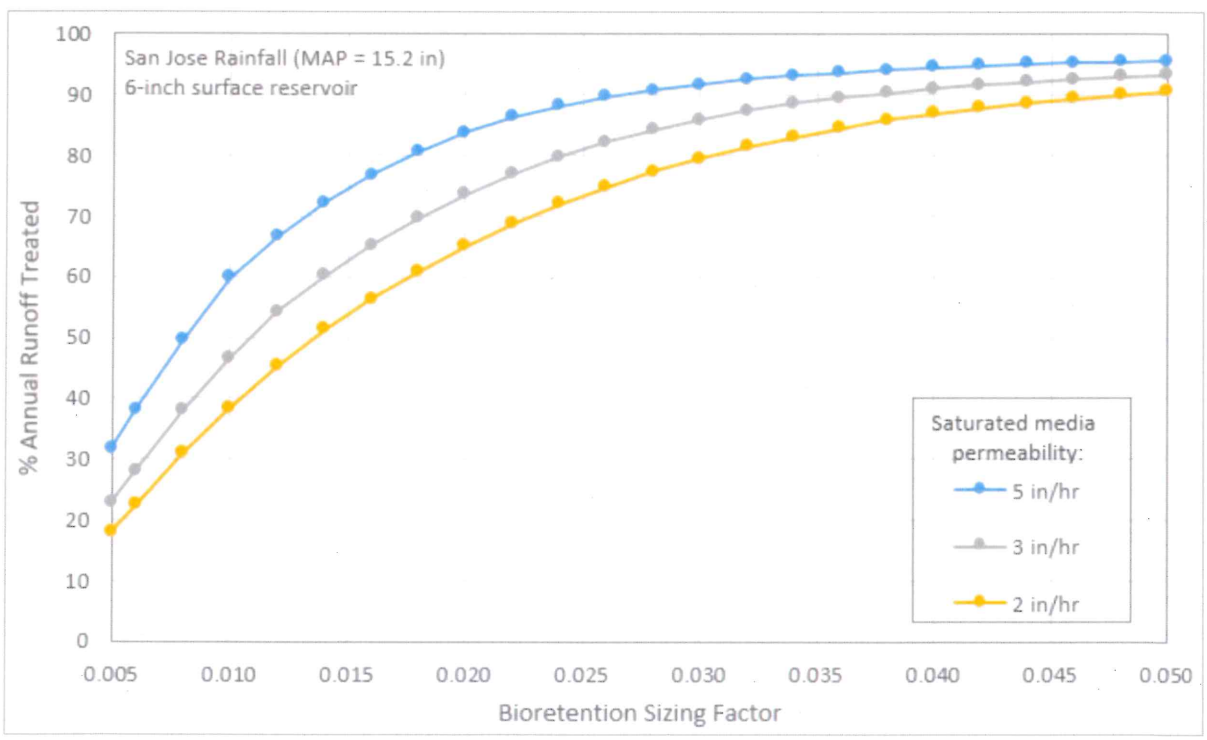


Figure 12. Treatment results for bioretention with variable media permeability, San Jose gauge (MAP = 15.2 in)

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

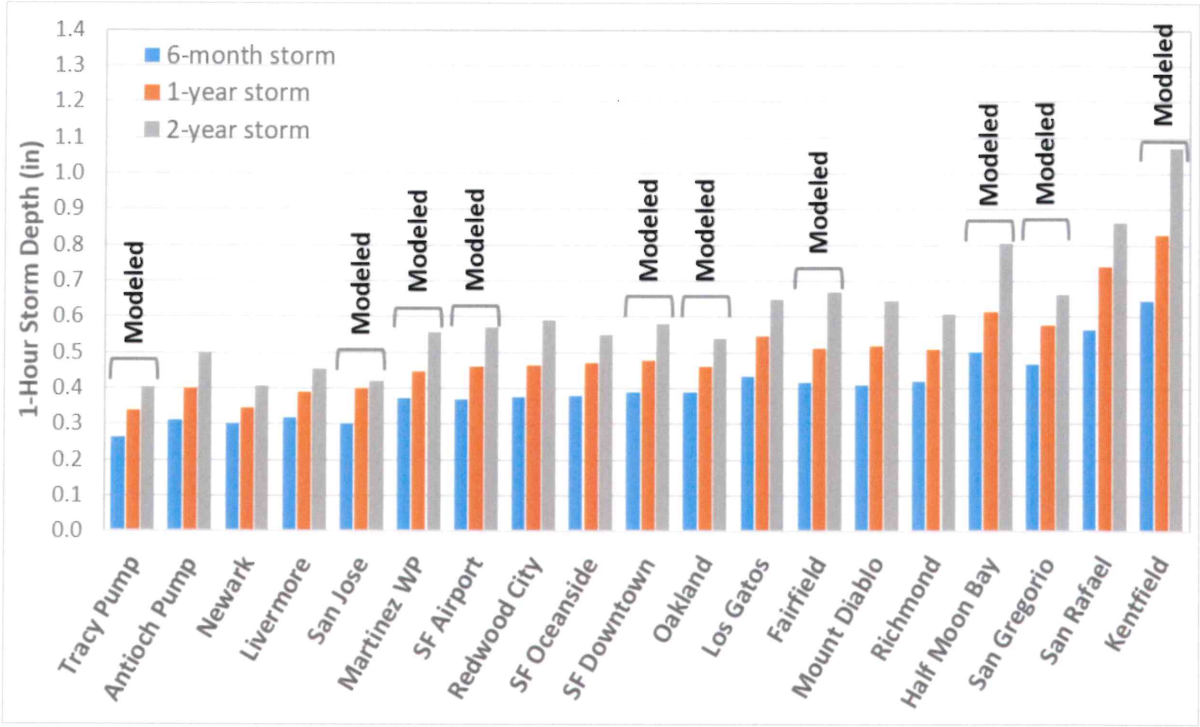


Figure 13. Storm depths for 1-hour duration

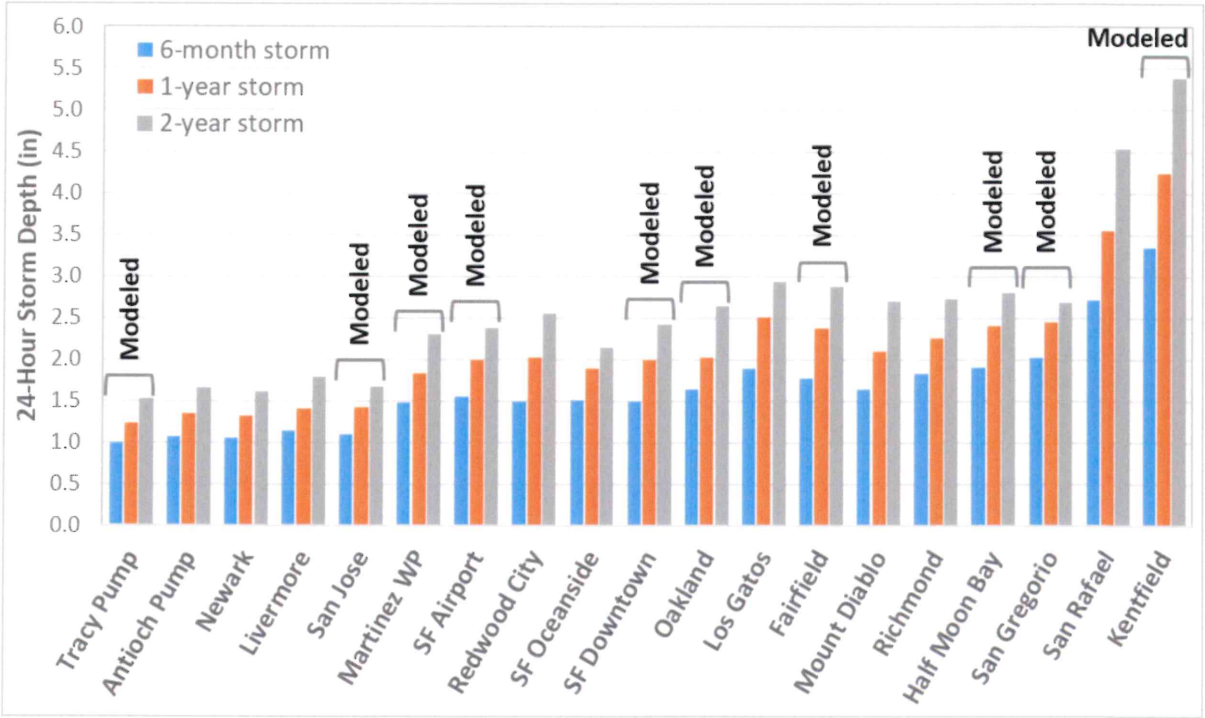


Figure 14. Storm depths for 24-hour duration

Appendix B: Treatment Percentage Results Graphics for All Rain Gauges

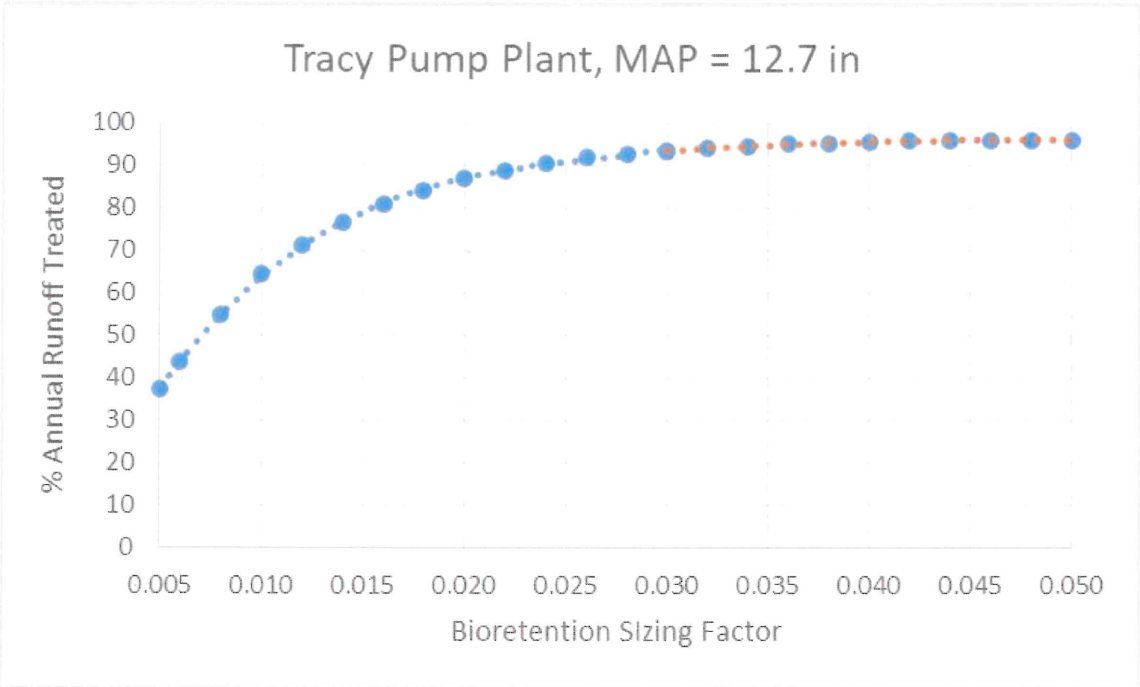


Figure 15. Annual treatment percentage for the Tracy Pump Plant rain gauge

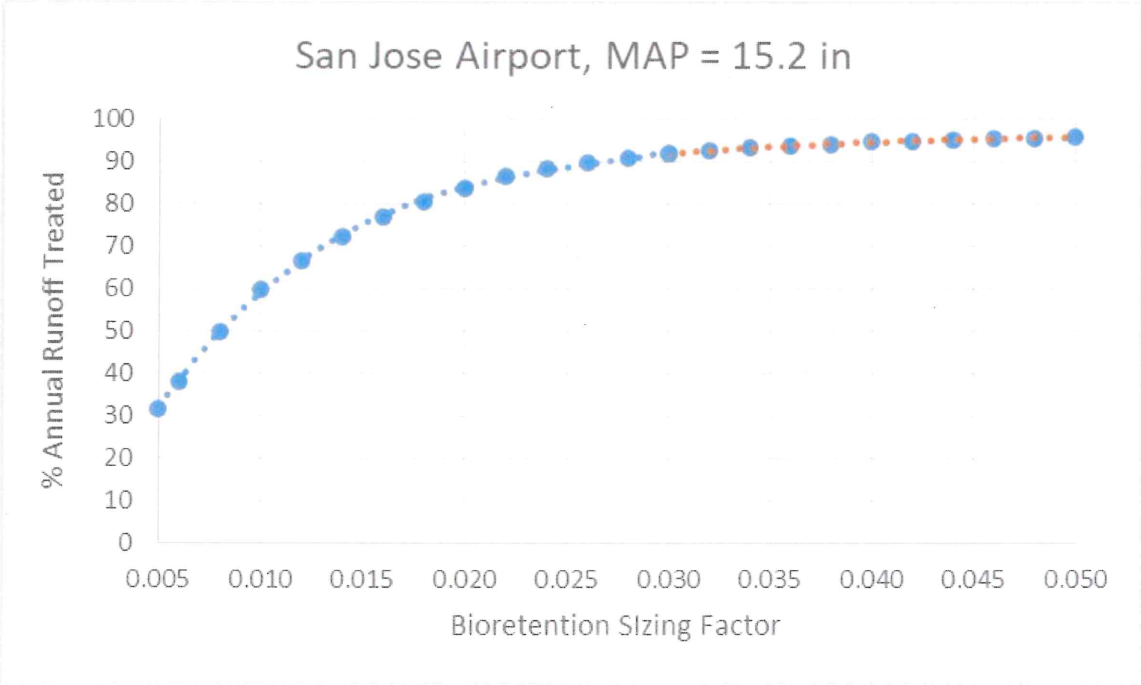


Figure 16. Annual treatment percentage for the San Jose rain gauge

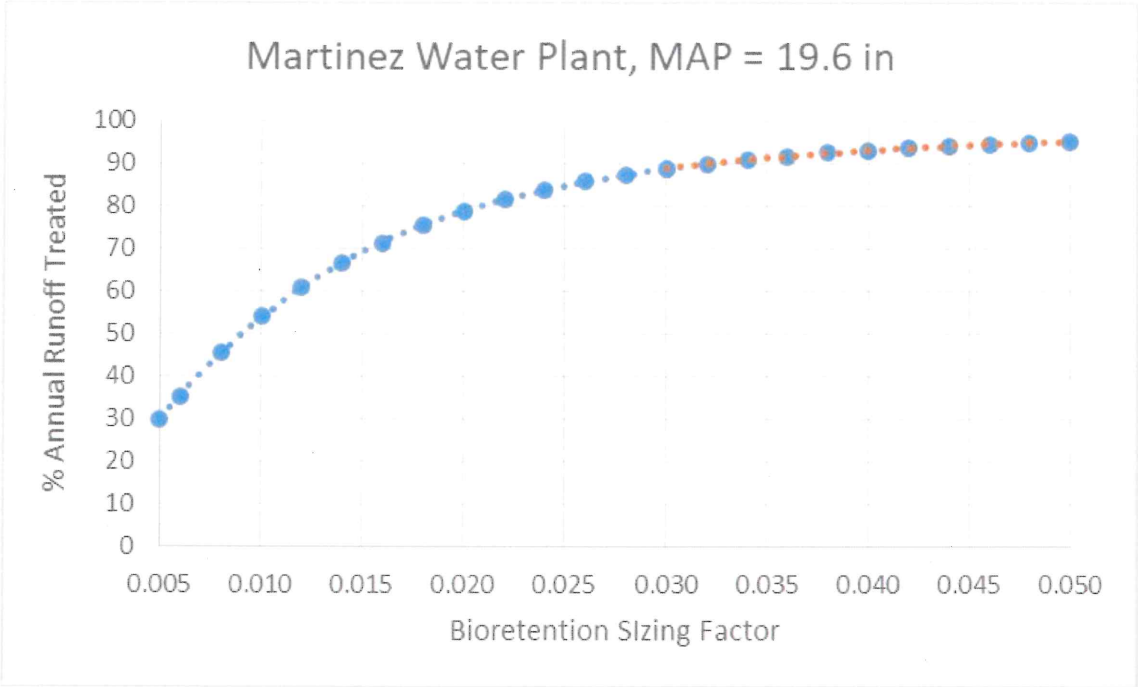


Figure 17. Annual treatment percentage for the Martinez Water Plant rain gauge

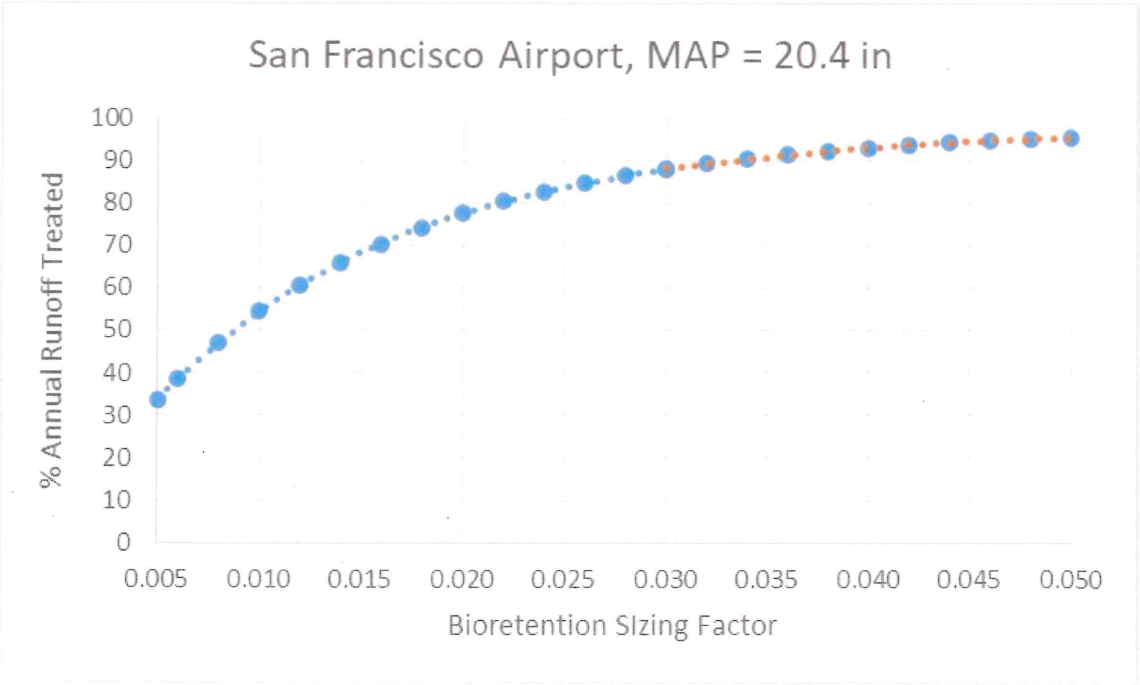


Figure 18. Annual treatment percentage for the San Francisco Airport rain gauge

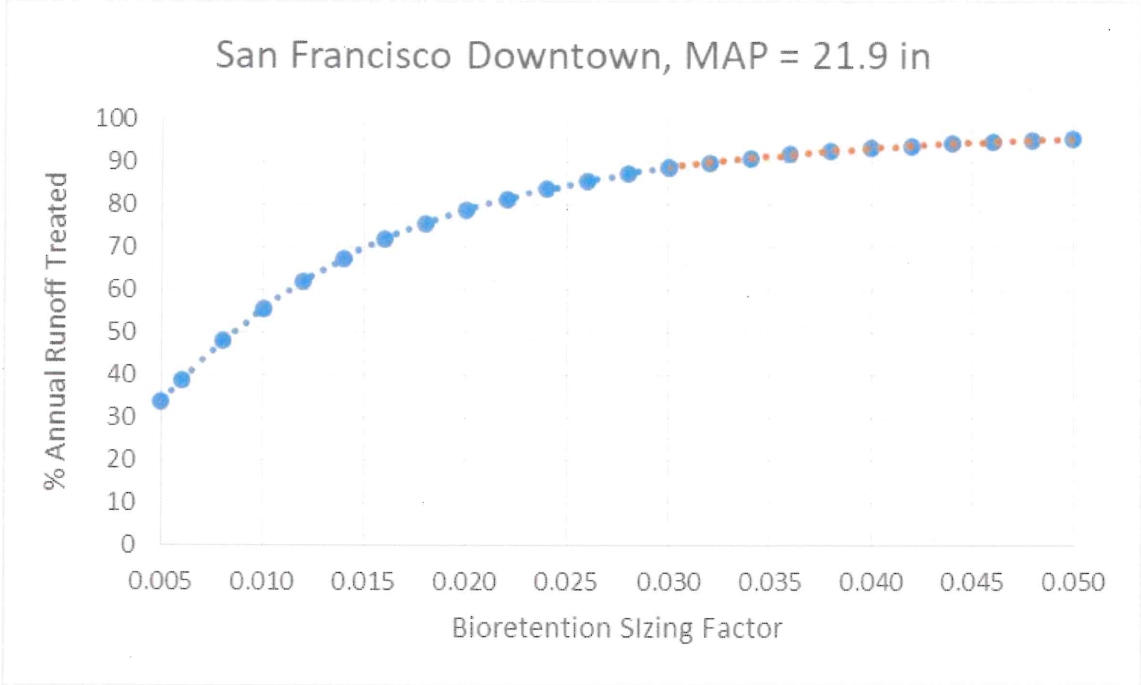


Figure 19. Annual treatment percentage for the San Francisco Downtown rain gauge

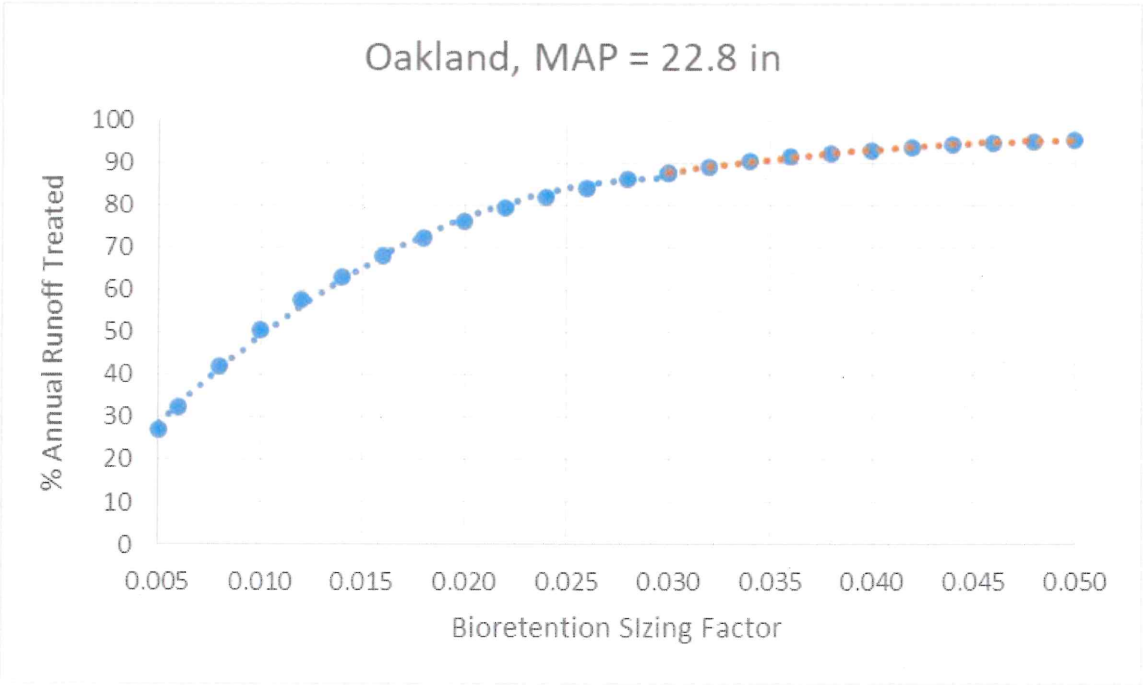


Figure 20. Annual treatment percentage for the Oakland rain gauge

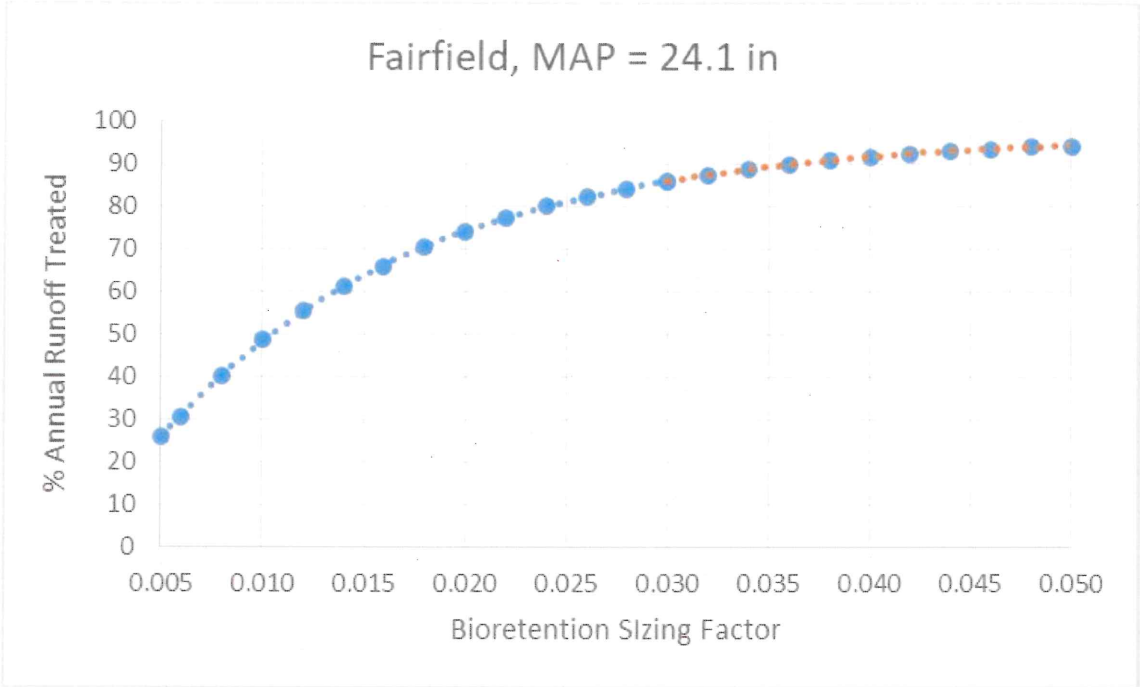


Figure 21. Annual treatment percentage for the Fairfield rain gauge

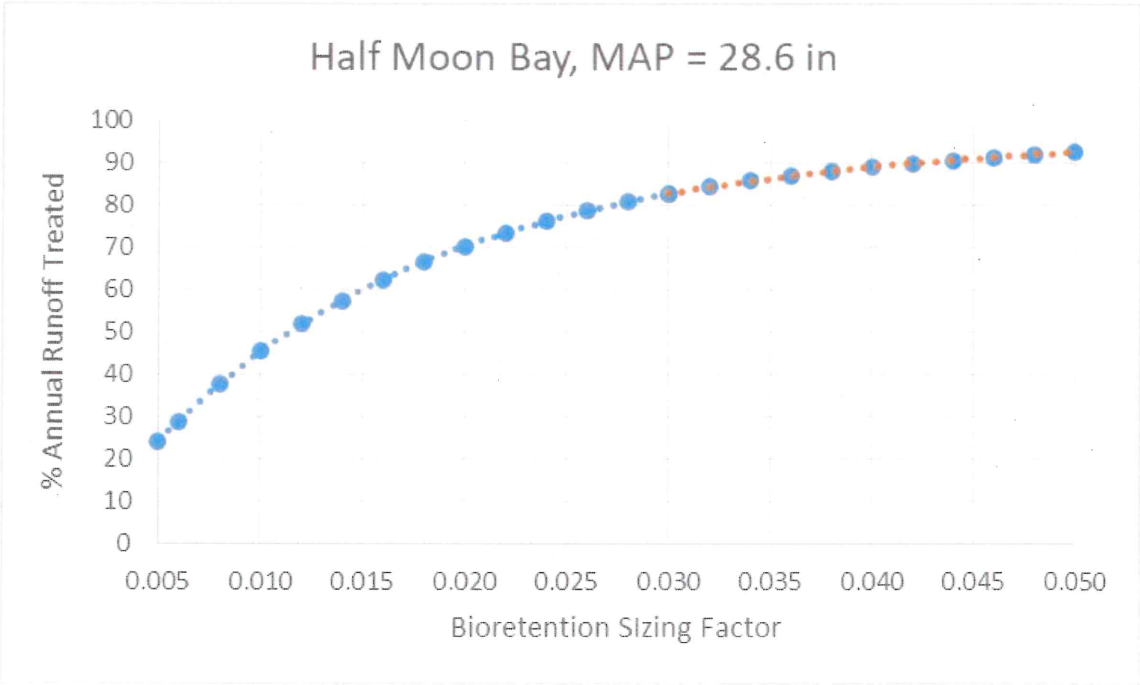


Figure 22. Annual treatment percentage for the Half Moon Bay rain gauge

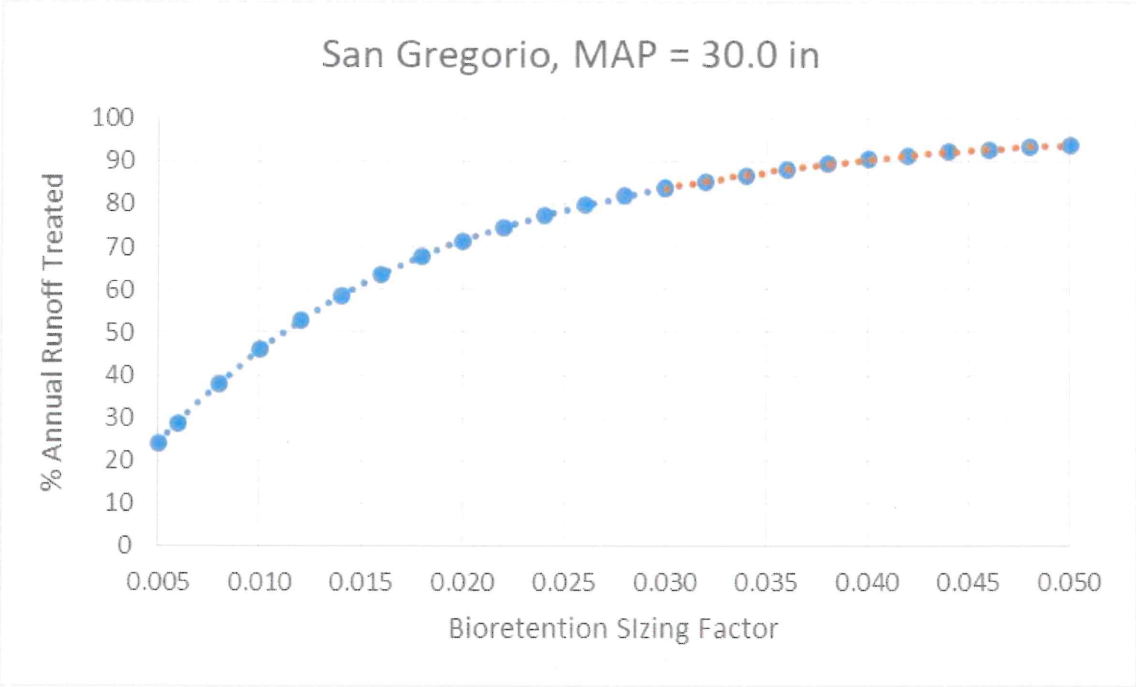


Figure 23. Annual treatment percentage for the San Gregorio rain gauge

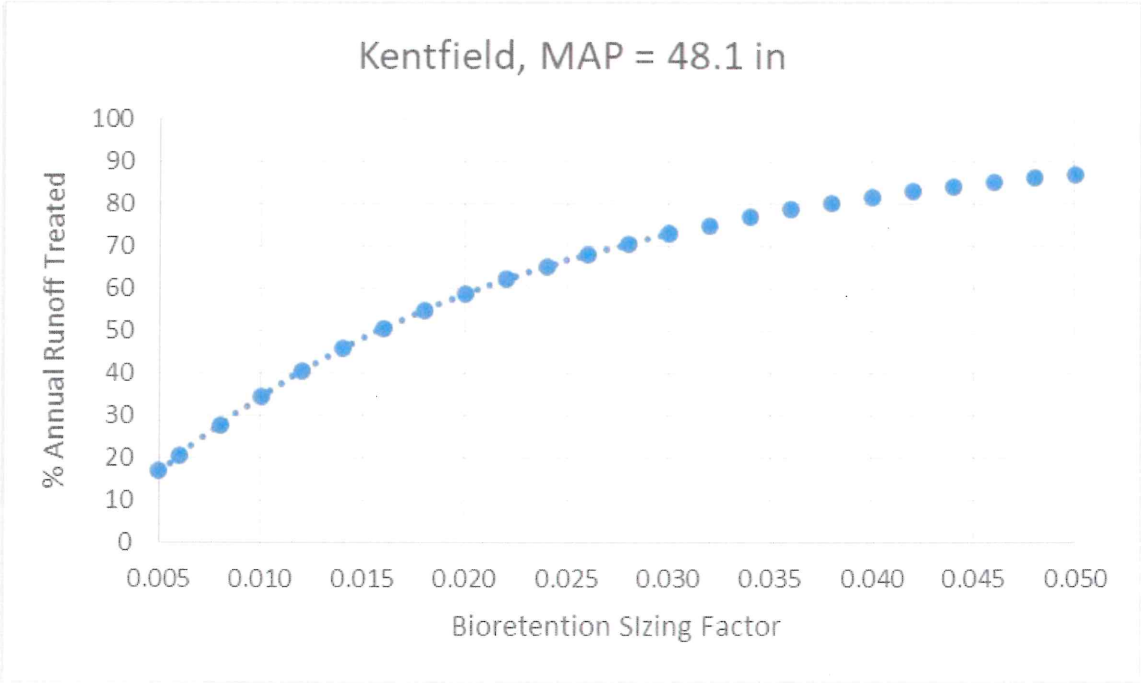


Figure 24. Annual treatment percentage for the Kentfield rain gauge

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

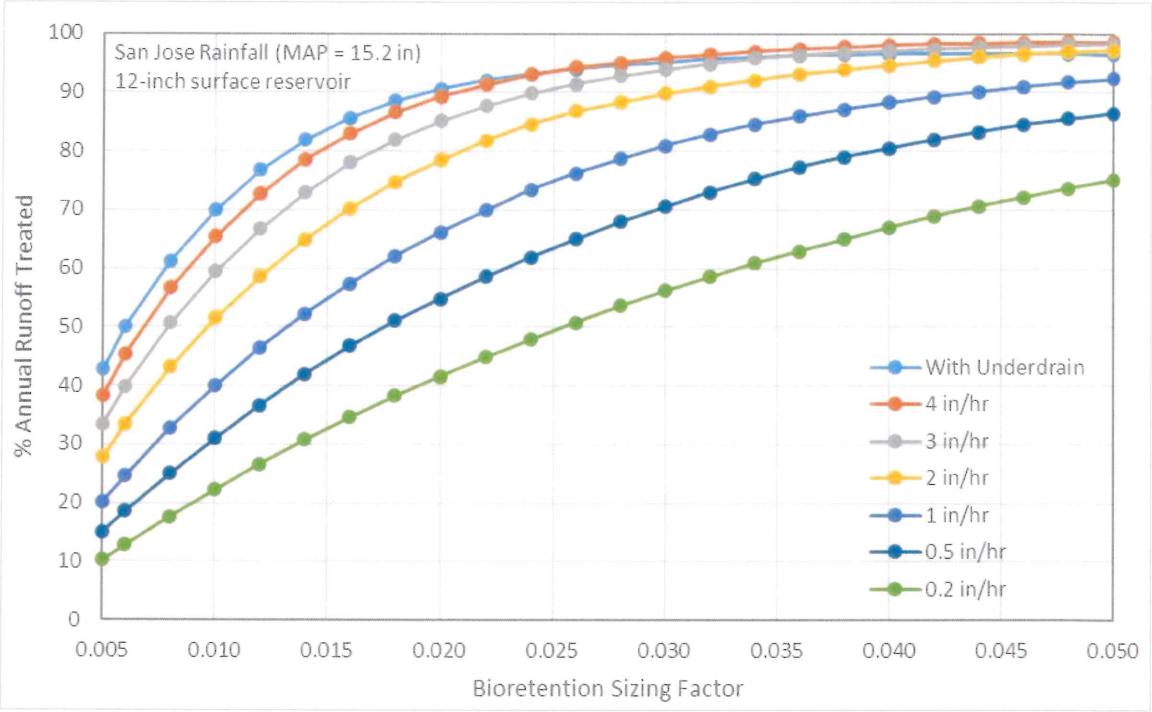


Figure 25. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)

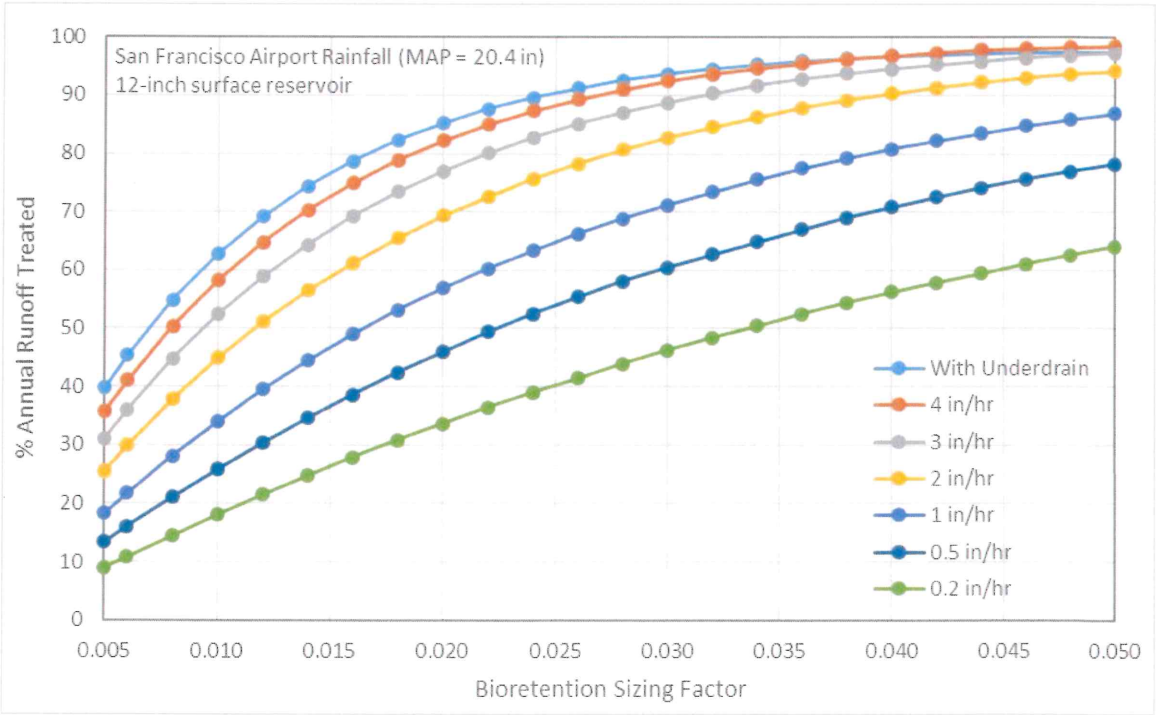


Figure 26. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)

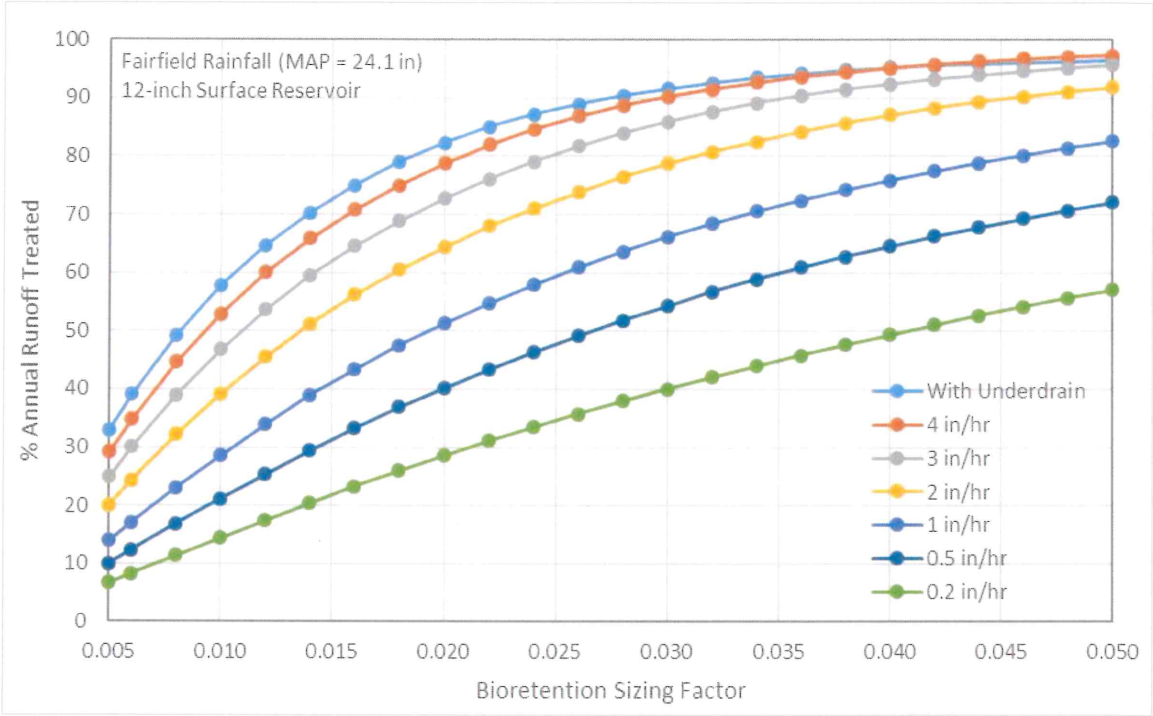


Figure 27. Treatment results for bioretention with no underdrain, San Jose gauge (MAP = 15.2 in)

Attachment C-7: Alameda Countywide Clean Water Program Technical Guidance Appendix C: Example Scenarios and Spreadsheet Tools for Sizing Stormwater Treatment Measures

Appendix C from the Alameda Countywide Clean Water Program's Technical Guidance Manual, developed to guide local jurisdictions through stormwater measures and MRP compliance, is provided on the following pages.

Appendix

C

Example Scenarios and Spreadsheet Tools for Sizing Stormwater Treatment Measures

1. Parking Lot Example
2. Podium Type Building Example
3. Spreadsheet Tools for Sizing Stormwater Treatment Measures
   - 3.1 Worksheet for Calculating the Water Quality Design Volume (80 percent capture method)
   - 3.2 Worksheet for Calculating the Combination Flow and Volume Method

C.1 Parking Lot Example

Introduction

This example shows a proposed parking lot in Alameda County with bioretention areas. LID feasibility/infeasibility criteria (Appendix J) shall be used to determine whether bioretention areas may be used and methods to design bioretention areas to maximize infiltration and evapotranspiration. This example demonstrates the use of the 4 percent standard for sizing bioretention areas.

Typical Parking Lot

Summary of Stormwater Controls

Site Design Measures

- Landscaped areas within one drainage management area is designed to function as a self-treating area, so that it bypasses the bioretention area, as described in Section 4.1 of this manual. A second landscaped area drains to the bioretention area.

Source Controls

- Stenciling storm drain inlets
- Landscape designer will be asked to follow Integrated Pest Management principles

Treatment Measures

- Bioretention areas

The example parking lot site description:

The project site is 1.2 acres with 1% slope from edge of lot to street.
The site has one ingress/egress point.

Sidewalks shall be graded toward landscaped areas.

The parking lot will have standard asphalt paving.

The parking lot will have landscaping as an amenity.

All areas will be graded to drain to bioretention areas along the perimeter of the site. Parking lot slopes are approximately 1%.

Bioretention areas are sized following the four percent standard described in Section 5.1.

The following shows sizing and calculations of the site and the treatment measures used.

Typical Bioretention Area

Procedure for sizing treatment measures using the 4 percent standard:

A1. Based on the topography of the site and configuration of buildings, divide the site into drainage management areas (DMAs), each of which will drain to an LID treatment measure. Implement Steps 2 through 5 for each DMA.

A2. To minimize the amount of landscaping or pervious pavement that will contribute runoff to the LID treatment measures, it was possible to design landscaping in Drainage Management Area B as a "self-treating area" (as described in Section 4.1), so that runoff from that landscaped area bypasses the treatment measure.

A3. List the area of impervious surfaces that drain to each treatment measure; include the area of pervious surface (landscaping) in Area A and multiply the pervious area by a factor of 0.1.

A4. For Area A, add the product obtained in Step A3 to the area of impervious surface, to obtain the area of "effective impervious surface."

A5. Multiply the impervious surface (or effective impervious surface in applicable DMAs) by a factor of 0.04. This is the required surface area of the LID treatment measure.

Steps 2 through 5 are shown in Table A-1.

Table A-1: Bioretention Sizing for Parking Lot Example (4% standard sizing approach)

DMA	Impervious Area (sf)	Pervious Area (sf)[1]	Pervious Area x 0.1	Effective Impervious Area (EIA) (sf)	EIA * 0.04 (sf)
A	6,788	7,868	786.8	7,575	303
B	24,491	0	0	24,491	980
Totals	31,279	7,868	786.8	32,066	1,283

[1] Include only the pervious area that drains to the treatment measure, not self-treating areas.

C.2 Podium Type Building Example

Introduction

This example is to show a proposed podium type building in Alameda County, with flow-through planters. LID feasibility/infeasibility criteria (Appendix J) need to be used to determine whether the use of flow-through planters will be allowed. Flow-through planters in this example are sized using the combination flow and volume sizing approach.

Typical Podium Building

Summary of Stormwater Controls

Site Design Measures
- Multistory building above covered parking

Source Controls
- Covered trash storage areas
- Landscape designer will be asked to follow Integrated Pest Management principles

Treatment Measures
- Flow-through planters

The example podium style building site description:

The project site is approximately 25,000 square feet.

The site is Type D soil with expected compaction of 95%.

Lot line is assumed to be to the edge of city right-of-way (sidewalks).

The proposed podium building is a zero lot line design with flow through planters in the center of the building around a concrete patio and down at ground level.

The podium building is a mixed use building with residential units on the top floors, retail space on the second floor and parking on the bottom floor. The building mechanical facilities and trash facilities are also on the bottom floor.

The roof area of the podium building consists of approximately 9,000 square foot patio, 1,000 square feet of landscaping and 15,000 square feet of conventional roof.

Off site sidewalks and driveways will be graded toward street.

The ground floor is a concrete slab with buildings and a covered parking structure. There is no potential for infiltration. The soils within the planter will be at least 18 inches of treatment soil with a surface loading rate of 5 inch/hour. A 12-inch layer of drain rock will be placed around the perforated underdrain to allow for dewatering of the flow through the planter.

The flow through planter areas will connect directly to the storm drain system through a system of perforated underdrains and overflow pipes.

The flow through planters shall have splash blocks at rain water leader discharge points to protect against erosion.

Design flow criterion: rainfall intensity – 0.2 in./hr.

Design volume criterion: capture 80% of the average annual runoff

The mean annual precipitation (MAP) at the site is 16 inches. Because this value is less than 16.4 inches, the applicable rain gauge is the San Jose Airport gauge (MAP = 14.4 inches)

The following steps show the sizes and calculations for the Podium building treatment measures.

Source Control
Parking and trash shall be under the building and covered.

City of Portland *2004 Stormwater Manual*

Typical Flow Through Planter

Procedure for sizing using combined flow and volume method:

B1. List areas to each treatment measure. ("A" in Q = CIA)

Impervious Patio Surfaces	9,000 square feet
Patio Landscaping	500 square feet
Roof Surfaces	15,000 square feet
Landscape	500 square feet

B2. The approach assumes that all of the design rainfall becomes runoff, and thus it is appropriate for use where the drainage area to the bioretention area is mostly impervious. Convert landscape area to effective impervious area by multiplying by 0.1. (Note: In this example, the landscaped area is designed to flow through the planter. For an example where self-treating areas bypass the bioretention area, see the preceding parking lot example.)

Patio Impervious Surfaces		9,000 square feet
Roof Impervious Surfaces		15,000 square feet
Landscape	1,000*0.1 =	100 square feet
Effective Impervious Area		**24,100 square feet**

B3. Determine the Unit Basin Storage Volumes for 80 Percent Capture using 48-hour drawdown. using Table 5.2 of Chapter 5 based on 100 percent impervious area (runoff coefficient of 1.0). The unit basin storage volume at the San Jose Airport gauge for a coefficient of 1.0 is **0.56 inches**. Adjust this volume based on the mean annual precipitation at the site (16 inches).

Adjusted unit basin storage volume = 0.56" * (16"/14.4") = 0.62".

B4. Calculate the Water Quality Design Volume. The water quality design volume is the area from Step B2 times the adjusted unit basin storage volume. (24,100 square feet * 0.62 inches * 1/12 feet per inch = **1,245 cubic feet**.)

B5. Use a constant surface loading rate of **5 inches per hour** through the soil as required by the Permit for use with treatment soils.

B6. Assume that the rain event that generates the required capture volume of runoff determined in Step B4 occurs at a constant intensity of 0.2 inches/hour from the start of the storm (i.e., assume a rectangular hydrograph). Calculate the duration of the rain event by dividing the unit basin storage volume by the intensity. In other words, determine the amount of time required for the unit basin storage volume to be achieved at a rate of 0.2 inches/hour. For this example, the unit basin storage volume is 0.62 inches, the rain event duration is 0.62 inches ÷ 0.2 inches/hour = **3.1 hours**.

B7. Compute Required Depth of Storage for a given treatment area. (Maximum Allowable Depth = 12 inches)

Start by calculating the bioretention area using the 4% standard sizing factor. For the effective impervious area calculated in Step B2 (24,100 square feet), the required bioretention surface area would be (0.04*24,100) = **964 square feet**. Then assume a bioretention area size that is 25% smaller than that calculated using the 4% standard. Using the example, 964 – (0.25 × 964) = **723 square feet**. Calculate the volume of runoff that filters through the treatment soil at a surface loading rate of 5 inches per hour (the design surface loading rate for bioretention facilities), for the duration of the rain event calculated in Step B6. For this example, for a bioretention treatment area of 723 square feet, with a surface loading rate of 5 inches per hour for a duration of 3.1 hours, the volume of treated runoff = 723 square feet × 5 inches/hour × (1 foot/12 inches) × 3.1 hours = **934 cubic feet**.

B8. The difference between the volume of runoff from Step B4 and the volume that flows through the planter for the storm duration from B7 is (1,245 cubic feet – 934 cubic feet) = **311 cubic feet**. If this volume is stored over a surface area of 723 square feet, the average ponding depth would be 311 cubic feet ÷ 723 square feet = **0.43 feet or 5.2 inches**.

B9. Check to see if the average ponding depth is between 6 and 12 inches, which is the recommended allowance for ponding in a bioretention facility or flow-through planter. If the ponding depth is less than 6 inches, the bioretention design can be optimized with a

smaller surface area (i.e., repeat Steps B7 and B8 with a smaller treatment area). If the ponding depth is greater than 12 inches, a larger surface treatment area will be required. In this example, the ponding depth of 5.2 inches is less than the recommended range of 6 to 12 inches. A repetition of steps B7 and B8 with a bioretention area that is 30 percent smaller than the bioretention area calculated in Step B2 is provided below.

B.10 Repeat Step B7 with a bioretention area 30% smaller than the bioretention area in Step B2: 964 sq.ft. – (0.30 x 964) = 674 sq.ft. Calculate the volume treated during the rain event duration: 674 sq.ft. x 5 in/hr x 1 ft/12 in x 3.1 hours = **871 cubic feet**.

Repeat Step B9 for the smaller bioretention area to calculate the volume remaining in the ponded area: 1245 cu.ft. – 871 cu.ft. = 374 cubic feet. Calculate the average ponding depth: 374 cu.ft. ÷ 674 sq.ft. = **0.55 feet or 6.6 inches**.

Note: See worksheets on the following pages:

3.1 Worksheet for Calculating the Water Quality Design Volume (80 percent capture method)
3.2 Worksheet for Calculating the Combination Flow and Volume Method

The worksheets are available for download at www.cleanwaterprogram.org, included in Appendix C of the online C.3 Technical Guidance.

Attachment C-8: Alameda Countywide Clean Water Program Technical Guidance Appendix L: Site Design Requirements for Small Projects

Appendix L from the Alameda Countywide Clean Water Program's Technical Guidance Manual, developed to guide local jurisdictions through stormwater measures and MRP compliance, is provided on the following pages.

Appendix

L

Site Design Requirements for Small Projects

Table of Contents

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Section L.2	Regional Guidance for Site Design Measures	Page L-2
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Section L.4	Selecting Site Design Measures for Constrained Sites	Page L-4
Attachment 1	Fact Sheet: Landscape Designs for Stormwater Management	
Attachment 2	Fact Sheet: Rain Gardens	
Attachment 3	Fact Sheet: Pervious Paving	
Attachment 4	Fact Sheet: Rain Barrels and Cisterns	

L.1 Permit Requirements for Small Projects

Since December 1, 2012, specific sizes of small projects have had to meet site design requirements in Provision C.3.i of the reissued Municipal Regional Stormwater Permit (MRP, Regional Water Board Order No. R2-2015-0049). This applies to projects that create and/or replace at least 2,500 but less than 10,000 square feet of impervious surface, and individual single family home projects that create and/or replace 2,500 square feet or more of impervious surface. Applicable projects must implement at least one of the following site design measures:

- Direct roof runoff into cisterns or rain barrels for use.
- Direct roof runoff onto vegetated areas.
- Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas.
- Direct runoff from driveways/uncovered parking lots onto vegetated areas.
- Construct sidewalks, walkways, and/or patios with permeable surfaces.
- Construct bike lanes, driveways, and/or uncovered parking lots with permeable surfaces.

Do the Requirements Apply to My Project?

The requirements apply to your project if it meets the size thresholds described above, and it received final discretionary approval on or after December 1, 2012. If your project does not require discretionary approval, such as tract map approval, conditional use permit, or design review, then the requirements apply if the building permit is issued on or after December 1, 2012.

Please note that projects in the following four ***"Special Land Use Categories"*** that create and/or replace 5,000 square feet or more of impervious surface are required to implement hydraulically-sized stormwater treatment, source control measures, AND site design measures:

- Restaurants;
- Retail gasoline outlets;
- Auto service facilities; and
- Surface parking (stand-alone or part of another use).

For these "Special Land Use Category" projects, the implementation of LID site design and stormwater treatment systems will satisfy the requirements of Provision C.3.i.

Consistent with Provision C.3.c, ***interior remodels and routine maintenance or repair are excluded from the Provision C.3.i requirements***, including:

- Roof replacement, including those that remove the entire roof;
- Exterior wall surface replacement; and
- Pavement resurfacing within the existing footprint. This exclusion applies to any routine maintenance of paved surfaces within the existing footprint, including the repaving that occurs after conducting utility work under the pavement, and the routine reconstruction of pavement, which may include removal and replacement of the subbase. If a repaving project results in changes to the footprint, grade, layout or configuration of the paved surfaces, it would trigger the requirements of Provision C.3. The pavement resurfacing exclusion also applies to the reconstruction of existing roads and trails.

L.2 Regional Guidance for Site Design Measures

To help you select and design site design measures appropriate for the project site, the Clean Water Program collaborated regionally through the Bay Area Stormwater Management Agencies Association (BASMAA) to develop four fact sheets that provide guidance regarding the six site design measures listed above. The fact sheet are included at the end of this appendix, and copies are available for download from the Clean Water Program's website www.cleanwaterprogram.org (Click on "Resources," then "Development").Table L-1 shows how the fact sheets correspond with the six site design measures.

Table L-1:
Regional Fact Sheets and Corresponding Site Design Measures

Fact Sheet	Corresponding Site Design Measures listed in Provision C.3.i
Managing Stormwater in Landscapes	• Direct roof runoff onto vegetated areas. • Direct runoff from sidewalks, walkways, and/or patios onto vegetated areas. • Direct runoff from driveways/uncovered parking lots onto vegetated areas.
Rain Gardens	• Corresponds to the same site design measures as "Managing Stormwater in Landscapes", above. Differences between rain gardens and other landscaped area include: o Applicants may choose to select a rain garden if they want to capture and infiltrate more stormwater in a smaller area than is possible with most native soils. o Rain gardens should have well-drained soil; soil amendments may be needed. o An underdrain may be required if native soils are slow-draining.
Pervious Paving	• Construct sidewalks, walkways, and/or patios with permeable surfaces. • Construct bike lanes, driveways, and/or uncovered parking lots with permeable surfaces.
Rain Barrels and Cisterns	• Direct roof runoff into cisterns or rain barrels for use.

L.3 Selecting Site Design Measures

To supplement guidance provided in the regional fact sheets, refer to Table L-2 to identify key opportunities and constraints for the site design measures listed in Provision C.3.i. Choose one or more site design measures that are a good match for your project site. Only one site design measure is required, but you may choose to implement additional measures to increase the water quality benefits of your project.

Table L-2: Opportunities and Constraints for Site Design Measures

Site Design	Opportunities	Constraints	Guidance to Address
Managing Stormwater in Landscapes	• Low areas. • Flat areas or minimal slope.	• Steep slopes • Insufficient space for landscaping	• Avoid in steep slopes where increased infiltration may undermine slope. • Landscaped area should be at least half the size of the impervious area draining to it. • Direct runoff away from building foundations.
Rain Gardens	• Low areas. • Flat areas or minimal slope. • Well-drained soil • Existing storm drain to tie in underdrain (if underdrain is needed)	• Steep slopes • Insufficient space for landscaping • Poorly drained soil	• Avoid in steep slopes. • Rain garden should be at least 4% of the size of the impervious area draining to it. • If soils do not drain well, consider soil amendments. • An underdrain may be needed if native soils are clayey. • Recommended setbacks: 10 ft. from building foundation and 5 ft. from property line
Pervious Paving	• Flat areas or minimal slope. • Well-drained soil. • Existing storm drain to tie in underdrain (if underdrain is needed).	• Steep slopes • Poorly drained soils • Buildings close to pavement	• Avoid use in 5% slopes and greater, unless municipality approves use of underdrain. • Underdrain may be needed if native soils are clayey. • Install away from buildings, or provide impermeable barrier.
Rain Barrels and Cisterns	• Roof area that drains to downspouts. • Flat, firm area near the building for rain barrel or cistern. • Landscaping that is downslope from rainbarrel or cistern, allowing gravity flow of water for irrigation and discharge of overflow.	• Lack of landscape that requires irrigation. • Irrigation system that requires high water pressure. • Absence of flat, firm area near the building. • Lack of suitable areas to receive overflow	• Interior non-potable use may be considered, if allowed by municipality. • Use with low-pressure irrigation systems. • Ensure adequate space to safely install rainbarrel or cistern and accommodate overflow.

L.4. Selecting Site Design Measures for Constrained Sites

Provision C.3.i does not allow for findings of infeasibility or impracticability, nor does it provide alternative compliance or in-lieu options. Therefore, one of the six site design measures must be implemented in applicable projects, even on sites with constraints such as those identified in Table L-2.

If your site has constraints such as poorly draining soils, steep slopes, or limited space for landscaping, consult with municipal staff regarding approaches to incorporating the site design measures within the constrained site.

Appendix D. Evaluation of Funding Options

Evaluation of Prioritized Project Funding Options for Green Infrastructure Planning and Implementation

1.0 Introduction

Provision C.3.j.i.(2)(k) of the reissued Municipal Regional Stormwater Permit (MRP 2) requires the Green Infrastructure (GI) Plans prepared in compliance with Provision C.3.j to include "[a]n 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 document has been prepared to meet this requirement. In view of the potential need to shift some existing funds to green infrastructure activities, some funding options are considered that may be appropriate for aspects of the Stormwater Program other than green infrastructure. The implementation of such options may potentially allow the use of some existing funds for green infrastructure activities.

2.0 Approach

2.1 Identification of Funding Options

The options for funding GI planning and implementation activities, discussed in Section 3, were identified based primarily on previous stormwater funding studies conducted by Hilton Farnkopf & Hobson, LLC for the Clean Water Program (ACCWP 2002) and the San Mateo Countywide Water Pollution Prevention Program (SMCWPPP 2008), as well as a funding study conducted for the City of Berkeley by MWH (City of Berkeley 2016).

2.2 Basis for Evaluation

The following criteria were used to evaluate the identified funding options.

- **Ballot approval** – This criterion considers whether approval by voters is needed to implement the funding option.
- **Reliability** – Considers the extent to which the funding option, once implemented, could be relied upon in the future.
- **Cost to implement** – Considers the resources needed to implement the funding option.
- **Obstacles** – Considers barriers to implementing the funding option.

To assist with the evaluation of funding options, one or more examples of each option are provided.

3.0 Evaluation of Funding Options

The following funding options are considered: existing resources, in-lieu fees (single jurisdiction or multi-jurisdictional), wastewater fees, refuse collection (solid waste) fees, water fees, regulatory fees and fees for service, development impact fees and capital contributions, stormwater fee, taxes and

assessments, and grants. For each funding option, an evaluation is provided, based on the criteria described in Section 2.

3.1 Existing Resources

Description

Under the Existing Resources Option, some of the funds that are currently used for other activities within the stormwater program would be shifted to GI planning and implementation activities. It may be feasible to shift some existing funds to GI if some current activities will be discontinued, thereby making some of the existing funds available for GI, or if new funding sources are identified for current activities. For example, in the event that it is determined to be feasible to fund street sweeping with revenue from a solid waste fee (see Section 3.5), some portion of the funds currently dedicated to street sweeping may potentially become available to contribute to the funding of GI planning and implementation.

Evaluation of Existing Resources Option

- **Ballot approval** – Ballot approval would not be required to use existing resources.
- **Reliability**
- **Cost to implement** – Resources would be required to verify and document the basis for using an existing funding source for GI planning and implementation, and to modify procedures.
- **Obstacles**
- **Example of Implementation**
    - City of Belmont moved the annual street sweeping cost from the stormwater division to solid waste services, which substantially improved the stormwater division's financial position without triggering a significant increase in solid waste rates (SMCWPPP 2008).

3.2 In-Lieu Fees (Single Jurisdiction)

Description

Provision C.3.e.i.(2) of MRP 2 allows development projects that are Regulated Projects under Provision C.3.b to meet the C.3 requirements for stormwater treatment by paying an in-lieu fee to a Regional Project that achieves a net environmental benefit, in addition to treating a portion of the runoff from the project onsite. Additionally, MRP 2 requires that the Regional Project be completed within three years after the end of construction of the Regulated Project, with an extension of up to five years, with prior approval of the Executive Officer of the Regional Water Quality Control Board. In this option, the agency would implement an in-lieu fee as a single jurisdiction.

Evaluation of In-Lieu Fees (Single Jurisdiction) Option

- **Ballot approval** -- In-lieu fees are not classified as a tax or special assessment, and therefore do not require voter approval to be enacted.
- **Reliability** – Amount of funding would fluctuate, due to the linkage to development projects.
- **Cost to implement** – Costs include initiating the planning phase of a regional project in preparation to receive contributions, setting up administrative procedures to manage the

contributions, and carrying the Regional Project through to completion per the required timeframe.

- **Obstacles**
  - Predicting sufficient level of contributions to warrant start-up costs.
  - Ensuring sufficient level of contributions to complete one or more regional projects.
- **Example of Implementation**
  - City of Portland, Oregon – Portland allows projects, under special circumstances, to pay a fee in lieu of constructing on-site stormwater management facilities. The fee is based on an average unit cost of onsite facilities where such facilities would be effective, and allows for the establishment of the calculation method and fee by rule (City of Portland 2016b). Section 1.5 of Portland's Stormwater Management Manual (Portland, Oregon 2016a) describes the collection of the stormwater offsite management fee, which is placed in a mitigation account to be used to mitigate the impacts of offsite discharge of stormwater runoff. The Bureau of Environmental Services determines whether all or a portion of the stormwater management obligations of a project may be fulfilled by paying an offsite management fee, based on information provided by the applicant. The current fee is listed with the current fiscal year's Sewer and Drainage Rates and Charges.

3.3 In-Lieu Fees (Multi-jurisdictional)

Description

This option is based on Provision C.3.e.i.(2) of MRP 2 and is similar to the In-Lieu Fee (Single Jurisdiction) option, except that the agency would not be solely responsible for the in-lieu program. Instead, the agency would participate in a multi-jurisdictional program, which could be managed by one of the participating jurisdictions, or by another entity. Provision C.3.e.i.(2) does not require Regional Projects to be located in the same watershed as the Regulated Project, which would allow for the implementation of an in-lieu fee program on a multi-jurisdictional basis, potentially including the entire county, or San Francisco Bay region. Provision C.3.e.i.(2) of MRP 2 allows development projects that are Regulated Projects under Provision C.3.b to meet the C.3 requirements for stormwater treatment by paying an in-lieu fee to a Regional Project that achieves a net environmental benefit, in addition to treating a portion of the runoff from the project onsite. See Section 3.2, In-Lieu Fees (Single Jurisdiction) for a discussion of the required timeframe for completion of Regional Projects.

Evaluation of In-Lieu Fees (Multi-Jurisdictional) Option

- **Ballot approval** -- In-lieu fees are not classified as a tax or special assessment, and therefore do not require voter approval to be enacted.
- **Reliability** – Amount of funding would fluctuate, due to the linkage to development projects.
- **Cost to implement** – Costs would be shared across the participating jurisdictions, including the up-front costs of planning and implementing Regional Projects, the ongoing administrative costs to operate the program, and financial exposure with regard to the need to complete projects within required time frames for all contributing Regulated Projects.
- **Obstacles** – While the agency could potentially influence the development of a multi-jurisdictional in-lieu fee option, the viability of this option would be dependent upon decisions

and actions by others, including the establishment of agreements and cost-sharing approaches with other jurisdictions or another entity that may be identified to manage the program.

- **Example of Implementation**
    - The Construction Industry Coalition on Water Quality prepared a framework for the development of a model alternative compliance program that would apply to various locations covered by municipal stormwater permits in the San Diego region, Orange County, Riverside County, and San Bernardino County. The framework consists of four key elements: (1) analysis of legal/regulatory issues, (2) analysis of institutional framework considerations, (3) integrate an analysis of project opportunities with a benefit-cost analysis, and (4) conduct case study and pilot project to test the programmatic and decision selection framework (Grey 2014).

3.4 Wastewater Fees

Description

The use of revenue from wastewater fees to fund stormwater programs does not require voter or property owner approval, but it must be in compliance with Proposition 218's majority-protest public hearing process. The amount of funding must be clearly related to the benefits received by wastewater rate payers. The basis for transferring revenue from sanitary sewer service charges to stormwater programs is the benefit that is accrued to sanitary sewer customers by flood control and drainage maintenance projects that reduce the inflow or infiltration (I&I) of stormwater into sanitary sewers (SMCWPPP 2008, City of Berkeley 2016). In the context of sanitary sewer systems, infiltration means stormwater or groundwater that seeps into the sewer system through cracks and other vulnerable locations in the pipes and joints; inflow is the introduction of stormwater into the sanitary sewer system via specific storm connections, either deliberate or inadvertent (USEPA 2014). Inputs of I&I into sanitary sewers produces much higher than average flows at wastewater treatment facilities during wet weather episodes. Wastewater facilities must be designed to temporarily store wet weather flows so that they can be treated and safely discharged.

In order to use revenue from wastewater fees to implement GI plans, the agency would need to identify the I&I reduction that is anticipated to result from the construction and maintenance of projects included in its GI plan. The manner in which applicable costs for stormwater capital and maintenance projects can be incorporated into the sewer rate structure should maintain proportionality, which has presumably been established already in the sewer rate design if it conforms to industry rate-making practices. Sanitary sewage flow contributions, numbers of accounts, equivalent dwelling units, or strength factors are all common in sewer rate structures that distribute stormwater costs equitably (SMCWPPP 2008).

Evaluation of Wastewater Fee Option

- **Ballot approval** -- Wastewater fees do not require voter or property owner approval to be enacted.
- **Reliability** – Amount of funding would be relatively steady, once established.

- **Cost to implement** – Costs to implement this option would include the analysis of GI projects to quantify I&I reduction benefits and develop the required documentation to incorporate into the wastewater fee structure.
- **Obstacles** –Estimating the I&I reductions that would result from activities proposed in the GI plan, and establishing a clear nexus between the fee and the costs incurred, and the proportionality to the user.
- **Examples of Implementation:**
    - City of Oakland funds part of its stormwater program from revenue from sewer service charges, capped at 5% of the sewer revenue requirements. This funding mechanism pre-dates Proposition 218 (SMCWPPP 2008).
    - City of Belmont has provided funding from sewer service charges to its stormwater program since 2000. The Sewer Fund provides funding for 55% of the stormwater program budget based on those activities in the stormwater program – both O&M and capital improvements – that reduce I&I. The transfer from the Sewer Fund to the Stormwater Program represents 10% of the Sewer Fund's budget (SMCWPPP 2008).
    - City of Petaluma included its stormwater program within the Sewer Fund in 2002 because the stormwater program consisted primarily of O&M activities that resulted in reducing I&I into the sanitary sewers. The stormwater program represents 5% of the Sewer Fund's budget (SMCWPPP 2008).
    - City of Lodi - For many years, Lodi has funded its stormwater O&M costs within the Sewer Fund and capital costs from the Public Works budget. The stormwater O&M expenses represent 7% of the Sewer Fund's budget (SMCWPPP 2008).

3.5 Refuse Collection (Solid Waste) Fees

Description

Both stormwater and solid waste programs have close associations with street maintenance programs. Streets convey stormwater and also collect litter and other wastes that must be removed or swept away. It is a common practice for cities to include street sweeping services within their solid waste services (SMCWPPP 2008).

In addition, streets provide garbage vehicles access to waste sources, transfer stations, and disposal sites. When streets are poorly maintained, they pose both drainage and sweeping problems, and the debris on poorly-maintained streets contributes stormwater pollutants. Solid waste customers benefit from street sweeping, as well as street repair and maintenance. Garbage trucks exert more wear and tear on streets than any other vehicle. They are the heaviest vehicles that regularly travel streets, particularly in residential area, which are vulnerable because they have often not been designed to standards that can withstand the weight of garbage vehicles. Clean streets drain properly, which reduces flooding and promotes vehicle access (SMCWPPP 2008). Roadway maintenance and repair activities, such as asphalt overlay, may be linked to the wear and tear of streets resulting from garbage trucks, particularly on residential streets, and could potentially be funded, in part, from refuse collection

fees. There may be cost savings to install GI in concert with roadway maintenance projects such as asphalt overlay.

Additionally, it could be argued that the solid waste utility bears responsibility, at least in part, for the litter that needs to be cleared from storm drains, because activities such as street sweeping benefit both street maintenance and storm drain maintenance (City of Berkeley 2016).

Evaluation of Refuse Collection (Solid Waste) Fee Option

- **Ballot approval** – Refuse collection fees do not require voter or property owner approval to be enacted.
- **Reliability** – The amount of funding would be relatively steady, once established.
- **Cost to implement** – Costs to implement this option would include the analysis of the cost of applicable projects to develop the required documentation to incorporate into the refuse collection fee structure.
- **Obstacles** – A clear nexus must be established between the fee and the costs incurred, and the proportionality to the user.
- **Example of Implementation:**
    - City of Petaluma moved street sweeping to solid waste services, which allowed the City to fund street sweeping from solid waste rates. Prior to this move, the streets had been damaged to the point where street sweeping could not be performed. With the necessary funding, pavement repair was possible, after which the City was able to resume street sweeping in compliance with its NPDES requirements (SMCWPPP 2008).

3.6 Water Fees

Description

Any stormwater that can enter a water supply system poses a water quality risk. This includes tributary surface waters (streams, reservoirs) and underlying groundwater basins (shallow and deep aquifers). Water customers of water supplies that are influenced by stormwater benefit from stormwater programs that protect water quality or improve water supplies (ACCWP 2003). GI facilities that are constructed within the watershed of water resource (reservoir, groundwater basin, etc.) that produces drinking water could potentially be funded by water fees.

Including the appropriate costs of stormwater activities in water rates involves a process comparable to the process for sewer rates. The stormwater costs are presumably allocated proportionately through the cost-of-service allocations and rate design that are currently used to determine water rates. If the local agency does not provide water service, it will need to coordinate with the water supplier to have the stormwater costs incorporated into the water rate making (ACCWP 2003).

Evaluation of Water Fee Option

- **Ballot approval** – Water fees do not require voter or property owner approval to be enacted.
- **Reliability** – The amount of funding would be relatively steady, once established.

- **Cost to implement** – Costs to implement this option would include the analysis of the cost of applicable projects to develop the required documentation to incorporate into the water fee structure.
- **Obstacles** – A clear nexus must be established between the fee and the costs incurred, and the proportionality to the user.
- **Examples of Implementation:**
    - City of Santa Monica has a water conservation fee known as the Bay Saver fee. This is charged to residential water customers whose property has not been retrofitted with water conserving fixtures. Proceeds from this fee go toward offsetting the expenses of the Environmental Programs Division, of which stormwater pollution reduction is a major component (SMCWPPP 2008).
    - City of Oceanside charges a surcharge per unit of water used by customers of all classes. Per the ordinance establishing the charge, it is based upon water consumption as a conservation measure to reduce the amount of polluted urban runoff entering the city's storm drain system. All revenue generated by this surcharge is used exclusively for storm water program expenses (SMCWPPP 2008).
    - City of Encinitas provides an example to learn from. Encinitas added a surcharge to its water rates to fund its stormwater program. The surcharge was graduated in proportion to the size of the service connection. The theory was that water from irrigation created runoff laden with chemicals from landscaping. Revenue from the surcharge was used to fund measures that would reduce irrigation waste and improve the use of landscape chemicals. Despite this clear nexus, the surcharge was challenged from agricultural water users who claimed their surcharges were disproportionately high. Following the challenge, Encinitas eliminated the surcharge (SMCWPPP 2008).

3.7 Regulatory Fees and Fees for Service

Description

Regulatory fees and fees for service may provide funding for aspects of GI planning and implementation. Regulatory fees are imposed under police powers granted cities to regulate, conduct, and defray actual or anticipated adverse effects of the fee payer's behavior or use of facilities. Fees for service can be set at the estimated cost of providing the service when voluntarily requested by the public. These fees are exempt from Proposition 218 but should still demonstrate that the rate-making standards required under Proposition 218 are met, as follows:

- Fee revenue does not exceed funding requirements.
- Fee revenue is used for purpose collected.
- Fee is proportionate to cost of service (SMCWPPP 2008).

Following those standards will establish the fees at cost and improve their defensibility if challenged. Examples of these fees include:

- Business licenses (cost of litter abatement included in fast-food take-out restaurants; cost of alcoholism programs included in the cost of liquor licenses), which are regulatory fees.

- Fees for office and field services (plan review, inspections, permitting, grading, monitoring, enforcement), which are fees for service.
- User fees (beaches, parks).

Business licenses are paid annually and are based on financial measures such as revenues or payrolls. Business licenses can include a component to fund programs that mitigate the consequences of the goods and services provided by the business.

Evaluation of Regulatory Fees and Fees for Service Option

- **Ballot approval** – Regulatory fees and fees for service do not require voter or property owner approval to be enacted.
- **Reliability** – Fees linked to business licenses and inspections of facilities on private property would produce a relatively steady amount of funding. Fees linked to development activities would fluctuate with land development activities.
- **Cost to implement** – Costs to implement this option would include the analysis of GI planning and implementation activities to develop fees.
- **Obstacles** – Establishing and quantifying the actual or anticipated adverse effects of the fee payer's behavior or use of facilities that would be covered by a fee related to GI, and establishing the proportionality of the fee.
- **Example of Implementation:**
    - City of Oakland adopted an excess litter fee in 2006, which is charged to fast food businesses, liquor stores, and convenience markets to help cover the cost of street sweeping and trash container emptying near these businesses. The fee varies from business to business based on annual revenues. The fee is included as part of the annual business license. The fee generated $447,000 in 2007. Revenue from the fee funds a youth employment program that pays for 14 part-time temporary local residents plus a supervisor to collect trash (SMCWPPP 2008). An annual amount of $230 to $3,815 is collected annually from businesses using tiered rates that assess fees based on the annual gross receipts of the business, and the ordinance allows for reduction in fees for businesses that are already providing trash clean-up in their neighborhoods (City of Berkeley 2016).
    - City of Sacramento charges a General Plan Maintenance Fee, at the rate of $2.00 per $1,000 of valuation not to exceed $20,000 added to the building permit (City of Sacramento 2016).

3.8 Development Impact Fees/Capital Contributions

Description

Development impact fees are imposed on new development to fund capital improvements that are attributable to growth. They are one-time fees paid at the time of development or connection to facilities and must comply with the Mitigation Fee Act (Gov. Code 66000). The fee must be proportionate to benefits received and cannot be used to fund operation and maintenance expenses. Development impact fees are commonly assessed for a wide range of infrastructure facilities that benefit growth, including stormwater, sewer, water, schools, roads, and public safety facilities. In some

cases, developers are required to make capital or other financial contributions to mitigate a project's impact on non-local facilities that are constructed by others. These capital contributions can be netted out of development impact fees (SMCWPPP 2008).

Evaluation of Development Impact Fees/Capital Contributions Option

- **Ballot approval** – Impact fees do not require voter or property owner approval to be enacted.
- **Reliability** – Due to its linkage to private development projects, revenue from impact fees fluctuates with development activity.
- **Cost to implement** – Costs to implement this option would include the analysis of GI planning and implementation activities to develop fees in proportion to the cost of services provided.
- **Obstacles** – Establishment of nexus and proportionality. Impact fees may not be used to fund maintenance activities.
- **Examples of Implementation**
    - City of Oakland assesses a transportation and capital improvements impact fee on development projects to assure that projects pay their fair share to compensate for the increased demand for transportation and capital improvements infrastructure generated by development projects within the City. Fee revenues may be used to fund a capital project or portion of a capital project that meets all of the following criteria:
        - The project is a capital project included in the City's Capital Improvement Program;
        - The project is part of the citywide transportation infrastructure or provides connectivity between neighborhoods and activity centers within the City, or to neighboring communities or regional transportation facilities, and is not primarily for access to one specific neighborhood or development site; and
        - The project improves or expands the citywide transportation infrastructure to address and manage travel demand from new development (City of Oakland 2016).
    - City of San Mateo imposes a Transportation Improvement Impact Fee on new development to fund City-wide traffic improvements needed to accommodate development as specified in the city's 2008 Traffic Mitigation Report. The fee is based on trip generation rates by various land use types; fee rates are reviewed annually (City of San Mateo 2016). The City of San Mateo's Sustainable Streets Plan recommends replacing the city's existing Transportation Improvement Impact Fee with a Sustainable Streets Fee focused more specifically on intermodal improvements and GI (City of San Mateo 2015).

3.9 Stormwater Fee

Description

Because stormwater fees are subject to Proposition 218, it has been rare for agencies to increase existing or create new stormwater fees since the passage of Proposition 218. A number of agencies within Alameda County have stormwater fees that pre-date Proposition 218, which have not been increased in recent years. The increase or adoption a stormwater fee can be assumed to require a major public outreach effort in order to obtain voter or property owner approval. The voting public will

need to clearly understand the benefits they will receive from approving the fee and the consequences of not approving the fee. Public agencies must provide this explanation as objectively as possible without taking an advocacy position. In addition, the public must understand that the fee structure equitably allocates costs among residents without imposing hardships (SMCWPPP 2008).

Evaluation of Stormwater Fee Option

- **Ballot approval** – Stormwater fees are subject to the Proposition 218 requirement for approval by a majority vote of the property owners of the property subject to the fee, or, at the option of the agency, by a two-thirds vote of the electorate residing in the affected area.
- **Reliability** – Revenue would be predictable, once the fee is established.
- **Cost to implement** – Costs to implement this option would include the analysis of GI planning and implementation activities to develop a fee in proportion to the cost of services provided, plus the costs of placing the fee on the ballot and conducting a major public outreach campaign.
- **Obstacles** – In addition to the high costs for this option, there is substantial risk that voters could reject a proposed fee.
- **Examples of Implementation**
    - City of San Clemente adopted stormwater fee following the passage of Proposition 218. San Clemente mounted a successful public outreach campaign and adopted stormwater fees of $2.96 per month per unit (single-family homes) and $29.60 per month per unit for non-residential properties, effective January 1, 2003, with a five-year sunset clause. San Clemente was effective at developing local environmental support, particularly from advocates of clean beaches. Fears about the negative impact of beach closures on the local tourist economy were a paramount concern. In October 2007, San Clemente successfully renewed the stormwater fees for an additional six years. The fee remained the same, with 75% voter approval.
    - City of Burlingame adopted a storm drainage fee in 2009, at the rate of 4.192 cents per impervious square foot, adjusted for inflation not exceeding 2% annually, requiring all funds expended only on storm drains. The ballot question asked property owners to approve the fee to "improve, upgrade and maintain the deteriorated storm drain system, protect water quality, further reduce pollutants flowing into our creeks and San Francisco Bay, prevent street flooding that impedes residents and police/fire, emergency access, and improve local drainage…" (PPIC 2014).

3.10 Taxes and Assessments

Description

Property taxes and special assessments were common funding sources for stormwater improvements before taxation restrictions were adopted through Proposition 13 in the 1970s and Proposition 218 more recently. Other taxes that can be considered as sources for stormwater funding include:

- Gas taxes for road maintenance and street sweeping,
- Sales taxes for stormwater operating or capital expenses, and
- Transient occupancy taxes for pollution control and runoff management (SMCWPPP 2008).

Any of these taxes that are already in place but are being used for other purposes could be redirected for use in funding stormwater improvements, subject to any specific legal limitations (SMCWPPP 2008). For example, the following countywide measures have been adopted relative to fund transportation improvements within the County:

- Measure B was passed by voters in 2000, authorizing the continuation of a ½-cent sales tax through 2022 to fund transportation improvements within the County.
- Measure BB was passed by voters in 2014, as an extension and augmentation of the existing transportation sale tax (Measure B), which will generate revenue for transportation improvements from April 2015 to March 2045.
- Measure F was passed by voters in 2010, imposing a Vehicle Registration Fee (VRF) for vehicles registered in Alameda County, to providing funding to sustain the County's transportation network and reduce traffic congestion and vehicle related pollution (ACTC 2016).

Special assessments for operating and capital facilities that are of benefit to specific property owners require voter approval of a subset of the community, which may allow for a more focused public outreach effort and a higher likelihood of success. Local jurisdictions that create new or increase existing taxes must comply with Proposition 218's voter approval requirements (SMCWPPP 2008).

Evaluation of Taxes and Assessments Option

- **Ballot approval** – Taxes and special assessments are subject to the Proposition 218 requirement for approval by a majority vote of the property owners of the property subject to the fee, or, at the option of the agency, by a two-thirds vote of the electorate residing in the affected area.
- **Reliability** – Revenue would be predictable, once the tax or assessment is established.
- **Cost to implement** – Shifting funds from existing taxes or special assessments to fund GI costs would require an analysis of GI planning and implementation activities to document the nexus and proportionality for the use of this revenue. The increase of existing taxes/assessments or creation of a new tax/assessment would have the additional costs of placing a measure on the ballot and conducting a major public outreach campaign.
- **Obstacles**
    - Obstacles to shifting funds from an existing tax or assessment to GI include the loss of funding for activities that currently use these funds.
    - Obstacles to increasing an existing tax/assessment or creating a new tax/assessment include the risk that a ballot measure would fail, in addition to the high costs for this option.
- **Examples of Implementation**
    - City of Los Angeles -- In 2004, voters in Los Angeles approved Proposition O, voting to tax themselves at the approximate rate of $35 per year on a $350,000 home for 24 years in order to pay for $500 million in bonds for property purchase and projects that protect drinking water sources, reduce flooding, decrease polluted runoff, and impound, clean, and reuse storm water (SMCWPPP 2008).
    - Orange County has a countywide sales tax increment for transportation projects. In 2006, the Orange County Transportation Authority (OCTA) added stormwater issues to the list of what the increment would pay for under the reauthorization that was placed

before voters. This was passed and now 2% of the revenues off the top go to water quality (SMCWPPP 2008).

- City of Santa Barbara increased its transient occupancy taxes following Proposition 218, for the specific purpose of funding stormwater programs that reduce the discharge of polluted stormwater into watercourses tributary to the coast. The City's reliance on beach tourism was a motivation to provide funding that would minimize beach closures due to polluted stormwater runoff (SMCWPPP 2008).
- City of Berkeley currently uses a gas tax to partially fund road improvements, and a small percentage of this tax is transferred to the City's stormwater program. Berkeley has identified a potential opportunity to use funds from the countywide Measure B sales tax for in-street GI capital improvements (City of Berkeley 2016).

3.11 Grants

Description

Grant funding from federal, state, and regional sources may be available to fund GI improvements; however, the competition to receive such grants is generally intense. In addition, the application process can be extensive and there is no guarantee that funding will be awarded following the submission of an application package. Storm water and dry weather runoff capture projects that receive grant funds from a bond approved after January 2014 are subject to the requirements in California Water Code section 10563 (as amended by Senate Bill 985), for the project to be included in a Storm Water Resource Plan or functionally-equivalent plan. A partial list of grants that may be used to fund GI improvements is provided below:

State Water Resources Control Board (SWRCB) Proposition 1 Grants – Proposition 1 (Assembly Bill 1471) authorized $7.5 billion in general obligation bonds for water projects including surface and groundwater storage, ecosystem and watershed protection and restoration, and drinking water protection. SWRCB will administer $200 million of Proposition 1 grant funds for multi-benefit storm water management projects, including GI project, rainwater and storm water capture projects, and storm water treatment facilities. To obtain funding under this program, projects must be included in a Storm Water Resource Plan, or functionally equivalent plan, in accordance with the approved Storm Water Resource Plan Guidelines. The application period for Round 1 is closed. Round 2 is anticipated in 2018 (SWCRB 2016).

State Coastal Conservancy (SCC) Proposition 1 Grants – Using Proposition 1 funding, SCC awards grants to multi-benefit ecosystem and watershed protection and restoration projects. Priority project types include water sustainability improvements, anadromous fish habitat enhancement, wetland restoration and urban greening. Over the next several years, the Coastal Conservancy will offer up to four grant rounds per year. Some solicitations will be open to all eligible projects, others will target specific Proposition 1 priorities identified in the Coastal Conservancy's Strategic Plan. In June 2015, the Conservancy adopted Proposition 1 Grant Program Guidelines and updated its Strategic Plan to identify priorities for Proposition 1 expenditure (SCC 2016).

California Natural Resources Agency (CNRA) Urban Greening Grants – CNRA's Urban Greening Grant Program was created by Senate Bill 859 to provide grants from the Greenhouse Gas Reduction Fund to

fund GI projects aimed at reducing greenhouse gas emissions throughout California. The California Natural Resources Agency, Bonds and Grants Office expects to release draft guidelines for public comment in Fall 2016 (CNRA 2016).

One Bay Area Grants (OBAG) – The Metropolitan Transportation Commission's (MTC) One Bay Area Grant program — or OBAG — is a funding approach that aligns the Commission's investments with support for focused growth. OBAG taps federal funds to maintain MTC's commitments to regional transportation priorities while also advancing the Bay Area's land-use and housing goals. The OBAG program targets project investments in Priority Development Areas (PDAs) and rewards cities and counties that approve new housing construction and accept allocations through the Regional Housing Need Allocation (RHNA) process. In late 2015, MTC adopted a funding and policy framework for the second round of OBAG grants (OBAG 2), which is projected to total about $800 million to fund projects from 2017-18 through 2021-22. OBAG funds can be used to invest in:

- Local street and road maintenance,
- Streetscape enhancements,
- Bicycle and pedestrian improvements,
- Transportation planning,
- Safe Routes to School projects, and
- Priority Conservation Areas (MTC 2016).

Caltrans Active Transportation Grants – On September 26, 2013, Governor Brown signed legislation creating the Active Transportation Program (ATP) in the Department of Transportation (Caltrans). The ATP consolidates existing federal and state transportation programs, including the Transportation Alternatives Program (TAP), Bicycle Transportation Account (BTA), and State Safe Routes to School (SR2S), into a single program. The ATP is administered by the Division of Local Assistance, Office of Active Transportation and Special Programs. The purpose of ATP is to encourage increased use of active modes of transportation by achieving the following goals:

- Increase the proportion of trips accomplished by biking and walking,
- Increase safety and mobility for non-motorized users,
- Advance the active transportation efforts of regional agencies to achieve greenhouse gas (GHG) reduction goals, pursuant to SB 375 (0f 2008) and SB 341 (of 2009),
- Enhance public health,
- Ensure that disadvantaged communities fully share in the benefits of the program, and
- Provide a broad spectrum of projects to benefit many types of active transportation users.

Caltrans is currently evaluating applications submitted in response to the request for proposals issued for the third round of ATP grants (Caltrans 2016). The ability to use ATP funds to build the green infrastructure components of an active transportation project may depend on whether the active transportation project is a C.3 Regulated Project (in which stormwater treatment measures are required). For non-Regulated Projects, it may possible to fund a portion of GI improvements based in accordance with the ATP guidelines regarding the inclusion of landscaping in an ATP project.

Measure AA Funding – In 2016, a super majority of voters (two-thirds of voters) in the nine-county San Francisco Bay Area approved Measure AA, which created a parcel tax of $12 per year to benefit San

Francisco Bay by reducing trash, pollution and harmful toxins, improving water quality, restoring habitat for fish, birds and wildlife, protecting communities from floods, and increasing shoreline public access, raising approximately $25 million annually for twenty years. The request for proposals (RFP) and grant evaluation guidelines will be developed in early 2017; the RFP will be published in 2017 (SFBRA 2016b). The San Francisco Bay Restoration Authority published Measure AA grant guidelines in April 2016, which include eligibility criteria, including a requirement for projects to be located on the Bay shoreline (SFBRA 2016a). Measure AA sets forth specific project activities to be funded to advance four programs:

1. Safe, Clean Water and Pollution Prevention Program - The purpose of this program is to remove pollution, trash and harmful toxins from the Bay in order to provide clean water for fish, birds, wildlife, and people.
2. Vital Fish, Bird and Wildlife Habitat Program - The purpose of this program is to significantly improve wildlife habitat that will support and increase vital populations of fish, birds, and other wildlife in and around the Bay.
3. Integrated Flood Protection Program - The purpose of this program is to use natural habitats to protect communities along the Bay's shoreline from the risks of severe coastal flooding caused by storms and high water levels.
4. Shoreline Public Access Program - The purpose of this program is to enhance the quality of life of Bay Area residents, including those with disabilities, through safer and improved public access, as part of and compatible with wildlife habitat restoration projects in and around the Bay (SFBRA 2016a).

Evaluation of Grants Option

- **Ballot approval** – Ballot approval is not required.
- **Reliability** – Grants are typically awarded for an individual project or planning activity, which must be completed by a specified date. Grants for project construction may specify that funds cannot be spent on maintenance.
- **Cost to implement** – Cost to prepare the application, which may be a lengthy process. Matching funds are typically required. Depending on the grant, there may be costs to prepare a Storm Water Resources Plan or functionally-equivalent plan.
- **Obstacles**
    - Resources must be spent to apply for grants, with no guarantee of success in obtaining a grant.
    - In order to receive grant funds from a bond (approved after January 2014), storm water and dry weather runoff capture projects must be included in a Storm Water Resource Plan or functionally-equivalent plan, in accordance with Water Code section 10563 (as amended by Senate Bill 985).
- **Examples of Implementation**
    - Union City – Obtained grant funding from Proposition 84 to construct three green street project: the Decoto Green Street, South Decoto Green Streets, and H Street - Green Street Improvement projects.

- City of Albany – Used funding from a Proposition 50 River Parkways Grant to construct the Codornices Creek Restoration Project, which included four rain gardens that provide stormwater treatment for runoff from 6th Street (BASMAA 2013).
- Alameda County – Used funding from Proposition 1B (Highway Safety, Traffic Reduction, Air Quality, and Port Security Bond Act of 2006) to partially fund the Stanley Boulevard green street project (BASMAA 2013).

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