California Stormwater Quality Association®

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Removing Barriers to Low Impact Development (LID)

Proposition 84 Grant 12-421-550

LID Technical Standards Review

Technical Memorandum #1
Bioretention Details and Standards Review

May 2017

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Technical Memorandum #1
Bioretention Details and Standards Review

Prepared for

California Stormwater Quality Association

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Preface

The California Stormwater Quality Association (CASQA) is a professional member association dedicated to the advancement of stormwater quality management through collaboration, education, implementation guidance, regulatory review, and scientific assessment. CASQA has been a leader since 1989 when the field of stormwater management was in its infancy. CASQA's membership is comprised of a diverse range of stormwater quality management organizations and individuals, including cities, counties, special districts, industries, and consulting firms throughout the state. A large part of CASQA's mission is to assist California stormwater permittees in developing, implementing, and maintaining effective stormwater quality management programs by drawing upon the collective experiences of its individual members, to share successes and avoid the pitfalls.[7]

CASQA was awarded a Proposition 84 Stormwater Grant (Grant) to provide Low Impact Development (LID) implementation support to municipalities throughout California. As part of the Grant, CASQA provided technical support to municipalities including developing LID technical resources and using existing LID details and standards, developed by others, including details and standards for bioretention and permeable paving. Subsequently, CASQA entered into an agreement with a team of specialists to provide review of the LID details and standards to verify that the materials being used are comprehensive, technically accurate, and identify areas of technical uncertainty or where differences in technical opinion exist.

The team of specialists include CASC Engineering and Consulting, Inc. as the project manager and technical specialist, EOA, Inc. as a technical specialist, and the Interlocking Concrete Pavement Institute as a technical specialist. The team brings together Jeff Endicott, PE, BCEE, Jill Bicknell, PE, and David Smith from these respective organizations.

This Technical Memorandum #1 provides review and commentary on bioretention details and standards originally developed by the Central Coast LID Initiative (LIDI) and modified by the Grant Project Team, including a review of the LIDI *Bioretention Technical Specifications* (April 17, 2013 version). Jill Bicknell is the primary author of Technical Memorandum #1, with technical and editorial review provided by Jeff Endicott and David Smith.

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[7] https://www.casqa.org/about

Introduction

CASQA was awarded a Proposition 84 Stormwater Grant (Grant) to provide Low Impact Development (LID) implementation support to municipalities throughout California. As part of the Grant, CASQA provided support to municipalities including developing LID technical resources and using existing LID details and standards, developed by others, including details and standards for bioretention and permeable paving. Subsequently, CASQA entered into an agreement with a team of specialists to provide review of the LID details and standards developed originally by LIDI and modified by the Grant Project Team to verify that the materials being used are comprehensive, technically accurate, and identify areas of technical uncertainty or where differences in technical opinion exist.

The team of specialists have been assigned three major tasks, including:

- Task 1 – Bioretention Details and Standards Review;
- Task 2 – Pervious Pavement Details and Standards Review; and
- Task 3 – Future Efforts Related to LID.

Task 1 and Task 2 each include several defining subtasks.

This Technical Memorandum (TM) #1 describes the work performed under Task 1. It provides the specialist team's comments and recommendations relative to the modification of bioretention standards and details currently in use as part of the Grant, which consists of the details and standards developed by the Central Coast LID Initiative (LIDI) in 2013 for use in the Central Coast region. These standards and details were developed consistent with the Small MS4 Phase II Municipal Permit for post-construction stormwater control requirements, specifically the post-construction requirements adopted by the Central Coast Regional Water Board. In late 2016, the standards and details were revised by the Grant Project Team to include modifications to address comments received while providing LID training and assistance to municipalities as part of the Grant project. This set of standards and details, dated December 16, 2016, was provided to the specialist team for review.

It is our understanding that products from the Prop 84 Grant will be made available to the stormwater practitioner community through the CASQA LID Portal. Part of the purpose of this review is to ensure that the standards and details are comprehensive and can be used throughout the State. Although there are regional differences, in part due to differences in stormwater permit requirements, the standards and details can provide common design elements and notes on regional requirements. For example, the requirement that bioretention facilities with underdrains use 24 inches of biotreatment soil media instead of 18 inches is unique to the Central Coast and should be called out in the notes. Notes that refer to the LIDI Bioretention Technical Specifications can also reference local or countywide guidance documents and/or the CASQA New Development/Redevelopment BMP Handbook[8].

Scope of Work

The work performed under Task 1 included the following subtasks:

Task 1A – General Review of Bioretention Details & Standards

A review was performed of the following documents currently used as part of the Prop 84 Grant:

[8] The CASQA New Development and Redevelopment BMP Handbook is currently undergoing a major revision. It was not possible, given the deadlines on the Grant project and the limited scope of work and budget for this review, to coordinate with the Handbook team on bioretention details and specifications. Based on a quick review of the draft Handbook, it appears that there are inconsistencies among the Handbook, the LIDI Bioretention Technical Specification, and this TM #1. It is recommended that CASQA conduct efforts to align the documents prior to completion of the Handbook.

- Low Impact Development Stormwater Management Standard Details, version 12/16/2016, sheets SW-1 through SW-21[9];
- Low Impact Development Initiative (LIDI) Bioretention Technical Specifications, version 4/17/13

This memorandum presents the general results of the review, technical opinions and recommendations for potential modifications. Attachment A provides specific recommended edits to the LIDI Bioretention Technical Specifications in a tracked changes format. Attachment B provides recommended revisions to the actual detail sheets, and Attachment C provides recommended edits to the Construction Notes and Design Notes on the detail sheets, in a tracked changes format.

Task 1B – Biofiltration Details & Standards

The original scope of work for this task was to develop biofiltration details and standards. As discussed in the next section under Terminology, Details SW-5 through SW-8 already provide details and standards for unlined bioretention systems with underdrains, which are often referred to as biofiltration systems. The detail set does not include details for lined systems with underdrains, and recommendations are made in this memorandum for adding new detail(s) for lined systems. Lined bioretention systems with underdrains are also often referred to as biofiltration systems. Subsequently, a biofiltration detail was later developed by the Grant Project Team.

Task 1C – Bioretention/Dry Well Combination Detail and Standards

Under this task, the LIDI bioretention/dry well system design was reviewed with regard to clarity, technical validity, and robustness. The following documents were reviewed:

- Low Impact Development Stormwater Management Standard Details, version 12/16/2016, sheet SW-24.
- Memorandum to Darla Inglis, Central Coast LIDI, from Geosyntec Consultants, re: Drywell Stormwater BMP – Drywell Information, Detail and Specifications for Enhanced Infiltration, September 2015

Recommendations are summarized in this memorandum and specific edits to the SW-24 design and construction notes are provided in Attachment C.

Terminology

The terms “bioretention”, “biofiltration”, “biotreatment”, and “bioswale” have different meanings in guidance documents developed throughout California (often because of the way they are defined in applicable MS4 permits), and are often used interchangeably. It is assumed that the terminology in the LIDI details and standards was based on the Central Coast Region Post-Construction Requirements (PCRs)[10] definitions:

- Bioretention -- a stormwater control measure designed to retain stormwater runoff using vegetated depressions and soils engineered to collect, store, treat, and infiltrate runoff. Bioretention designs do not include underdrains.

[9] Detail sheet numbering has changed from the original 100-105 and 200-205 series. SW-22 is a pervious pavement detail that was not reviewed as part of Task 1, but should be updated per recommendations in TM #2 (Task 2). SW-23 contains plant inundation zones and recommended plant lists and was not reviewed as part of this contract. SW-24 was reviewed as part of Task 1C.

[10] California Regional Water Quality Control Board, Central Coast Region, “Post-Construction Stormwater Management Requirements for Development Projects in the Central Coast Region”, July 12, 2013.

- Biotreatment or Biofiltration -- a stormwater control measure designed to detain stormwater runoff, filter stormwater through soil media and plant roots, and release the treated stormwater runoff to the storm drain system. Biotreatment/biofiltration systems include an underdrain.

These definitions do not describe the type of stormwater control measure that has an underdrain but is designed to store and infiltrate a significant portion of the water quality design volume (WQv). This type of design is used widely in parts of California where clayey soils preclude infiltration of the entire WQv, but maximizing the amount of infiltration that can be achieved is encouraged or required.

It is recommended that the following definitions be included in the guidance that accompanies the LIDI details and standards:

- Bioretention -- a stormwater control measure designed to retain stormwater runoff using vegetated depressions and soils engineered to capture, treat, and infiltrate runoff. Stormwater runoff volume reduction is generally achieved via infiltration into the underlying native soil. Pollutant removal is achieved through a combination of infiltration, filtration, settling and biochemical processes. Bioretention designs may include an aggregate layer designed to increase retention capacity. Underdrains may also be used to discharge runoff that exceeds the design objective.
- Biofiltration (sometimes referred to as biotreatment) -- a stormwater control measure designed to detain stormwater runoff using vegetated depressions and soils engineered to capture and treat runoff. Pollutant removal is achieved through a combination of filtration, settling and biochemical processes. Treated stormwater runoff is routed out of the facility (e.g. to the existing underground storm drain system or surface overflow). Biofiltration systems include an underdrain installed near the bottom of the aggregate layer, and a horizontal and/or vertical impermeable base or liner when necessary to avoid infiltration (e.g., a facility located adjacent to a building, high groundwater table, contaminated native soils). Biofiltration stormwater control measures provide negligible to no infiltration.

The bioretention definition is consistent with the titles of details SW-1 through SW-7A. The biofiltration detail is provided in SW-9.

The LIDI details cover two types of bioretention side configurations: “flat/planter” (SW-1, 3, 5, and 7) and “slope sided” (SW-2, 4, 6, and 8). The term “flat/planter” is confusing, since all bioretention systems should include flat bottoms. It is recommended that the term “planter-box” be defined as a facility with vertical sides (i.e., drop the word “flat”).

We recommend that definitions of terms and a list of abbreviations be provided in a cover sheet to the detail sheets, or included at the beginning of the Bioretention Technical Specifications.

Task 1A – General Review of Bioretention Details & Standards

A review was performed of the LIDI details SW-1 through SW-21, and the LIDI Bioretention Technical Specifications. Specific recommended edits to the Bioretention Technical Specifications are provided in Attachment A, and recommended revisions to the detail sheets are provided in Attachment B. Attachment C contains recommended edits to the Construction Notes and Design Notes on the detail sheets.

This section describes the key topics addressed by the revisions, the general recommendations, and the technical or practical justification for the recommendations.

Bottom Width of Facilities

Facility width may be constrained by site specific factors (e.g. available right-of-way width). However, we agree with the recommendation of a minimum 2-foot wide, flat bottom for both planter and sloped-

sided bioretention facilities. This is primarily to ensure that the components of the facility will be properly constructed, given the size of construction equipment, and that the bottom is flat (not V-shaped) to allow runoff to spread evenly throughout the aggregate base. Since the flat base area is used in infiltration design calculations, this area should be maximized to optimize facility performance. Additionally, a greater than 2' bottom width is also preferred where underdrains are used, to provide sufficient separation between the pipe and sidewalls.

Allowable Standing Water Duration

The Bioretention Technical Specifications correctly states that the allowable ponding time typically associated with mosquito vector control is 72 hours, but this applies to a detention basin, not a bioretention facility. A bioretention or biofiltration facility should drain its 6-12 inches of ponded water through the BSM (and drain excess flows through the overflow structure) within several hours after the storm event. If it ponds longer than 6 hours, then there is a problem with design, construction, or maintenance of the facility that needs to be addressed. The ponding duration of biofiltration stormwater control measures is a function of the bioretention soil media infiltration rate and ponding duration should not exceed six hours. In contrast bioretention stormwater control measures may function to include longer ponding duration as a function of the underlying native soil. Acceptable ponding duration may be a function of vector control, public safety, perceived nuisance flooding or other factors.

Ponding Depth

We agree with the specified ponding depth of minimum 6 inches and maximum 12 inches. In Bay Area guidance documents, we encourage a 6-inch depth to allow more varieties of plants in the facility and to minimize the drop into the facility from the adjacent grade. The 12-inch depth is more often used in above-grade flow-through planters, often used next to a building or on a podium structure, when there are space constraints and a desire to minimize the facility surface area.

However, we disagree with the way the ponding depth is called out in the details. The ponding depth should be measured from the water surface to the surface of the bioretention soil media, not the surface of the mulch. The surface of the BSM should be considered the finished elevation, as it is an engineered, lightly compacted, and relatively permanent surface. Mulch is a loose media that is often not applied uniformly, not compacted, and contains a lot of void space for the ponded water. Mulch also degrades over time and needs replacement. For this reason, it is recommended that the details be modified to show the finished elevation at the top of the BSM, and show the ponding depth extending from the top of the BSM to the maximum water level. The maximum ponding water level should coincide with the elevation of the edge of the opening to the overflow structure (i.e., the grate overflow elevation, not the top of the beehive grate). When setting the maximum ponding water surface level in this manner, it is understood that there will be a small additional and very temporary increase in water surface level to drive volumes in excess of the water quality design volume through the outlet. To address concerns of "overfilling" the facility with mulch, a note should be added to the details indicating the correct elevation of the mulch in comparison to the inlet elevation.

Side Slope

We agree with the recommendation of a preferred 4:1 side slope, or a maximum 3:1 slope with a 12-inch wide shelf, for stability of the BSM. Extending the native soil side slope below the BSM layer (at a slope or length based on geotechnical conditions) for structural support, as shown in SW-2, 4, 6, and 8, appears to be a reasonable approach; however, it is unclear how far the native soil slope will extend in length, and whether the area above the native soil slope and shallow BSM section should count as part of the ponded surface area of the bioretention facility. This is a new concept in design that warrants further discussion, and at a minimum, a revised detail that shows the correct scale of a typical native

side slope. We agree that this surface undoubtedly allows for some infiltration; however, existing design guides use only the flat bottom for making infiltration estimates. Further, the sloped sides complicate drawdown calculations as the wetted horizontal perimeter changes as drawdown takes place.

Longitudinal Slope

We disagree that the longitudinal slope of a bioretention facility can be a maximum of 6% slope. The facility should be relatively flat so that water ponds and infiltrates evenly across the facility surface. If needed to pass runoff through the facility (e.g., in-line facilities), the hydraulic grade line (HGL) of the water surface profile can be sloped above the flat bioretention facility (e.g., from inlet to overflow). If the facility must be installed on a slope, it should be terraced and separated by check dams and weir overflows to provide flat-bottomed cells with proper storage and infiltration. Check dams should be placed for every 4-6" of elevation change and so that the top of each dam is at least as high as the toe of the next upstream dam.

Depth and Width of Aggregate

A minimum total aggregate depth of 12 inches is generally the design standard in most areas of the State. Both the Phase II Small MS4 Permit (Provision E.12.e.ii.(f)(4)) and the Central Coast PCRs require a "subsurface drainage/storage (gravel) layer with an area equal to the surface area and having a minimum depth of 12 inches" (or equivalent). This depth allows for complete drainage of the BSM and also provides some storage for treated water prior to infiltration into native soils. In cases where bioretention facilities will be used to meet retention or hydromodification standards, the depth of aggregate may need to be greater than 12 inches to accommodate the required storage volume.

To achieve the benefits of complete drainage of the BSM and maximizing the available storage, it is also standard practice to extend the aggregate section to the edges of the BSM, such that the surface area of the aggregate and BSM are similar (per the Phase II permit requirements above and bioretention design guides that use the horizontal bottom area of the aggregate section for sizing the bioretention system). This is illustrated in the planter details (SW-1, 3, 5, and 7) but not the case in the bioretention facilities with sloped sides (SW-2, 4, 6, and 8). We recommend that details SW-2, 4, 6, and 8 be redrawn to show a wider aggregate section (the maximum that can be accommodated between the native soil bench and slope on each side), especially if the intent is to include these areas in drawdown calculations at some point in the future (design procedures will need to be reviewed and revised). However, the width of aggregate (and BSM) application may be influenced by geotechnical issues related to the structural stability of the facility and adjacent infrastructure. In some cases, excavation to achieve an aggregate width equal to the BSM width may not be practical or desirable. Consultation with a geotechnical engineer is advised when there is uncertainty concerning facility excavation.

Position of Underdrain in Aggregate Section

The Phase II Permit (Provision E.12.e.ii.(f)(5)) and Central Coast PCRs specify that the underdrain should have a discharge elevation "at top of gravel layer". This is echoed in the LIDI Bioretention Technical Specifications; however details SW-5 through 8 show the underdrain 6 inches below the top of the aggregate (the discharge elevation is not shown). With a 12-inch depth section and a 4-inch underdrain, this would leave only 2 inches of available storage below the underdrain. In the Bay Area, a typical design is to place the underdrain 2 inches below the top of the aggregate, which leaves 6 inches of storage below the underdrain.

Another approach is to raise the discharge elevation of the underdrain at the point at which it connects to a downstream manhole, using a 90-degree elbow. With this approach, the underdrain can be placed at any height within the aggregate section, including close to the bottom. If the discharge elevation is the same as the top of the aggregate, the entire aggregate section can be used for storage. It would be helpful to add a detail illustrating this option.

BSM Depth

Bioretention soil media (BSM) removes pollutants through various processes, including filtration, adsorption, microbial processes, decomposition, plant uptake and evapotranspiration. The Phase II permit (Provision E.12.e.ii.(f)(3)) requires a minimum planting medium depth of 18 inches. This is consistent with the design standard that is used in the Bay Area and other parts of the State. The Central Coast PCRs require a BSM depth of 18 inches for facilities with no underdrains, and 24 inches for facilities with underdrains. The rationale is that for systems with no underdrains, the treated water gets further treated via infiltration, and for systems with underdrains, the runoff gets treated in the BSM only and therefore needs more contact time with the BSM. (There is no design standard in the PCRs for systems with underdrains that allow some infiltration.) Data on bioretention system performance indicates that increased media depth can increase removal of certain pollutants, such as nitrogen and phosphorus, but that removal of other pollutants (including sediment and many pollutants bound to sediment) occurs in the top 2-8 inches of the BSM and does not improve with increased media depth.

The LIDI details for systems with underdrains (SW-5, 6, 7, and 8) indicate a minimum BSM depth of 24 inches, in accordance with the PCRs. It is recommended that the detail be modified to indicate a minimum depth of "18 inches or 24 inches where required".

BSM Specifications

The Phase II permit and the Central Coast PCRs state that "a mixture of sand (60%-70%) meeting the specifications of American Society for Testing and Materials (ASTM) C33 and compost (30%-40%) may be used" as the bioretention soil media. This is consistent with biotreatment soil media specifications developed by the Bay Area Stormwater Management Agencies Association (BASMAA) in 2011. The BASMAA BSM specification contains more detailed specifications for each of the sand and compost components than the permit requirements listed above. The BASMAA specifications were updated in 2016 to include minor changes to make it easier for suppliers to comply with the compost specifications.[11]

Experience with the BASMAA BSM specifications has indicated that the fast draining mix does not retain moisture to sustain plants during long dry periods, and does not contain enough nutrients for large shrubs or trees. On June 30, 2016, the BASMAA Development Committee Soil Specifications Work Group conducted a roundtable meeting of experts to revise or develop new specifications to address these issues. Prior to the roundtable, a literature review was prepared to examine potential changes to the BSM and to the design of bioretention systems for the benefit of trees.[12] The experts did not come to consensus, and work groups are continuing to explore these issues. The point is that while we support referencing the BASMAA BSM specifications in the LIDI Bioretention Technical Specifications, BSM specifications continue to evolve, and some flexibility for use of alternative mixes that provide equivalent performance and benefits should be allowed. For example, there are designer BSMs and BSM specifications that target specific pollutants, such as phosphorus, and when appropriate, their use should be encourages. The use of these designer BSMs is site- and pollutant-specific, and therefore not appropriate for inclusion in general standards. Selection of the appropriate BSM should be based on regional guidance or requirements. Additionally, BSM tailored to target specific pollutants may be used to meet treatment performance objectives.

[11] Bay Area Stormwater Management Agencies Association (BASMAA) Regional Biotreatment Soil Specification (revised January 29, 2016).
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/MRP/provisionC.3/Revised_%20Biotreatment%20_Soil.pdf

[12] BASMAA, Biotreatment Soil Media and Specification: Current Research on Trees and Water Quality Treatment, Literature Review, San Francisco Bay Area, CA. Prepared by WRA Environmental Consultants. September 2016.

Mulch

Mulch is needed to protect plants, retain soil moisture, prevent erosion, minimize weed growth and adsorb pollutants. It is recommended that three inches of mulch be applied over the entire surface of the bioretention facility. Projects subject to the State's Model Water Efficiency Landscaping Ordinance (or comparable local ordinance) are required to provide at least three inches of mulch. Aged mulch, also called compost mulch, reduces the ability of weeds to establish, keeps soil moist, and replenishes soil nutrients. Aged mulch can be obtained through soil suppliers or directly from commercial recycling yards.[13] Some public agencies and facility owners prefer to use a pea gravel or washed crushed aggregate mulch because of the reduced need for maintenance (it does not need replacement like aged mulch). Gravel mulch has some of the same benefits as aged mulch except that it does not provide any pollutant removal at the surface. For aged mulch/compost a depth of 3 inches should be specified. Bark mulch can be problematic due to mobilization during ponding and potential to clog overflow inlets. Some designs include bark mulch around the non-wetted perimeter of the facility but not within the ponded area. Because of the practice of "overfilling" the facility with mulch, design/construction notes should indicate that while the finished elevation is the top of the BSM, the mulch layer should not prevent routing of stormwater into the facility.

Curb Cut Width

The bioretention facility details and the curb cut inlet detail (SW-14) do not specify the curb cut width. It is recommended that curb cuts be constructed with a width sufficient to pass the hydraulic design flow and with a minimum width of 12 to 18 inches, with rounded edges. This will help ensure that sediment and leaves do not clog the inlet and will allow trash to enter the facility. The curb cut inlet detail could also show the option of a curb cut that is a minimum 12 inches at the bottom of the cut and 18 inches at the top (i.e., the curb cut sides are angled outward toward the solid curb).

Plan Views and Longitudinal Sections

As a future task, it would be helpful to provide plan views and longitudinal sections to this set of details, so that the design of the facilities can be fully understood.

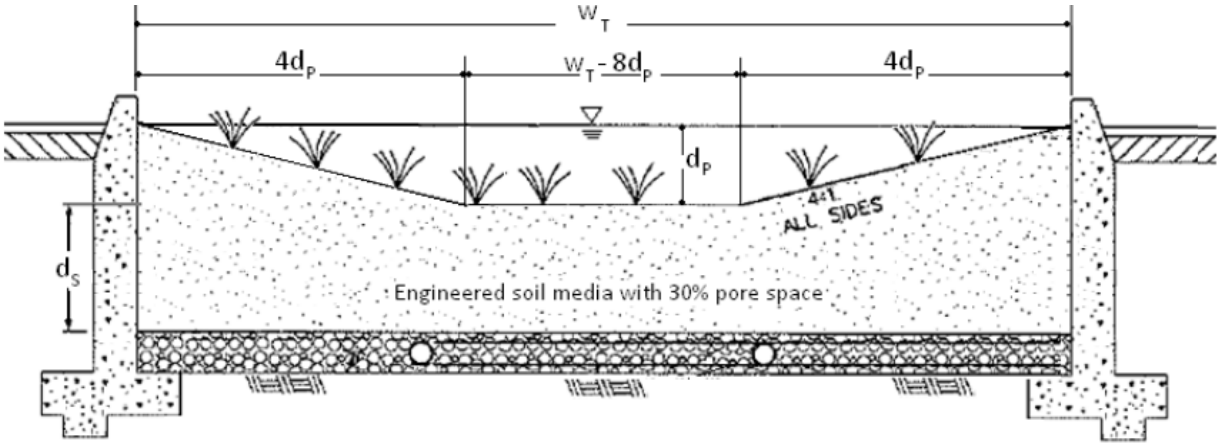
Structural Details

The structural design of bioretention and biofiltration facilities is crucial to achieve the intended water quality performance and also to ensure the long-term structural stability of the facility and any adjacent infrastructure. However, the specific design elements that address structural stability are often project specific and influenced by factors such as the native soil type and facility siting (e.g., directly adjacent to heavy load bearing areas such as parking stalls). Conventionally, engineering details provide the specific design elements and dimensions for an engineered structure, which provide the information needed by the designer to ensure projects meet all the necessary performance criteria. However, bioretention and biofiltration facilities often require that the designer understands, or seeks consultation from a geotechnical expert, as to the best design to address structural stability. Consequently, the ability to provide explicit guidance in the engineering design details is problematic.

The LIDI standards and details were updated to include better structural support for curbs. However, the BSM sand and compost mix is only lightly compacted and cannot support adjacent curbs without additional reinforcement. The LIDI detail set provides options such as deep curbs (SW-10), a native soil bench extending beyond the base of the curb (SW-1 through SW-8), and for slope-sided facilities, notes indicating that the native soil side slope should be determined by a geotechnical engineer. Depending on where the vehicle loads are applied relative to the edge of the BSM section, additional structural support, or a retained design, may be needed. "Retained design" refers to bioretention facility sections

[13] Ibid #8.

that require sidewall or side slope retention due to soil loading. Sidewall or side slope retention can be accomplished with a retaining wall, or other designs such as soil reinforcement using geotextiles. An example is shown below:



Because the issues related to geotechnical stability for bioretention, biofiltration and associated infrastructure are complex, it is beyond the scope of this memorandum to provide recommendations to modify the existing details and specifications. However, it is recommended that the design notes should indicate that consultation with a geotechnical engineer is important to ensure proper design and performance.

Bioretention as a Class V Injection Well

The United States Environmental Protection Agency (USEPA) implements the Underground Injection Control (UIC) program in California. Through the UIC program, EPA regulates injection wells, including Class V wells. Some stormwater control measure designs include attributes that fall under the definition of a Class V well, and thereby subject to registration and compliance with applicable USEPA rules and regulations.

USEPA noted the increase in use of green infrastructure measures (another name for LID measures), and noted the reluctance of some to use these measures due to their potential for regulation under the UIC program. To address this uncertainty, USEPA issued guidance the helps, but does not fully explain when stormwater control measures are likely to be Class V wells and subject to regulation.[14]

USEPA noted that rain gardens and bioretention facilities are generally not considered Class V wells. In making this general determination, USEPA described rain gardens and bioretention as follows:

"Rain gardens and bioretention areas are landscaping features adapted to provide on-site infiltration and treatment of stormwater runoff using soils and vegetation. They are commonly located within small pockets of residential land where surface runoff is directed into shallow, landscaped depressions; or in landscaped areas around buildings; or, in more urbanized settings, to parking lot islands and green street applications."

[14] Boornazian, Linda, Director, Water Permits Division and Heare, Steve, Director, Drinking Water Protection Division, United States Environmental Protection Agency. Clarification on which stormwater infiltration practices/technologies have the potential to be regulated as "Class V" wells by the Underground Injection Control Program. Memorandum to Water Division Directors, June 11, 2008.

Later, when describing an infiltration trench, USEPA noted that this type of facility would probably be a Class V well based on attributes of some infiltration trenches that are now common to bioretention facilities.

"In certain circumstances, for example, if an infiltration trench is "deeper than its widest surface dimension," or includes an assemblage of perforated pipes, drain tiles, or other similar mechanisms intended to distribute fluids below the surface of the ground, it would probably be considered a Class V injection well."

Key to this determination appears to be the EPA's differentiator between rain gardens and bioretention, that with a trench, "…Runoff may or may not pass through one or more pretreatment measures…" per USEPA.

Considering that bioretention and biofiltration facilities often include assemblages of perforated pipes or other similar mechanism that are sometimes intended to distribute fluids below the ground and that the fluids reaching these assemblages will have usually been pre-treated by passing through 18 inches to 24 inches of BSM, it appears likely that bioretention facilities will not be classified as Class V wells. However, where bioretention or biofiltration overflows are connected to underdrains in a manner such that overflows could reach the underdrain without having first passed through the BSM, then the bioretention facility may qualify for registration and regulation as a Class V well.

In conclusion, those designing and approving bioretention and biofiltration facilities must read, understand, and comply with USEPA requirements for registration, design, and operation of Class V wells. Registering a well is easy, and is recommended when there is any doubt regarding whether the design is a Class V well.

Task 1B – Biofiltration Details & Standards

The original scope of work for this task was to develop biofiltration details and standards. As discussed under Terminology, Details SW-5 through SW-8 already provide details and standards for unlined bioretention systems with underdrains, which are often referred to as biofiltration systems, and comments have been provided on those details. However, the detail set does not include details for lined systems with underdrains. It is recommended that new details be added for lined biofiltration systems and include a design note that liners should be used only when needed to address infiltration concerns (e.g., high groundwater, facilities adjacent to buildings, contaminated native soils).

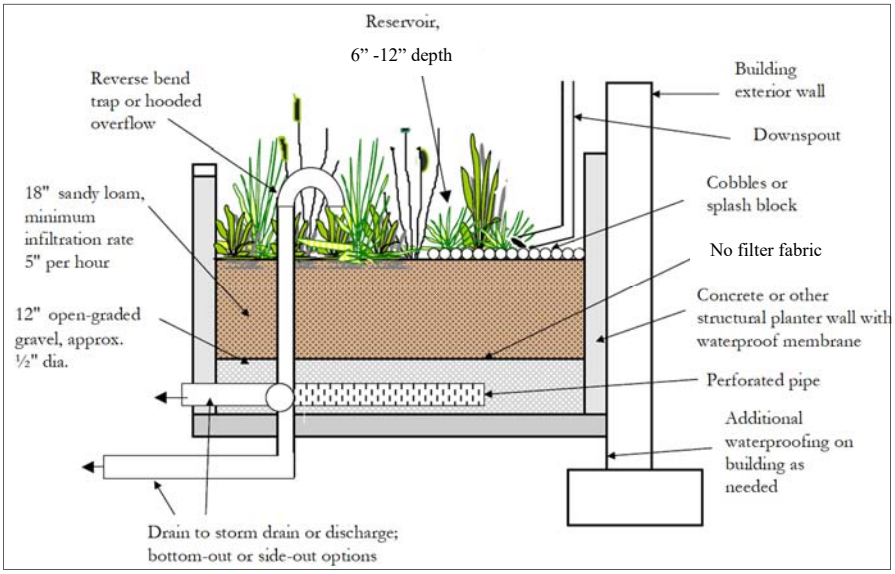
Although infiltration from bioretention or biofiltration systems is encouraged (or required by stormwater permits) wherever feasible, there are situations in which infiltration is not allowed or is technically infeasible. The Phase II Permit (Provision E.12.e.ii.(h)(2)) allows facilities located above contaminated soil or groundwater or where infiltration could contribute to a geotechnical hazard, and facilities located on elevated plazas or other structures to incorporate an impervious liner. Underdrains in facilities with liners should be placed at the bottom of the aggregate layer, just above the liner.

There are two recommended approaches for creating details for lined biofiltration facilities:

1. For slope-sided bioretention facilities with underdrains (details SW-6 and SW-8), add a flexible liner (e.g., 30 ml. HDPE material) to the sides and bottom and lower the underdrain to the bottom of the aggregate section; and
2. For planters with underdrains (details SW-5 and SW-7), revise the detail to show concrete planter box walls and bottom with waterproof membranes and an underdrain located at the bottom of the aggregate section (i.e., a flow-through planter design).

An example of the design of an above-grade flow-through planter next to a building is shown below. These types of facilities can be installed at grade in narrow sections between streets and sidewalks, or

above grade next to buildings and on podium structures. They represent a “retained design” as described above, and they prevent seepage of water from damaging nearby structures.



Source: Dan Cloak Environmental Consulting, 2010, with modifications

Task 1C – Bioretention/Dry Well Combination Detail and Standards

The LIDI bioretention/dry well system design (Detail SW-24) and the accompanying guidance memorandum by Geosyntec was reviewed with regard to clarity, technical validity, and robustness. In our opinion, this is a very robust and effective design for stormwater capture via deep infiltration of treated stormwater. The memorandum provides clear guidance on the design of the bioretention/dry well system and a technically sound basis for the design. The plan view and longitudinal section on Detail SW-24 clearly illustrate the construction of the system. The shut-off valve is an important feature to prevent hazardous material spills from breaking through the bioretention facility and entering the dry well, further minimizing the risk to groundwater quality.

With the exception of one minor clarification on the design detail itself, our comments are focused on edits to the SW-24 design and construction notes to make the notes more clear and correct some inaccuracies. Comments on the notes are provided in the table in Attachment C.

References

The recommendations in this technical memorandum are based on the collective experience of the technical specialist team, the references listed below, and the author’s specific involvement in development of the first two documents listed below, as well as years of training and support of municipal staff on bioretention design.

Santa Clara Valley Urban Runoff Pollution Prevention Program, C.3 Stormwater Handbook, June 2016. http://www.scvurppp-w2k.com/c3_handbook.shtml

San Mateo Countywide Water Pollution Prevention Program, C.3 Stormwater Technical Guidance, Version 5.0, June 2016.
http://flowstobay.org/newdevelopment

Contra Costa Clean Water Program, Stormwater C.3 Guidebook, 6th Edition, February 2012.
http://www.cccleanwater.org/stormwater-c-3-guidebook/

Project Clean Water, County of Santa Barbara, Stormwater Technical Guide for Low Impact Development, February 2014.
http://www.sbprojectcleanwater.org/uploadedFiles/sbprojectcleanwater/Development/Stormwater%20Technical%20Guide%20-%202014-02-18.pdf

Bay Area Stormwater Management Agencies Association (BASMAA) Regional Biotreatment Soil Specification (revised January 29, 2016).
http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/stormwater/MRP/provisionC.3/Revised_%20Biotreatment%20_Soil.pdf

BASMAA, Biotreatment Soil Media and Specification: Current Research on Trees and Water Quality Treatment, Literature Review, San Francisco Bay Area, California. Prepared by WRA Environmental Consultants. September 2016.

California Regional Water Quality Control Board, Central Coast Region, "Post-Construction Stormwater Management Requirements for Development Projects in the Central Coast Region", July 12, 2013.
http://www.waterboards.ca.gov/centralcoast/water_issues/programs/stormwater/docs/lid/lid_hydromod_charette_index.shtml

State Water Resources Control Board, Waste Discharge Requirements for Stormwater Discharges from Small Municipal Separate Storm Sewer Systems (Phase II Small MS4 General Permit), February 5, 2013.
http://www.waterboards.ca.gov/water_issues/programs/stormwater/phase_ii_municipal.shtml

Attachment A

Low Impact Development Initiative (LIDI)
Bioretention Technical Specifications – Comments from Jill Bicknell 1-27-17

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

Facility Design/Dimensions

- Bioretention facilities should be sized to retain and/or treat the water quality design flow and/or volume in accordance with the stormwater permit requirements that apply to the local jurisdiction and appropriate local, countywide, and/or statewide (CASQA) guidance documents. Design parameters specified in stormwater permits will determine the surface area and storage volume required within the facility.
- Bottom width – facilities should have flat bottoms and sufficient width for ease of constructability and maintenance.
  - ~~p~~Provide 2' wide minimum ~~flat bottom~~ for facilities with side slopes and ~~longitudinal slope~~planters (facilities with vertical side walls).
  - Provide 4' wide minimum for planters in ROW with trees (or as directed by arborist).
- ~~Allowable standing water duration – 72 hours.~~
  - ~~Allowable ponding time is typically associated with mosquito vector control, and varies by location. Confirm with local vector control agency to confirm appropriate drawdown time for facility.~~
- ~~Planter minimum widths are typically associated with their application. Considerations influencing minimum widths include:~~
  - ~~4' minimum for planters in ROW with trees~~
  - ~~2' minimum for planters without trees~~
- Ponding depth - Min. 6", max. 12". The depth is measured from the surface of the bioretention soil media and not adjusted for application of mulch.
- Planter depth – (from adjacent pedestrian walking surface to facility finished elevation/planting surface) is based on desired ponding plus freeboard, but also relates to planter width. Planters can be deeper if they are wider, and need to be shallower as they narrow. This is a pedestrian perception and safety issue. Some recommended width to depth guidelines are as follows (allowable depths and appropriate edge treatments may be specified by the local jurisdiction and may be determined by ADA requirements):

PLANTER WIDTH	MAX. PLANTER DEPTH
~~<~~ 5'	16"
4' – 5'	12"
3' – 4'	10"

Commented [JCB1]: Recommend deleting this design criterion. These are not detention basins. If designed and maintained properly, bioretention facilities should drain (or overflow) within a few hours of the storm event.

2’ – 3’	8”

- Slope/grades
  - Side slope - 4:1 preferred
    - Max. 3:1 allowed with min. 12" wide shoulder (2% slope toward facility) adjacent to pedestrian use or curb.
  - Longitudinal slope – ~~Max. 6%~~Facility should be relatively flat (i.e., maximum of 2% longitudinal slope of bottom) so that water ponds and infiltrates evenly across the facility surface.
    - ~~Erosion and movement of soil and mulch intensifies with increased longitudinal slope, minimize longitudinal slope.~~
    - ~~Stair stepping planters~~If installed on a slope, facilities should be terraced and ~~to provide flat bottomed cells~~ separated by check dams~~/~~ and weir overflows ~~can~~ to provide ~~more~~ flat-bottomed cells with proper storage and infiltration ~~than a sloped facility~~.
    - Installation not recommended on slopes > 8%.
  - Grades on opposite sides within a facility should be similar to optimize ponding across the entire basin/cell.

Hard Infrastructure

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

- Where impermeable liner is included between facility and adjacent infrastructure (street, parking lot), use 30 ML HDPE or PVC material, see Impermeable Liner detail.
- Check dams – provide for facilities ~~with bottom~~installed on slope
  - Per check dam details ~~130,131~~SW-17 and SW-18
  - ~~Use LIDI check dam spacing detail (under development detail TBD)~~Check dams should be placed for every 4-6" of elevation change and so that the top of each dam is at least as high as the toe of the next upstream dam.~~.~~
- Overflow structure – required for on-line systems without an overflow bypass
  - Per overflow structure details ~~140, 141~~SW-19, SW-20
  - Connect~~s~~ to approved discharge point or another downstream bioretention area.
- Provide ~~monitoring~~ observation well in ~~each~~ facility if required
  - Upright 6 inch rigid PVC (SDR 40 or equivalent) pipe, perforated for the section extending through the depth of the bioretention soil media (and aggregate layer if included), extending 6 inches above the top of soil elevation, with a threaded cap.
  - Locate to avoid damage from maintenance activities.

Facility Media (soil, aggregate, mulch)

- Aggregate layer – where an aggregate layer is included in the design (underdrain design or optional use based on project requirements, depth based on sizing calculations), specify "CalTrans Class 2 Permeable."
  - CalTrans Class 2 Permeable does not require an aggregate filter course between the aggregate storage layer and the bioretention soil media above.
  - When CalTrans Class 2 Permeable is not available, substitute CalTrans Class 3 Permeable.
    - Class 3 Permeable requires an overlying 3" deep layer of ¾" (No. 4) open graded aggregate (between Class 3 and bioretention soil media above).
  - Filter fabric - do NOT use fabric between bioretention soil media and aggregate layer
- Bioretention soil media (BSM) - use Bay Area Stormwater Management Agencies Association (BASMAA) ~~Specification of Soils for Biotreatment or Bioretention Facilities (Attachment L)~~Regional Biotreatment Soil Specification (revised January 29, 2016)[1].
  - Using performance specification for alternative bioretention soil mix is not recommended (but may be allowed by the local jurisdiction).
  - A pre-mixed bioretention soil media is preferable to mixing soil on-site.
- BSM depth – 18" minimum depth~~;~~, 24" recommended, and required in the Central Coast Region for facilities with underdrains.

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

- ~~For systems with underdrain, BSM min. depth is 24".~~
- Where ~~aggregate layer is used and~~ trees are specified, ~~replace aggregate with~~ increase~~d~~ BSM depth in tree planting locations, per arborist's direction, or allow trees access to sufficient volume of native soil.
  - Tree planting in bioretention ~~detail (TBD).~~ see BASMAA Literature Review - Bioretention Design for Tree Health (September 15, 2016)[2]

- Bioretention ~~S~~soil media placement and compaction – place BSM in 6" lifts. Compact each lift with a landscape roller or by lightly wetting. Allow BSM to dry overnight before planting.
- ~~Filter fabric – do not use fabric between BSM and aggregate layer~~
- Mulch depth – 2" – 3" (3" recommended and required by State Model Water Efficiency Landscape Ordinance)
  - ~~Mulch use optional below ponding high water mark.~~
  - Do not apply mulch in ponding zone just prior to or during rainy season.
  - When mulch is used, excavation must allow for specified bioretention soil and mulch depths to achieve finished elevations as shown on civil plans.
- Mulch type - when used in ponding zone, must be aged, stabilized, non-floating mulch, such as a specified composted wood mulch. Gravel mulch may also be used when high flow velocities through the system are expected.

Commented [JB2]: The faciliy should only have ponded water for a very short amount of time. The rest of the year, mulch is needed to protect plants, retain soil moisture and adsorb pollutants.

Commented [JCB3]: It is our practice to call the surface of the bioretention soil the finished elevation, and the mulch is applied on top of that, within the design ponding depth. Mulch moves around, decomposes, and has to be replaced, so it is not really a finished surface.

Landscape (planting and irrigation)

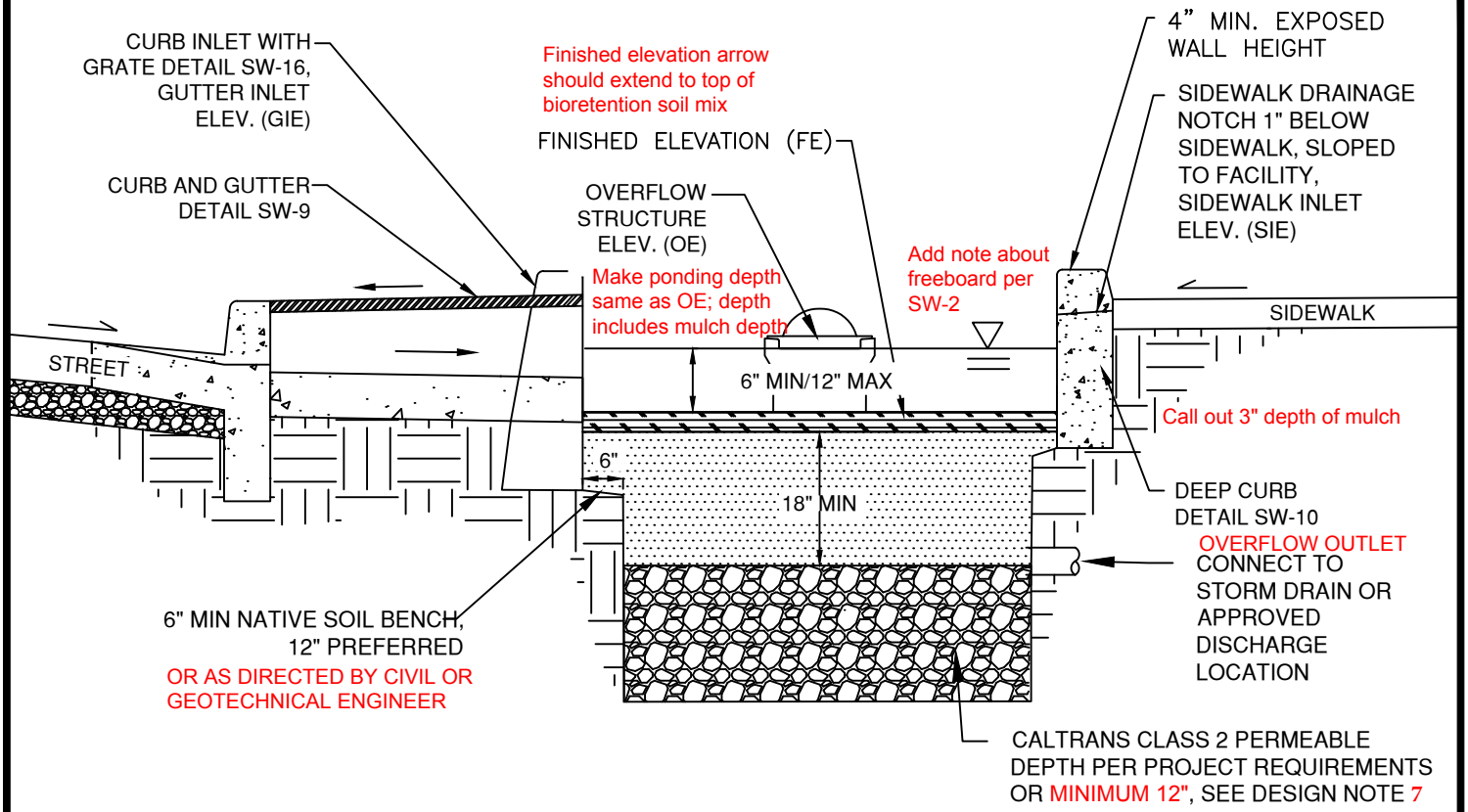
- Irrigation - Provide irrigation for plant establishment (2-3 years), and supplemental irrigation during periods of prolonged drought.
  - Provide separate zone for connection to water supply
- Planting - see LIDI plant guidance for bioretention areas technical assistance memo (TAM) or use plant list in other local or countywide guidance document.
  - Landscape Architects who have not previously designed bioretention systems should use plants from the LIDI TAM or other approved plant list. Landscape Architects with experience designing for bioretention may use additional plant species consistent with the above lists and appropriate for the facility design and local conditions.
  - Do not locate plants at inlets. Consider mature growth to determine planting layout and avoid future blockage of inlets by plants.
  - Trees located on slopes should be 5' minimum from inlets to avoid erosion of soil at root ball.

Underdrain Design

[2] www.basmaa.org

- ~~BSM depth – 24" minimum depth.~~
- Aggregate layer depth – 12" minimum depth.
- Underdrain – use 4" diameter, PVC SDR 35 perforated pipe.
  - Install underdrain with holes facing down.
  - Underdrain discharge elevation ~~shall~~ should be near top of aggregate layer if facility is allowed to infiltrate into native soil.
  - Underdrain slope may be flat or have a slight slope.
  - Connect~~s~~ underdrain to approved discharge point.
  - Provide capped, threaded PVC cleanout for underdrain, 4" min. dia. with sweep bend.
  - Do NOT wrap underdrain with filter fabric.

Attachment B



CONSTRUCTION NOTES

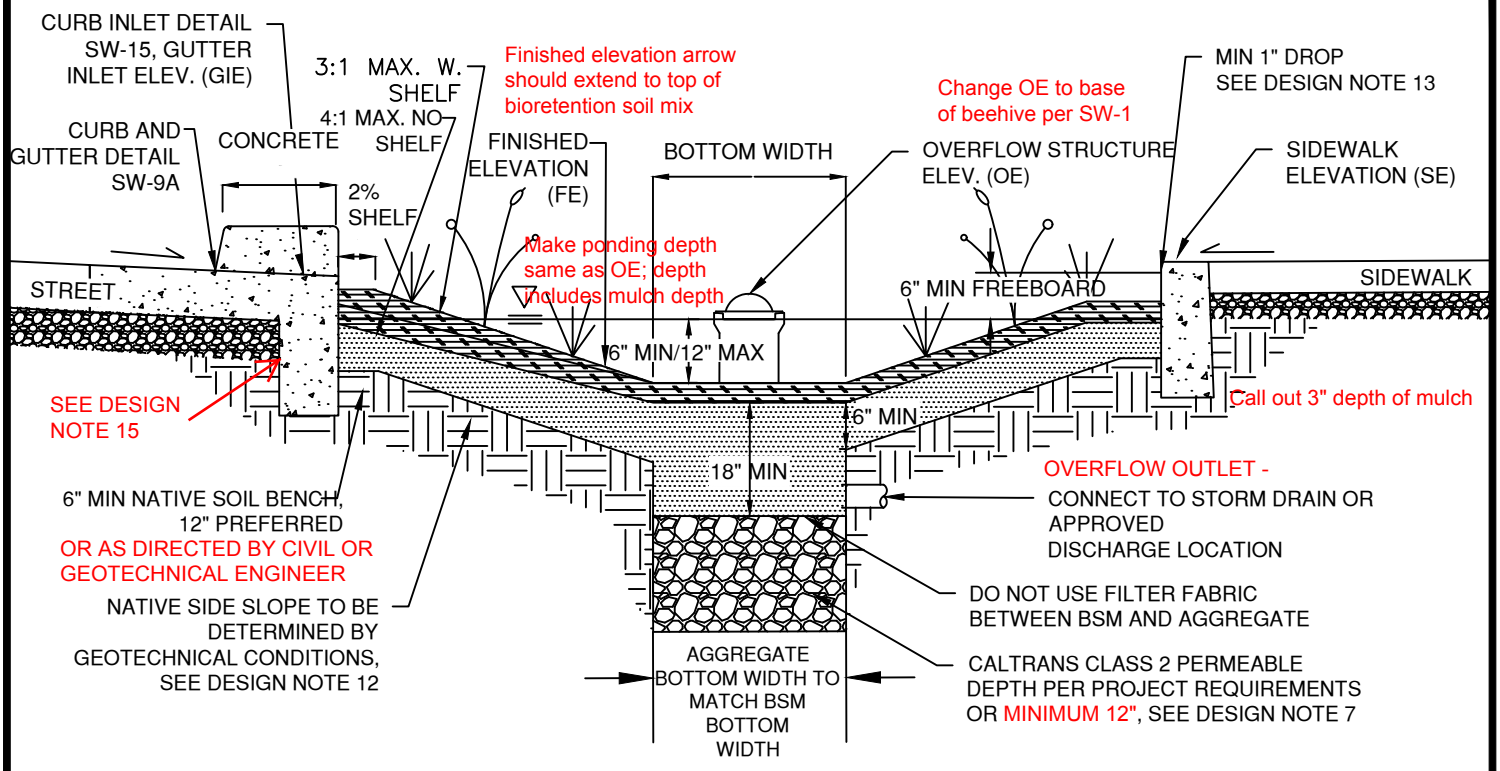
1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND SOIL.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE,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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	STREET BIORETENTION FACILITY (PLANTER, ON-STREET PARKING, SIDEWALK, WITHOUT UNDERDRAIN) USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-1 SHEET 1 OF 2

DESIGN NOTES

1. ALL BIORETENTION ELEMENT WIDTHS TO BE DETERMINED BASED ON SIZING. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM, DETAIL SW-19 OR BROOKS STYLE GRATED CURB VALVE BOX OR CATCH BASIN. ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).
3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-15.
4. SITE CONDITIONS WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND SIDEWALK DETAILS TO BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.
5. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
6. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-17, SW-18)
7. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.
8. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
9. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.
10. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.
11. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.
12. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.



Change drawing to reduce width of BSM over native side slope and increase width of aggregate section (by a lot)

LEGEND

- MULCH/COMPOST LAYER SEE DESIGN NOTE 10
- BIORETENTION SOIL MEDIA
- AGGREGATE
- NATIVE SOIL

CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	STREET BIORETENTION FACILITY (SLOPE SIDED, ON-STREET PARKING, SIDEWALK, WITHOUT UNDERDRAIN) USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-2 SHEET 1 OF 2

DESIGN NOTES

1. ALL BIORETENTION ELEMENT WIDTHS TO BE DETERMINED BASED ON SIZING. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM, DETAIL SW-19 OR BROOKS STYLE GRATED CURB VALVE BOX OR CATCH BASIN. ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-15.

4. SITE CONDITIONS WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND SIDEWALK DETAILS TO BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.

5. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

6. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-17, SW-18)

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

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

9. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

10. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

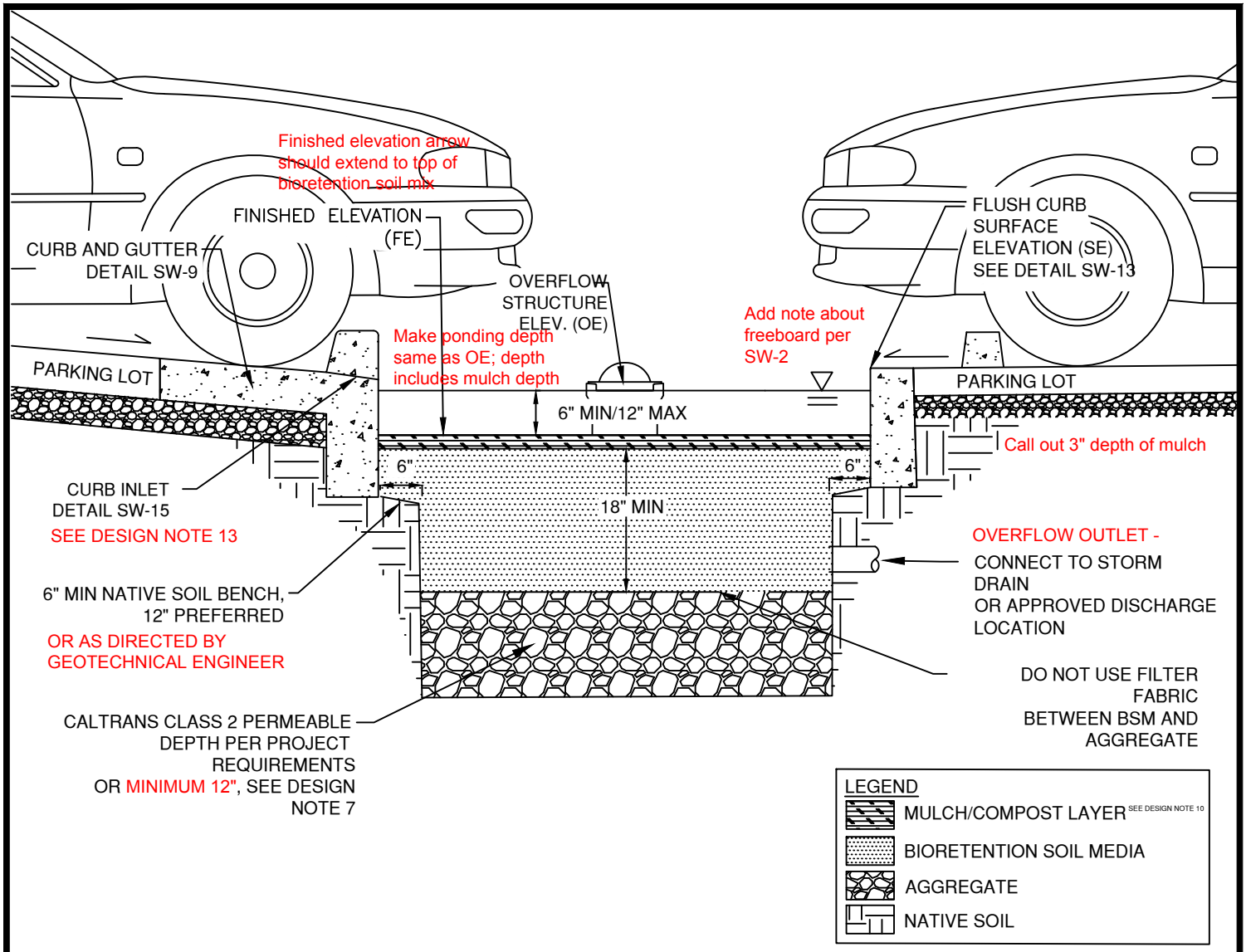
11. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.

12. NATIVE SIDE SLOPE 4:1 (HiV) PREFERRED, 3:1 WITH SHELF.

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

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

15. ADD NOTE REGARDING RETAINED DESIGN.



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11. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.
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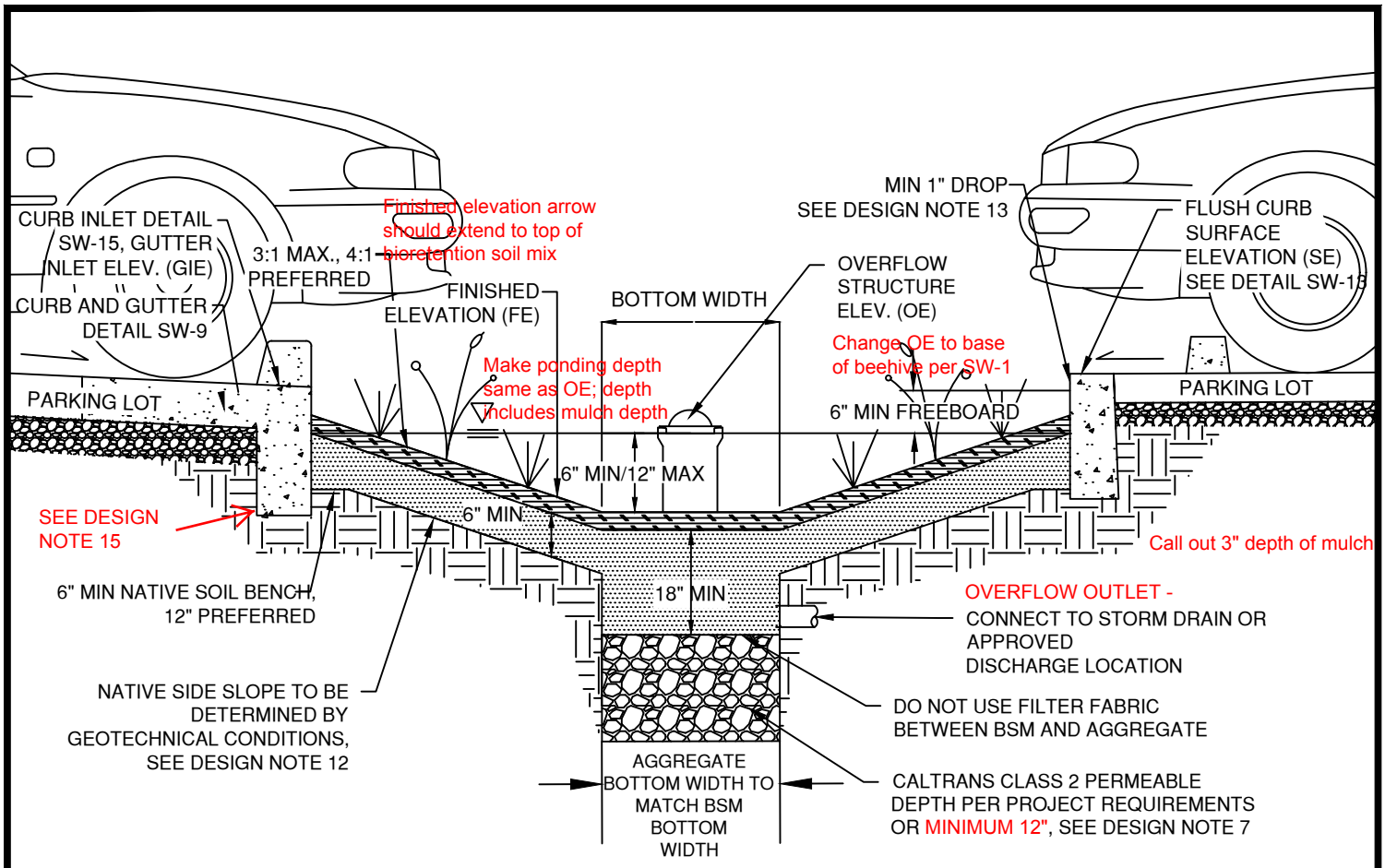

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5. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL DRAINAGE AREA IS STABILIZED.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	PARKING LOT BIORETENTION FACILITY (SLOPE SIDED, WITHOUT UNDERDRAIN) USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-4 SHEET 1 OF 2

DESIGN NOTES

1. ALL BIORETENTION ELEMENT WIDTHS TO BE DETERMINED BASED ON SIZING. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM, DETAIL SW-19 OR BROOKS STYLE GRATED CURB VALVE BOX OR CATCH BASIN. ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURE ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-15.

4. SITE CONDITIONS WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND SIDEWALK DETAILS TO BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.

5. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

6. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-17, SW-18)

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

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

9. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

10. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

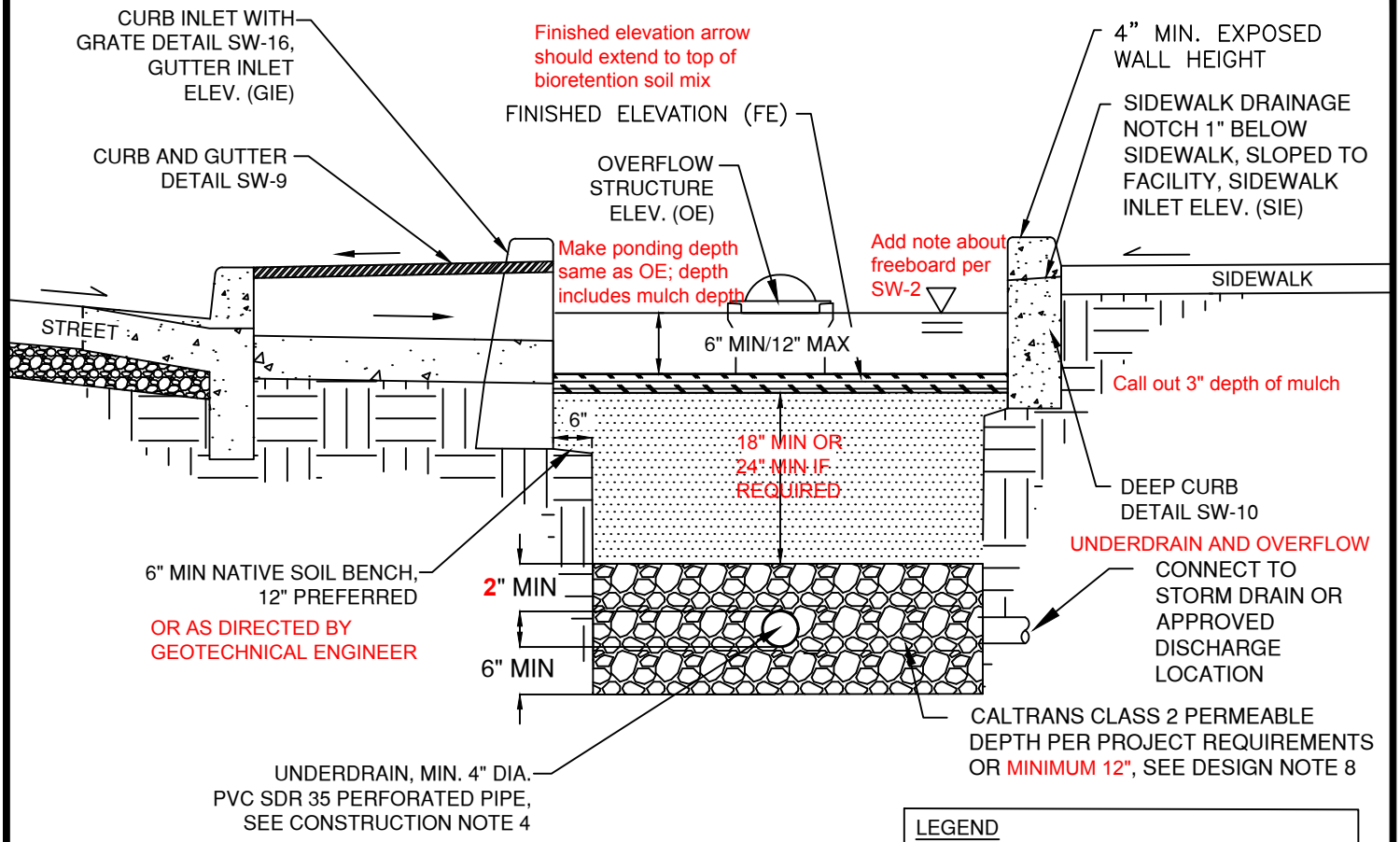
11. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.

12. NATIVE SIDE SLOPE 4:1 (HiV) PREFERRED, 3:1 WITH SHELF.

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

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

15. ADD NOTE REGARDING RETAINED DESIGN.



CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	STREET BIORETENTION FACILITY (PLANTER, ON-STREET PARKING, SIDEWALK, WITH UNDERDRAIN) USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-5 SHEET 1 OF 2

DESIGN NOTES

1. ALL BIORETENTION ELEMENT WIDTHS TO BE DETERMINED BASED ON SIZING. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM, DETAIL SW-19 OR BROOKS STYLE GRATED CURB VALVE BOX OR CATCH BASIN. ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-15.

4. SITE CONDITIONS WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND SIDEWALK DETAILS TO BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.

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

6. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

7. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-17, SW-18)

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

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

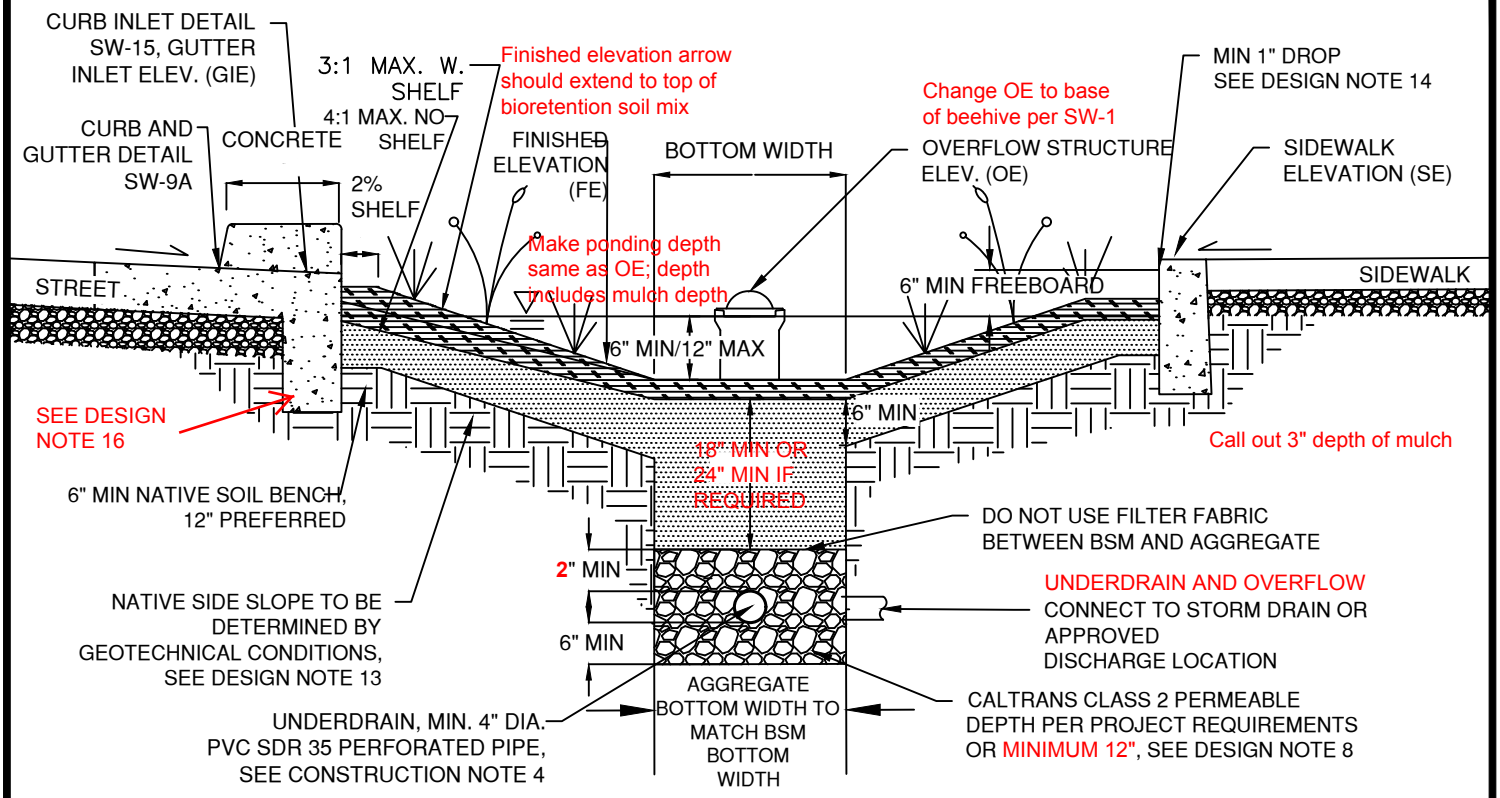
10. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.

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

14. OVERFLOWS THAT DISCHARGE THROUGH THE PERFORATED UNDERDRAIN IN THE BIORETENTION SYSTEM MAY QUALIFY THE SYSTEM AS A CLASS V WELL SUBJECT TO REGISTRATION WITH USEPA.



Change drawing to reduce width of BSM over native side slope and increase width of aggregate section (by a lot)

CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	STREET BIORETENTION FACILITY (SLOPE SIDED, ON-STREET PARKING, SIDEWALK, WITH UNDERDRAIN) USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-6 SHEET 1 OF 2

DESIGN NOTES

1. ALL BIORETENTION ELEMENT WIDTHS TO BE DETERMINED BASED ON SIZING. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM, DETAIL SW-19 OR BROOKS STYLE GRATED CURB VALVE BOX OR CATCH BASIN. ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (EG. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-15.

4. SITE CONDITIONS WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND SIDEWALK DETAILS TO BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.

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

6. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

7. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-17, SW-18)

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

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

10. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.

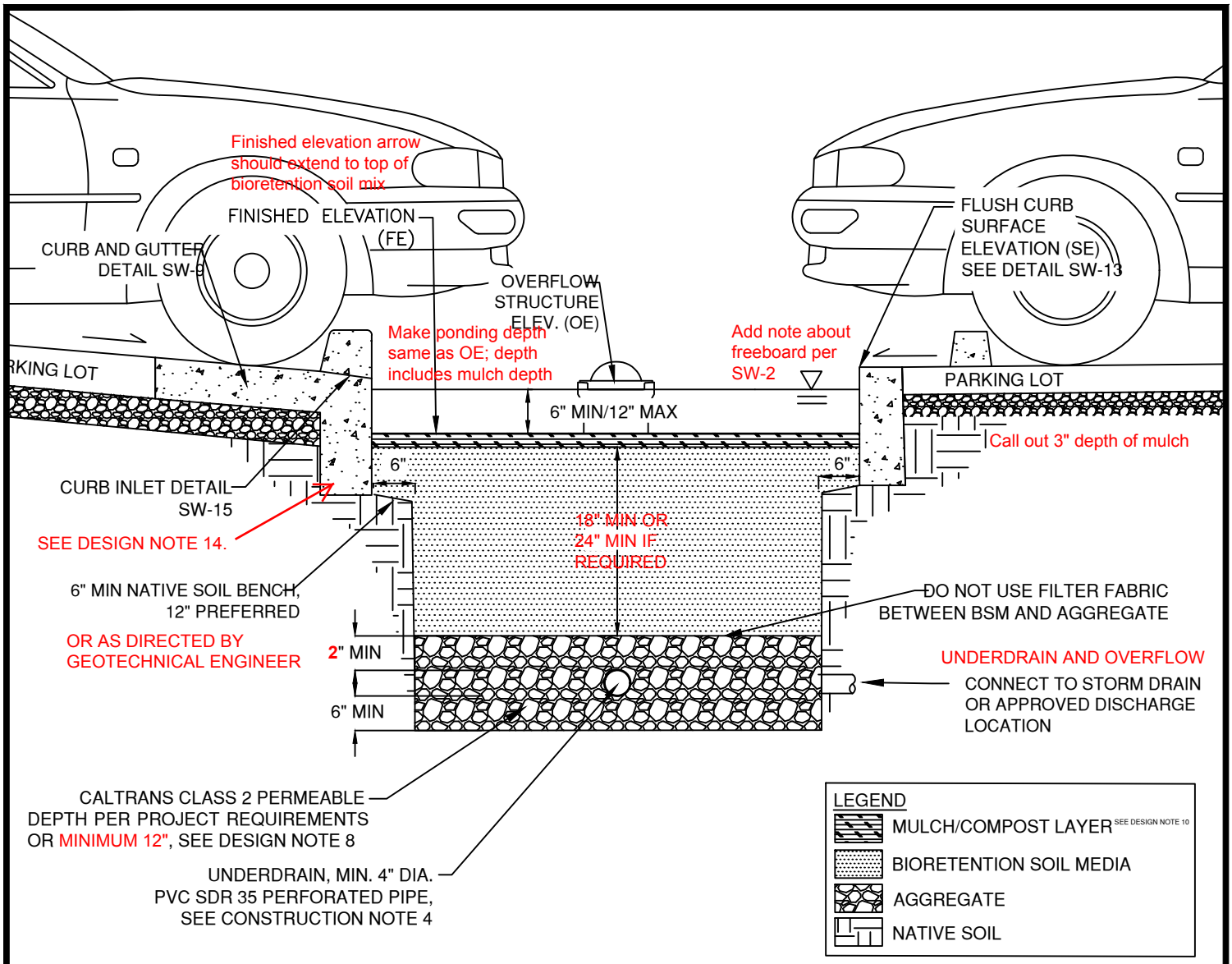
13. NATIVE SIDE SLOPE 4:1 (HiV) PREFERRED, 3:1 WITH SHELF.

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

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

16. ADD NOTE REGARDING RETAINED DESIGN.

17. OVERFLOWS THAT DISCHARGE THROUGH THE PERFORATED UNDERDRAIN IN THE BIORETENTION SYSTEM MAY QUALIFY THE SYSTEM AS A CLASS V WELL SUBJECT TO REGISTRATION WITH USEPA.



CONSTRUCTION NOTES

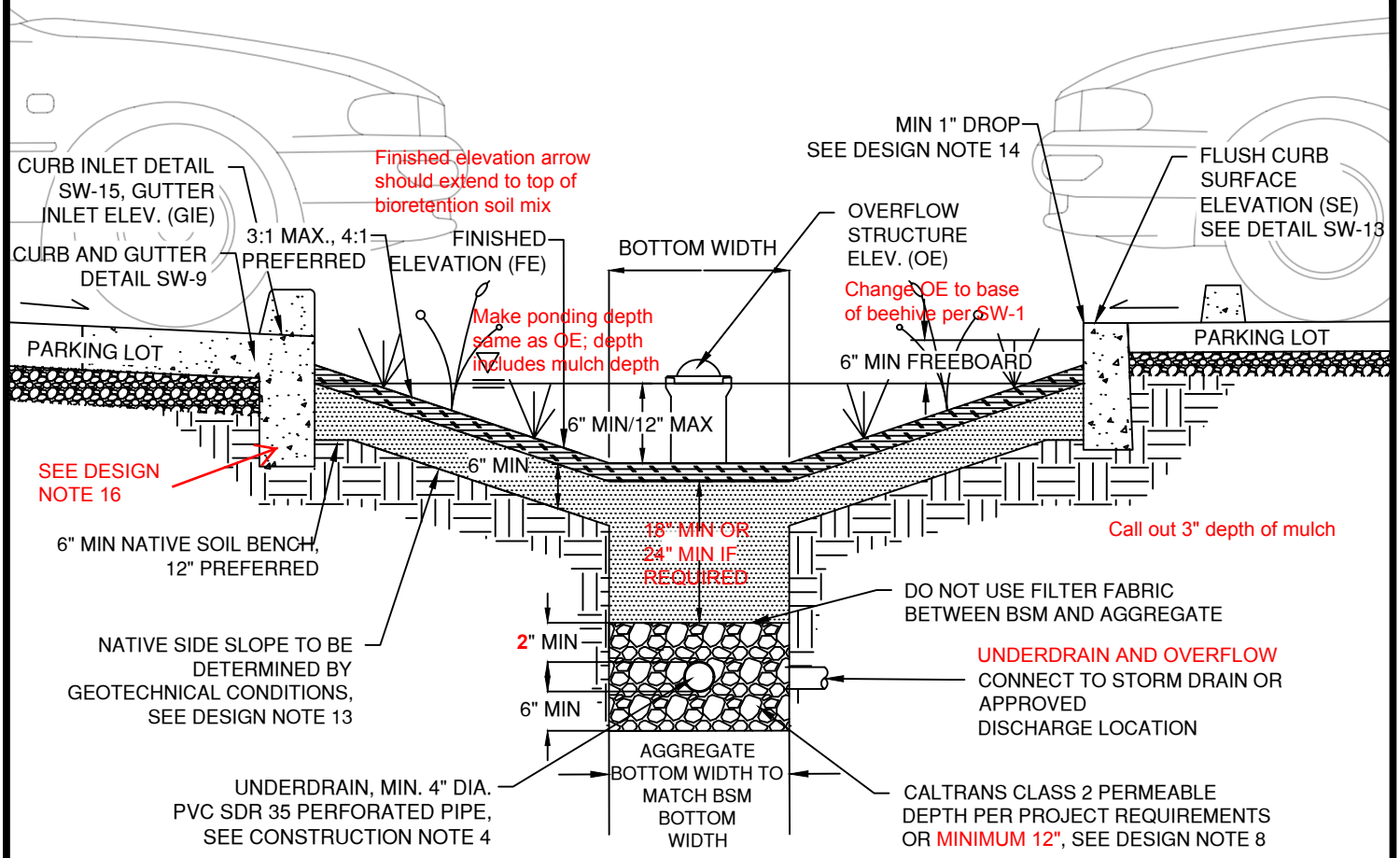
1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND SOIL.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE,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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	PARKING LOT BIORETENTION FACILITY (PLANTER, WITH UNDERDRAIN) USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-7 SHEET 1 OF 2

DESIGN NOTES

1. ALL BIORETENTION ELEMENT WIDTHS TO BE DETERMINED BASED ON SIZING. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM, DETAIL SW-19 OR BROOKS STYLE GRATED CURB VALVE BOX OR CATCH BASIN. ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (IE. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).
3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-15.
4. SITE CONDITIONS WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND SIDEWALK DETAILS TO BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.
5. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.
6. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
7. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-17, SW-18)
8. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE.
9. BIORETENTION SOIL MEDIA (BSM) SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS.
10. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.
11. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.
12. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.
13. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.
14. ADD NOTE REGARDING RETAINED DESIGN.
15. OVERFLOWS THAT DISCHARGE THROUGH THE PERFORATED UNDERDRAIN IN THE BIORETENTION SYSTEM MAY QUALIFY THE SYSTEM AS A CLASS V WELL SUBJECT TO REGISTRATION WITH USEPA.



Change drawing to reduce width of BSM over native side slope and increase width of aggregate section (by a lot)

CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	PARKING LOT BIORETENTION FACILITY (SLOPED SIDED, WITH UNDERDRAIN) USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-8 SHEET 1 OF 2

DESIGN NOTES

1. ALL BIORETENTION ELEMENT WIDTHS TO BE DETERMINED BASED ON SIZING. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT.

2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM, DETAIL SW-19 OR BROOKS STYLE GRATED CURB VALVE BOX OR CATCH BASIN. ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (EG. CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.).

3. PROVIDE SPOT ELEVATIONS AT INLETS AND OVERFLOW STRUCTURES ON CIVIL PLANS (FE,OE, GIE, SIE), PER DETAIL SW-15.

4. SITE CONDITIONS WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND SIDEWALK DETAILS TO BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.

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

6. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.

7. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-17, SW-18)

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

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

10. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

11. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE.

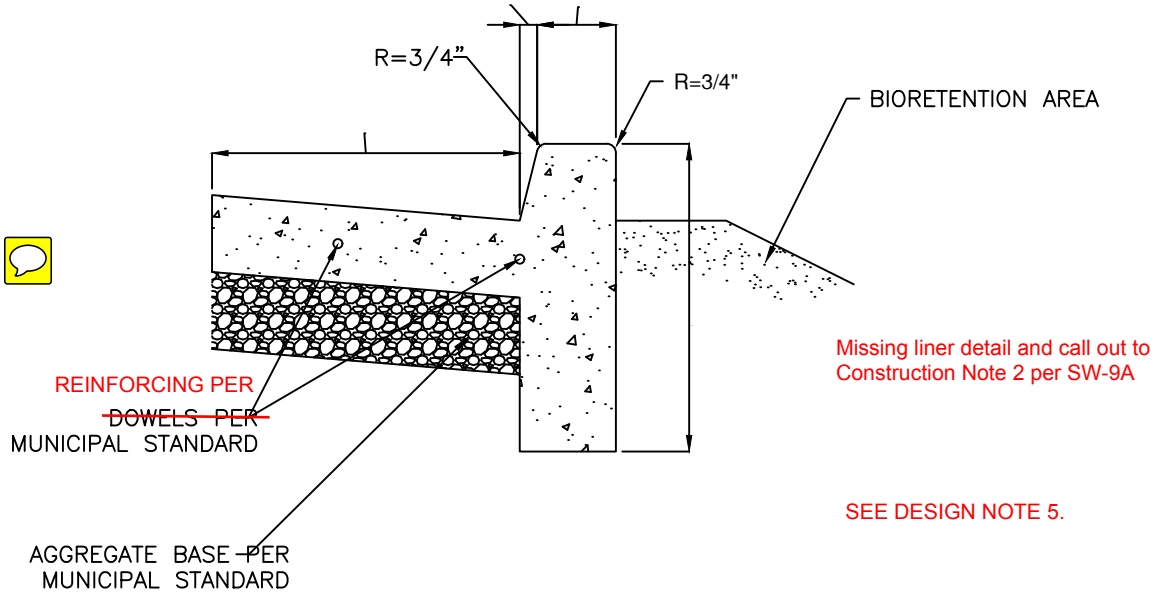
13. NATIVE SIDE SLOPE 4:1 (HiV) PREFERRED, 3:1 WITH BENCH.

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

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

16. ADD NOTE REGARDING RETAINED DESIGN.

17. OVERFLOWS THAT DISCHARGE THROUGH THE PERFORATED UNDERDRAIN IN THE BIORETENTION SYSTEM MAY QUALIFY THE SYSTEM AS A CLASS V WELL SUBJECT TO REGISTRATION WITH USEPA.



DESIGN NOTES

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

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

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

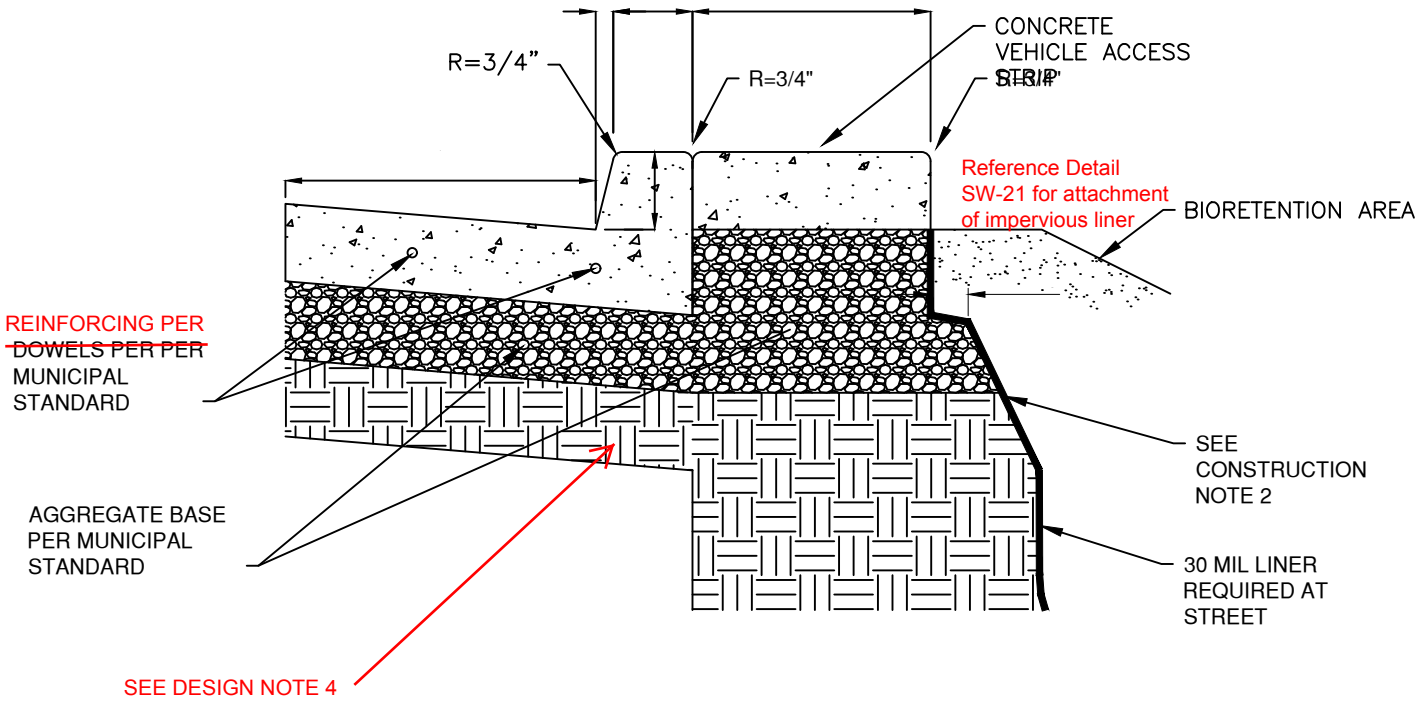
4. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.

5. ADD NOTE REGARDING RETAINED DESIGN.

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

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



DESIGN NOTES

1. SPECIAL CONCRETE AND EXPANSION JOINS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.

2. PROVIDE OPENINGS IN CURB (12" WIDE) TO ALLOW FOR SURFACE DRAINAGE TO BIORETENTION AREAS IF DEDICATED INLET NOT USED. SPACING TO BE DETERMINED BY PROJECT ENGINEER BASED ON DESIGN STORM TO MINIMIZE PONDING AGAINST CURB FOR MEDIAN ISLAND APPLICATION.

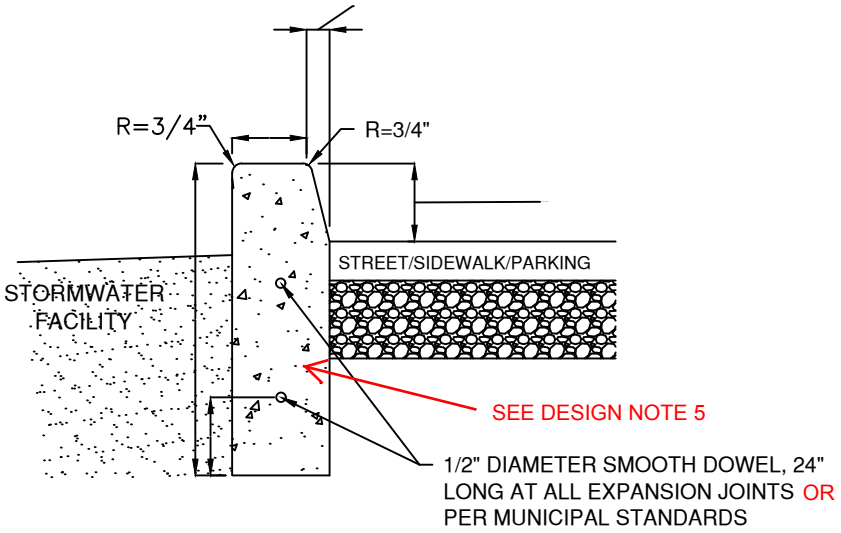
3. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.

4. ADD NOTE REGARDING RETAINED DESIGN.

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

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



DESIGN NOTES

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

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

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

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

5. ADD NOTE REGARDING RETAINED DESIGN.

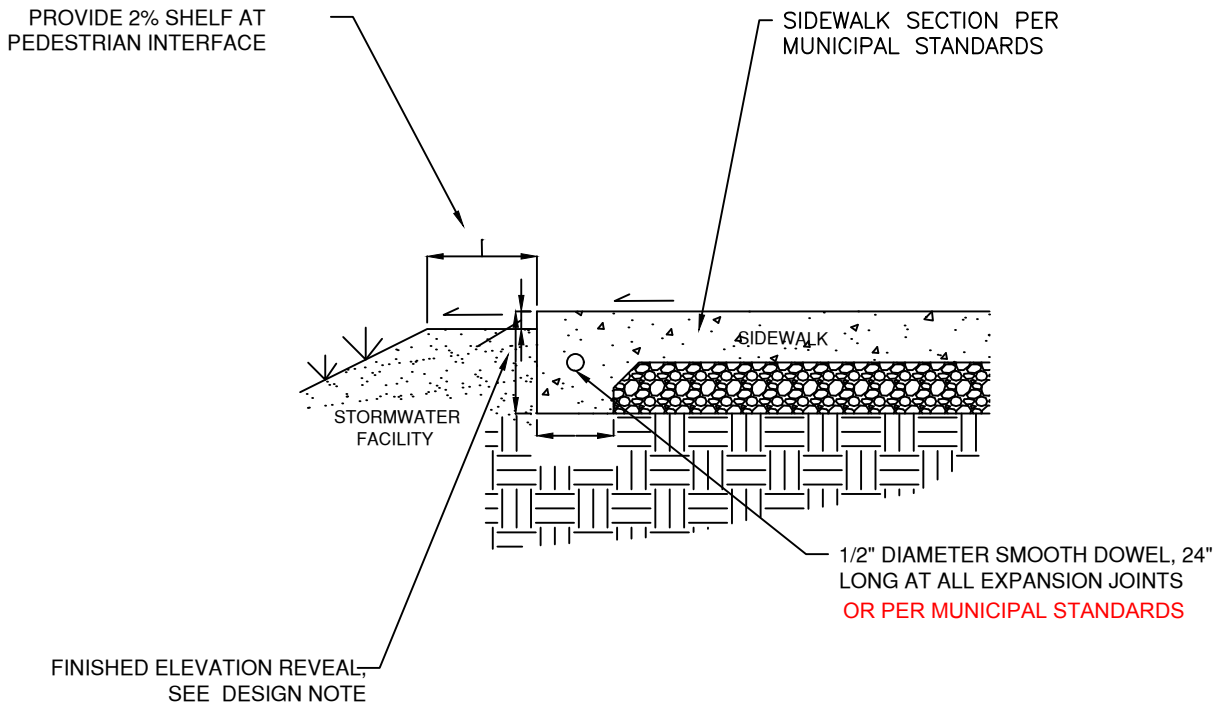
CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	DEEP CURB USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-10 SHEET 1 OF 1



DESIGN NOTES

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

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

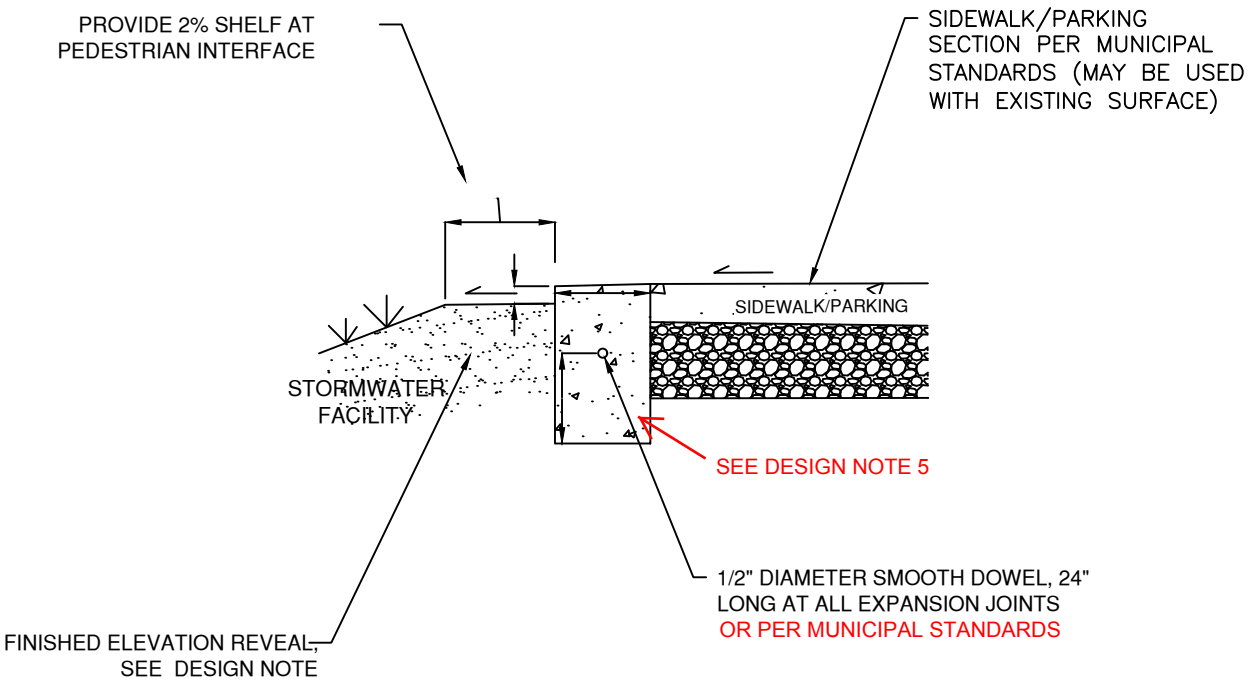
3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	THICKENED EDGE SIDEWALK USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-11 SHEET 1 OF 1



DESIGN NOTES

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

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

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

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

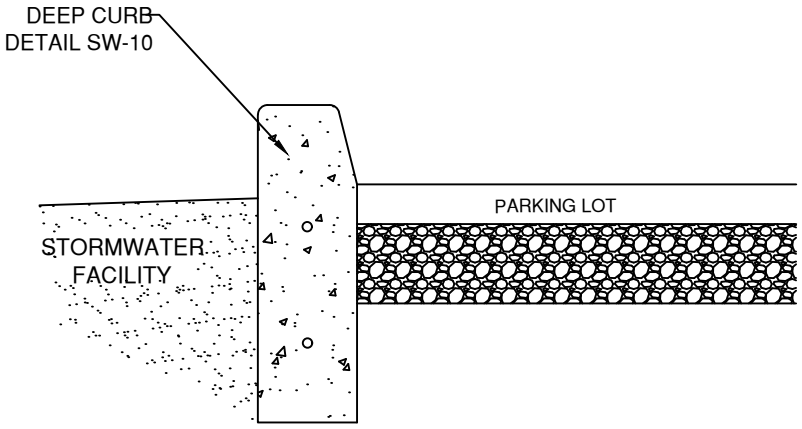
5. ADD NOTE REGARDING RETAINED DESIGN.

CONSTRUCTION NOTES

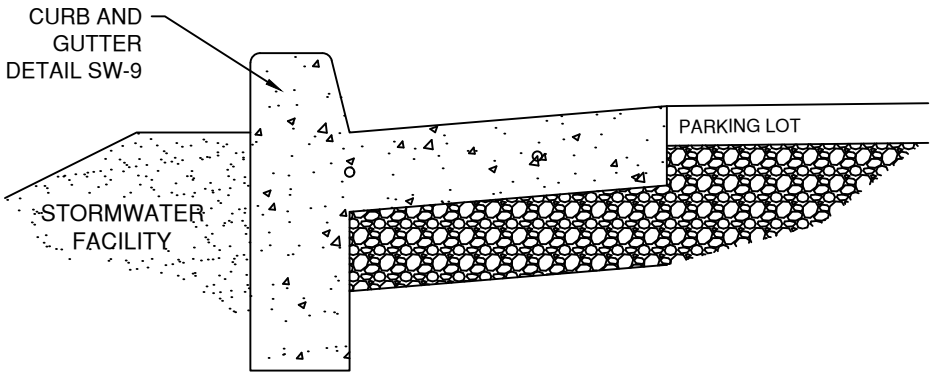
1. FINISH ALL EXPOSED CONCRETE SURFACES.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

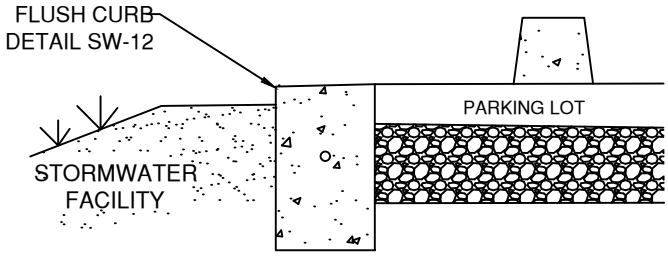
Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	FLUSH CURB AT SIDEWALK USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-12 SHEET 1 OF 1



DEEP CURB



CURB AND GUTTER



FLUSH EDGE/WHEEL STOPS

DESIGN NOTES

1. WHEEL STOPS MAY BE USED ON NON-FLUSH DESIGNS TO KEEP CARS FROM OVERHANGING BIORETENTION FACILITY.

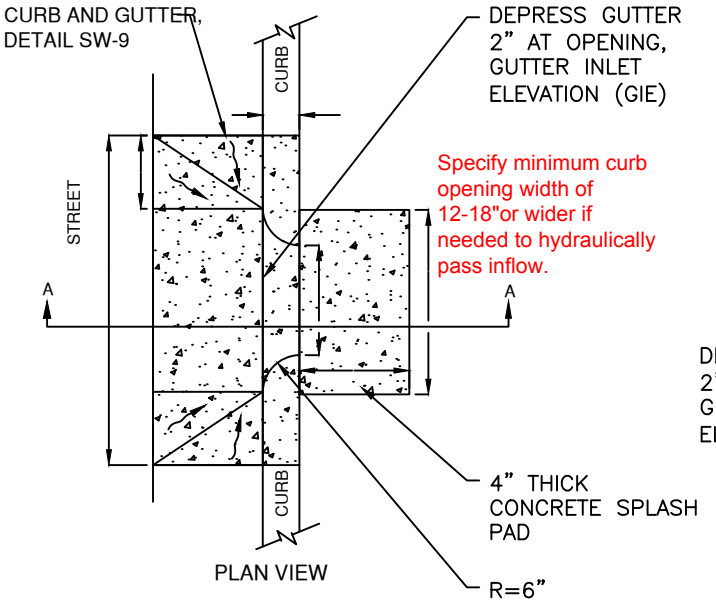
2. VEHICLE OVERHANG CAN BE USED TO REDUCE IMPERVIOUS PAVEMENT AREA.

3. WHERE VEHICLE OVERHANG IS UTILIZED SELECT LOW GROWING PLANTS THAT WILL TOLERATE SHADING.

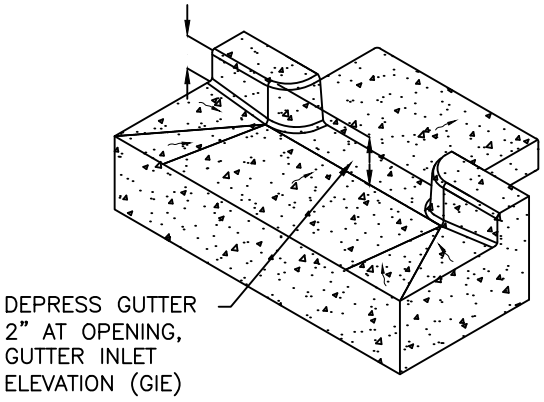
4. ADD NOTE REGARDING RETAINED DESIGN.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

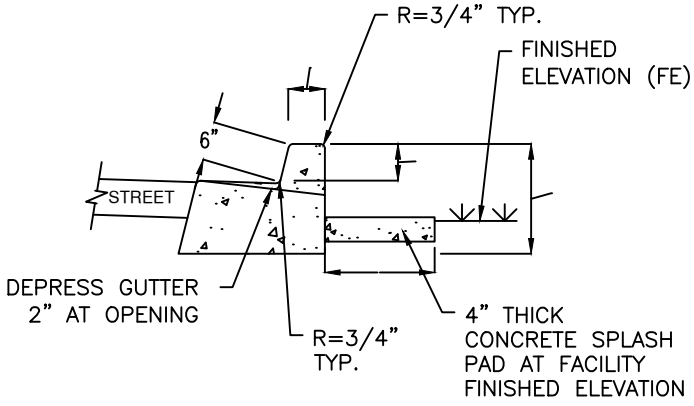
Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	PARKING LOT EDGE OPTIONS USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-13 SHEET 1 OF 1



PLAN VIEW



PERSPECTIVE VIEW



SECTION A-A

Specify minimum drop from curb opening to splash pad of 4-6"

BIORETENTION DESIGN NOTES

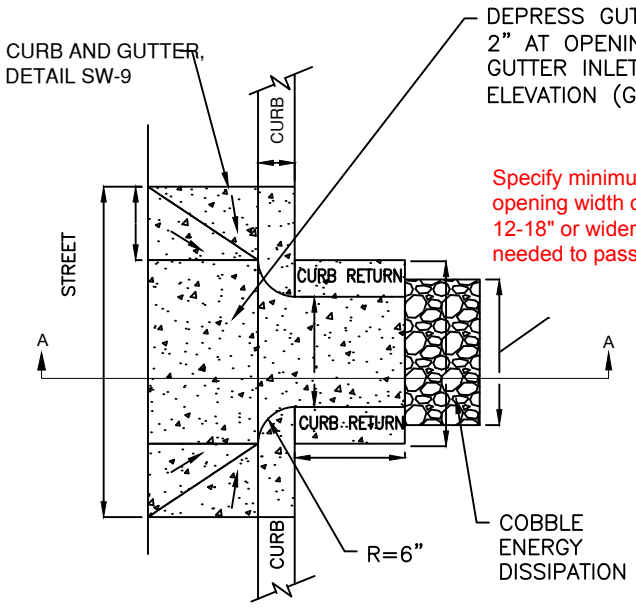
1. FOR USE WITH STORMWATER FACILITIES WITH FLAT BOTTOMS.
2. PROVIDE SPOT ELEVATIONS ON PLANS (FE, OE, GIE, IE). SEE DETAIL SW-1.
3. CURB AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.
4. CURB HEIGHT MAY BE REDUCED TO 4-INCHES WHERE ADJACENT TO A SIDEWALK. SEE DETAILS SW-9 & SW-10.

CONSTRUCTION NOTES

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

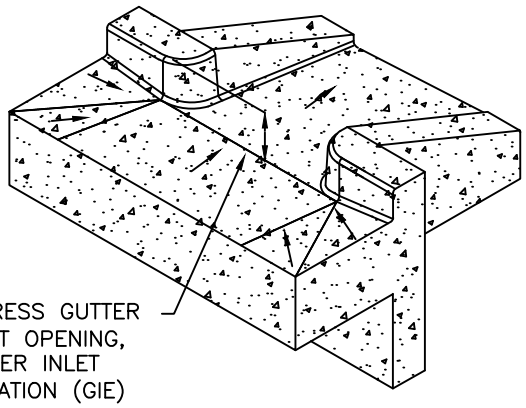
LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	CURB CUT INLET FOR PLANTERS USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-14 SHEET 1 OF 1



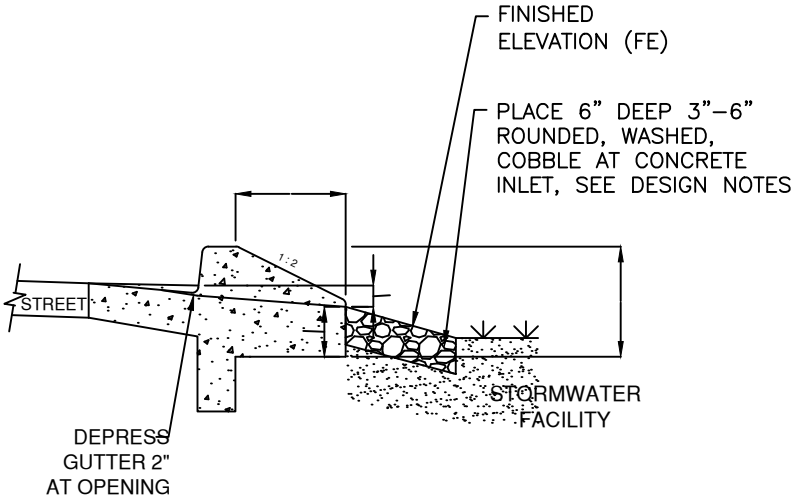
PLAN VIEW

Specify minimum curb opening width of 12-18" or wider if needed to pass inflow.



PERSPECTIVE VIEW

FE should be top of BSM for consistency with other details



SECTION A-A

Specify minimum drop from curb opening to FE of 4-6"

BIORETENTION DESIGN NOTES

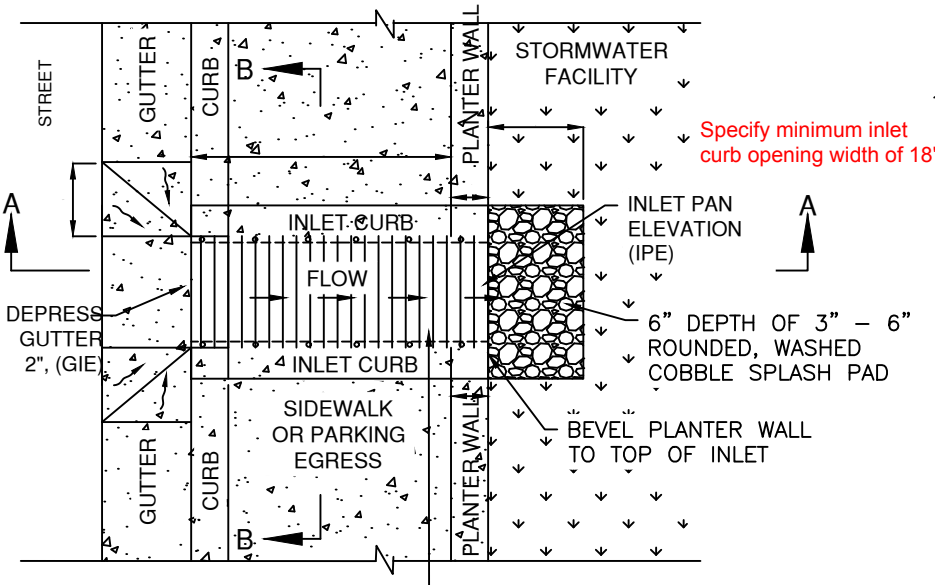
1. FOR USE WITH STORMWATER FACILITIES WITH SIDE SLOPES.
2. PROVIDE SPOT ELEVATIONS ON PLANS (FE, OE, GIE, IE). SEE DETAIL SW-1.
3. CURB AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.
4. WHERE INLET FLOW VELOCITY IS HIGH, EXTEND COBBLE INTO FACILITY, BUT AVOID EXCESSIVE USE.
5. CURB HEIGHT MAY BE REDUCED TO 4-INCHES WHERE ADJACENT TO A SIDEWALK. SEE DETAILS SW-9 & SW-10.

CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

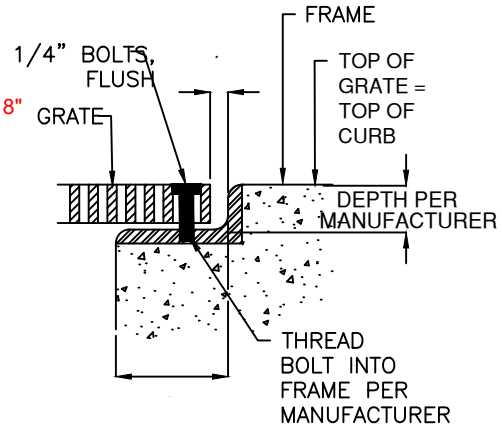
Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	CURB CUT INLET FOR SLOPE SIDED BIORETENTION FACILITY USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-15 SHEET 1 OF 1



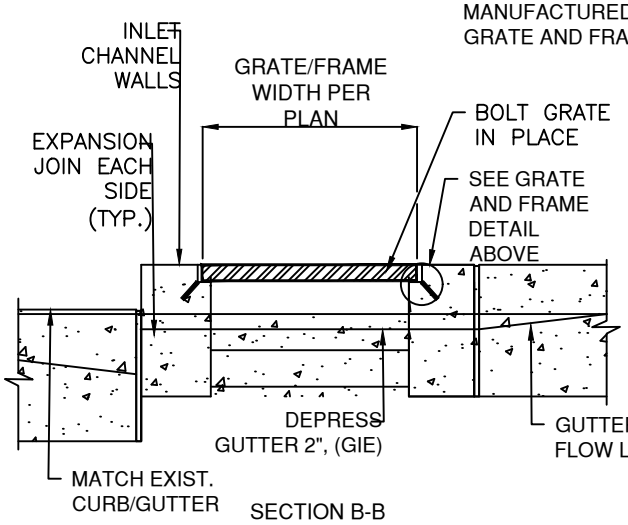
Specify minimum inlet curb opening width of 18"

PLAN VIEW

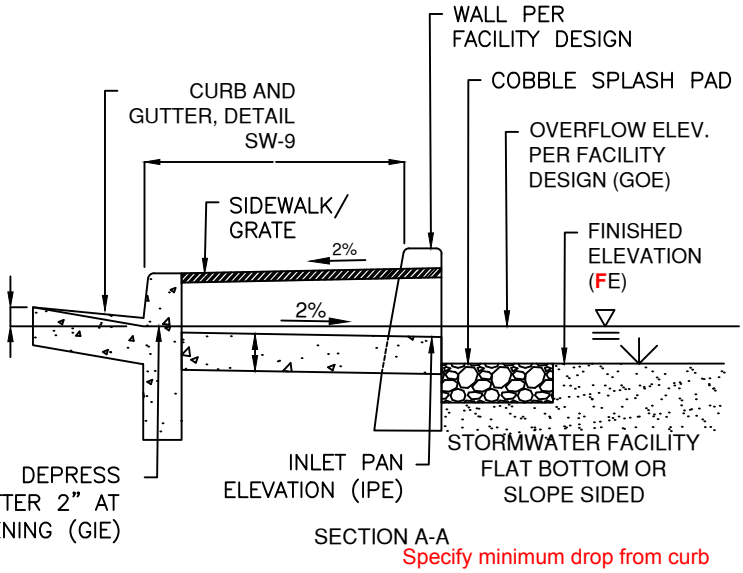
ADA COMPLIANT MANUFACTURED STEEL GRATE AND FRAME



GRATE AND FRAME



SECTION B-B



SECTION A-A

Specify minimum drop from curb opening to FE of 4-6"

BIORETENTION DESIGN NOTES

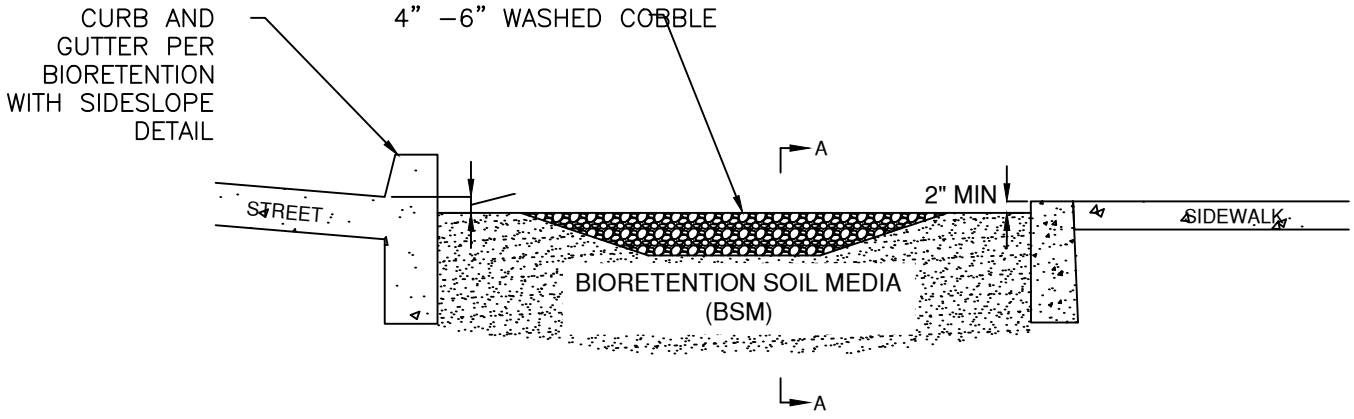
1. FOR USE WITH STORMWATER FACILITIES WITH SLOPED SIDES OR FLAT BOTTOMS.
2. PROVIDE SPOT ELEVATIONS ON PLANS (FE, OE, GIE, IPE). SEE DETAIL SW-1.
3. REFER TO MUNICIPAL STANDARD DRAWINGS AND MATCH GUTTER PAN OF ADJACENT CURB AND GUTTER.
4. IF SLOPED SIDES, WHERE INLET FLOW VELOCITY IS HIGH, EXTEND COBBLE INTO FACILITY, BUT AVOID EXCESSIVE USE.
5. BASE MATERIAL FOR CURB, GUTTER, AND SIDEWALK PER MUNICIPAL STANDARDS.

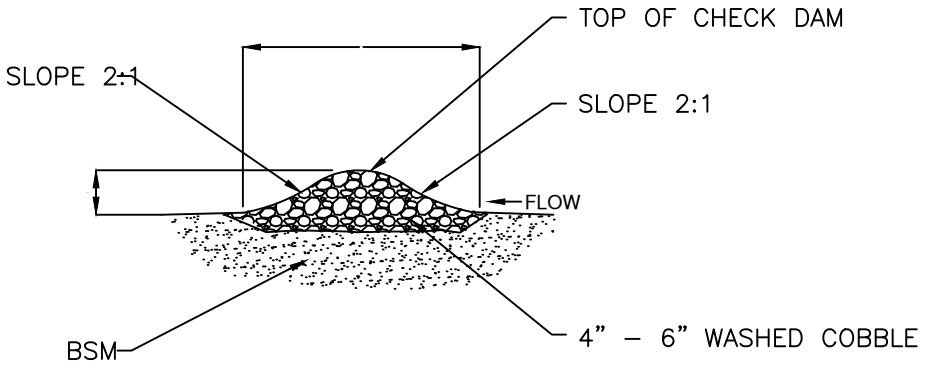
CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	INLET WITH GRATE USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-16 SHEET 1 OF 1





SECTION A-A

BIORETENTION DESIGN NOTES

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

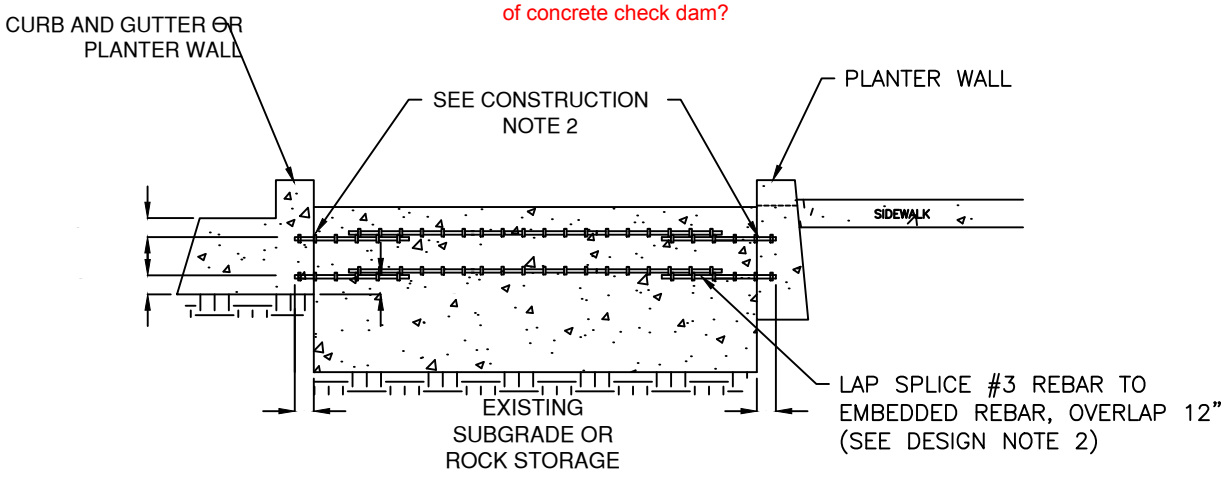
CONSTRUCTION NOTES

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

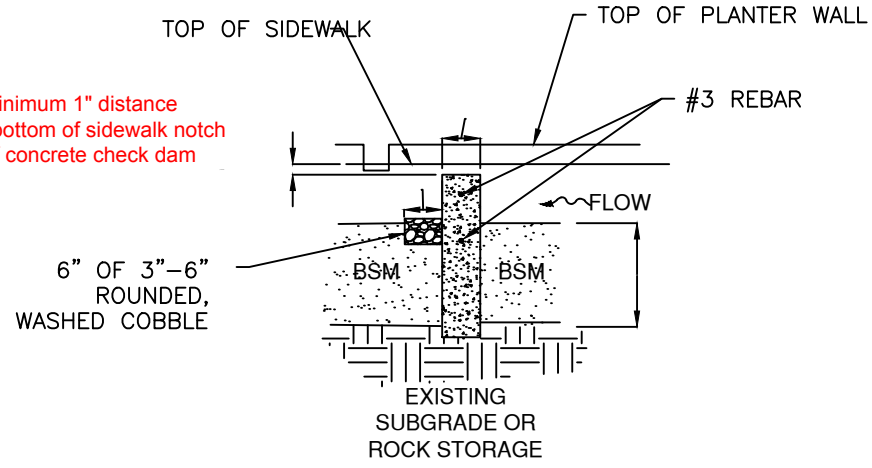
LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	GRAVEL CHECK DAM USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-17 SHEET 1 OF 1

Show weir shape cut out in middle of concrete check dam?



Specify minimum 1" distance between bottom of sidewalk notch and top of concrete check dam



BIORETENTION DESIGN NOTES

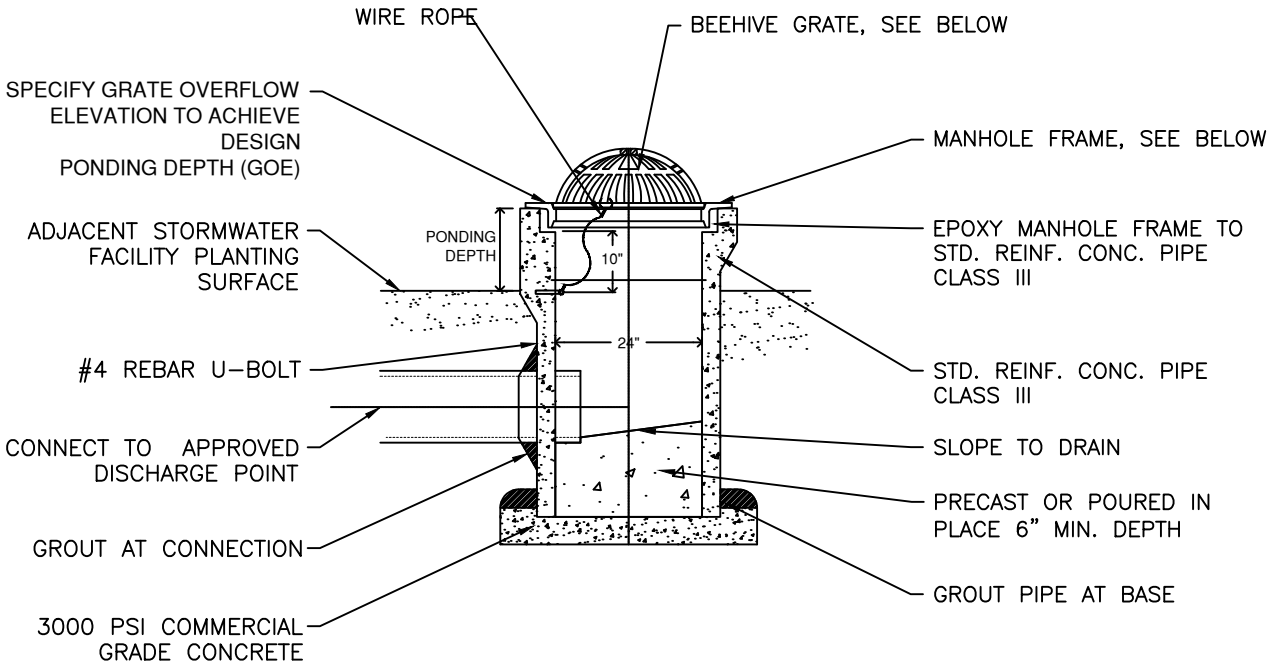
1. FOR USE WITH BIORETENTION PLANTERS OR SLOPED SIDED SWALES/RAIN GARDENS.
2. FOR CHECK DAMS LONGER THAN 12' SPECIFY REBAR OVERLAP LENGTH.
3. SPACE CHECK DAMS TO MAXIMIZE PONDING ACROSS CELLS.
4. PROVIDE ELEVATIONS AND STATIONING AND/OR DIMENSIONING FOR CHECK DAMS.
5. ENSURE THAT CHECK DAM ELEVATIONS DO NOT CAUSE STORMWATER TO OVERFLOW TO SIDEWALK.
6. SHOW PLANTER WALL EMBEDDED IN EXISTING SUBGRADE OR DRAINROCK.

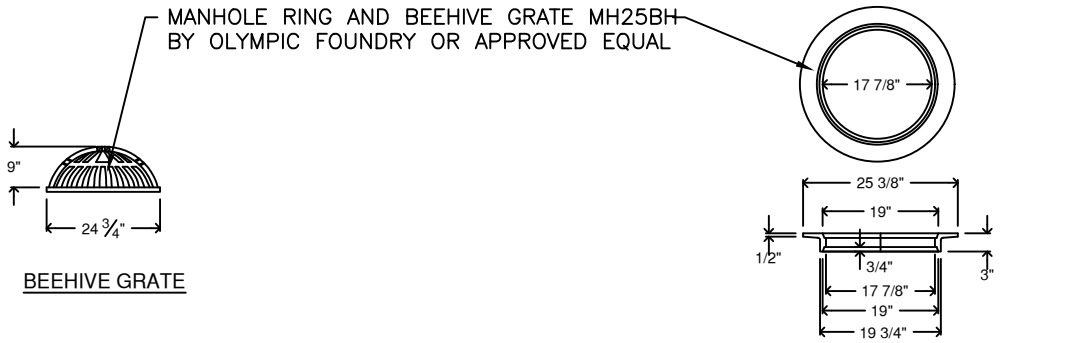
CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	CONCRETE CHECK DAM USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-18 SHEET 1 OF 1





BEEHIVE GRATE

24"x4" REVERSIBLE MANHOLE FRAME

DESIGN NOTES

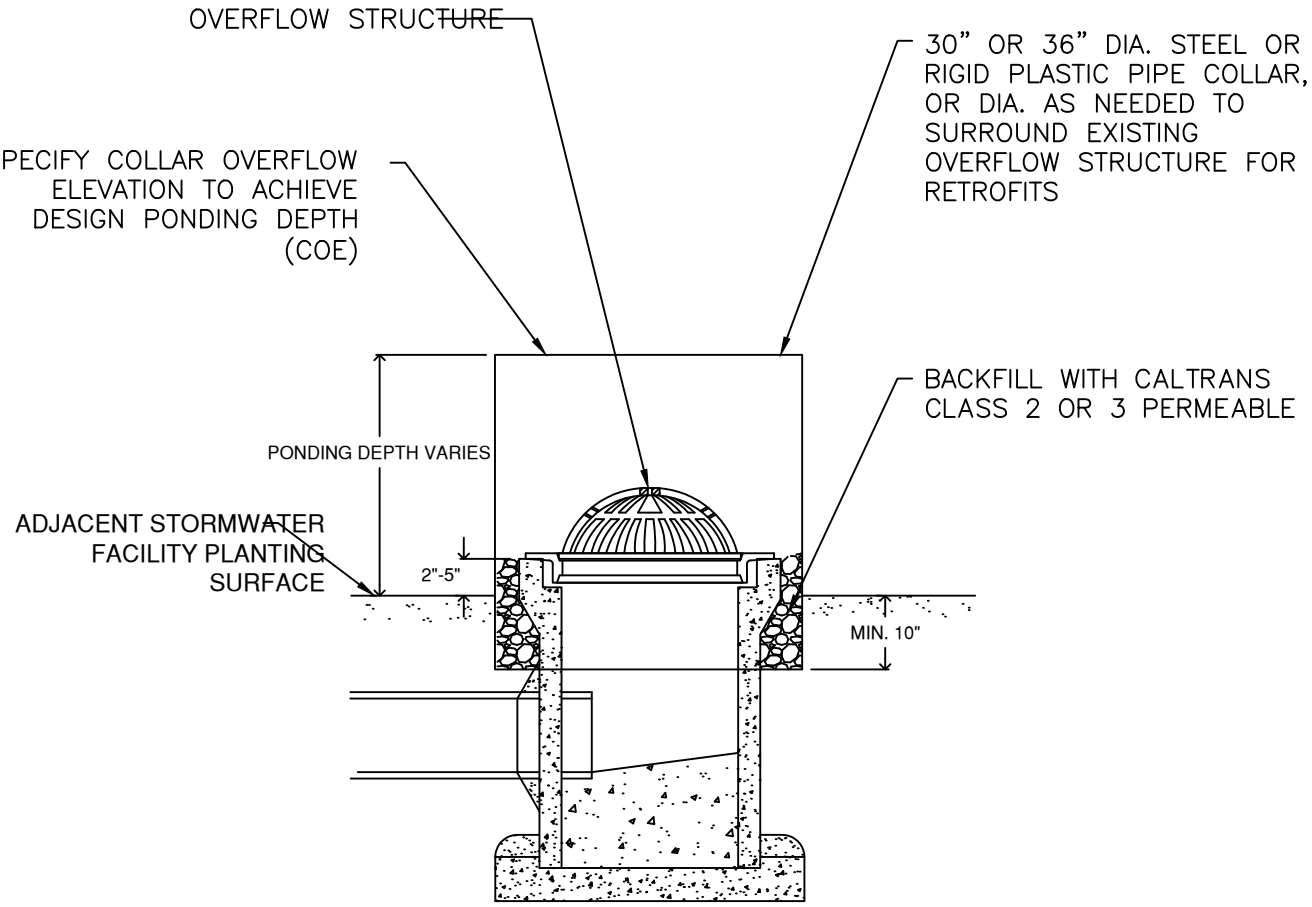
1. PROVIDE GRATE OVERFLOW ELEVATION ON PLANS.
2. TO INCORPORATE FLEXIBILITY INTO DESIGN OVERFLOW ELEVATION OR CORRECT ELEVATION OF AN EXISTING STRUCTURE, INSTALL OVERFLOW COLLAR, PER DETAIL SW-20.
3. IN PRIVATE SITES NOT IN CITY R/W THE PROJECT CIVIL ENGINEER MAY PROPOSE ALTERNATIVES FOR GRATE INSTALLATIONS USING ALTERNATIVE MANUFACTURER'S PRODUCT/CONFIGURATION.

CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	OVERFLOW STRUCTURE WITH BEEHIVE GRATE USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-19 SHEET 1 OF 1



DESIGN NOTES

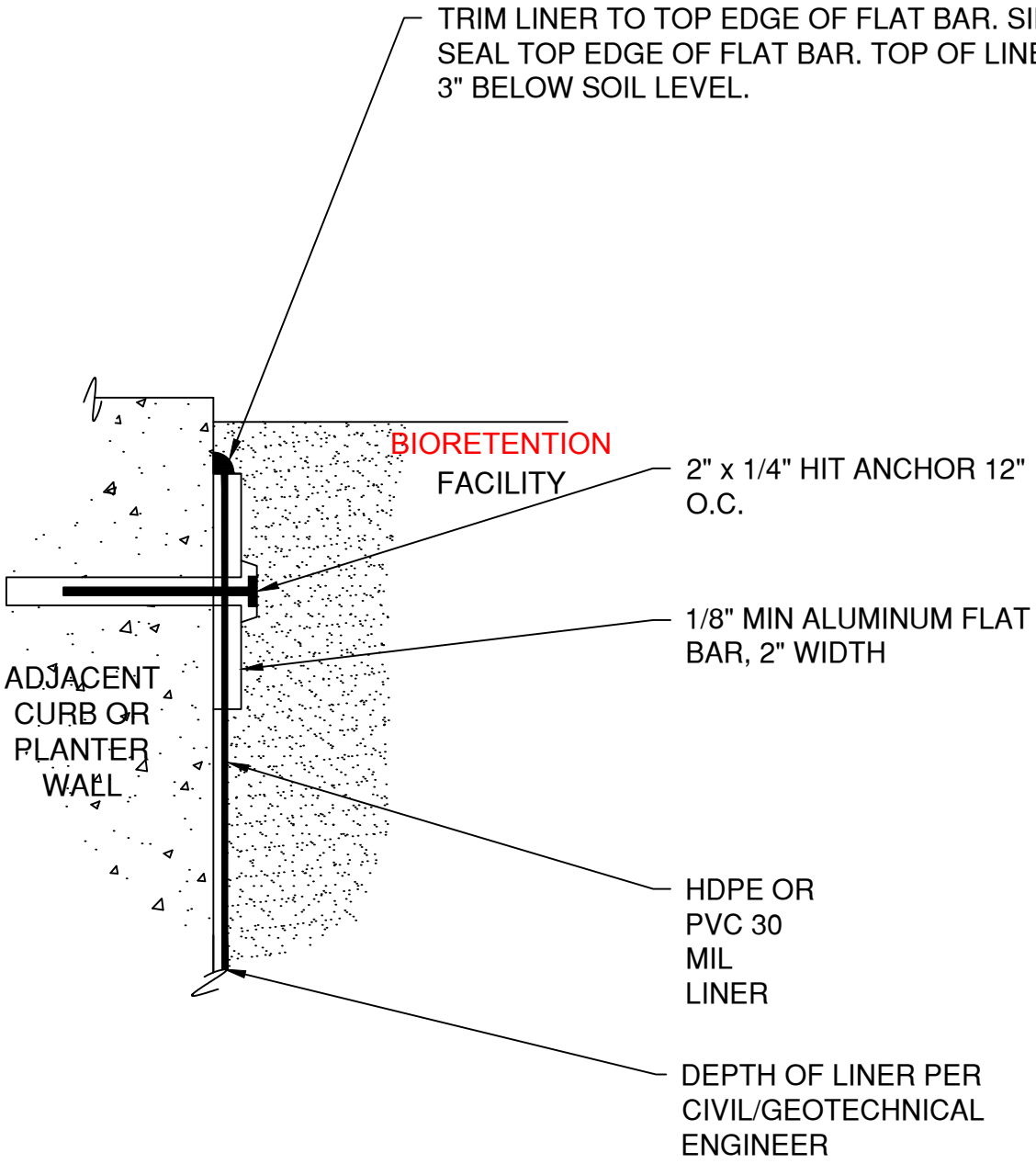
1. MAY BE USED IN CONJUNCTION WITH OVERFLOW STRUCTURES TO ALLOW FOR FIELD ADJUSTMENT OF OVERFLOW ELEVATION, OR AS RETROFIT TO CORRECT EXISTING STRUCTURE THAT DOES NOT ALLOW PONDING TO OCCUR.
2. PROVIDE COLLAR OVERFLOW ELEVATION (COE) ON PLANS.
3. PCC PIPE RISER EXTENSIONS MAY BE UTILIZED IN LIEU OF OVER FLOW STRUCTURE COLLAR.

CONSTRUCTION NOTES

1. CENTER COLLAR ON OVERFLOW GRATE.

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

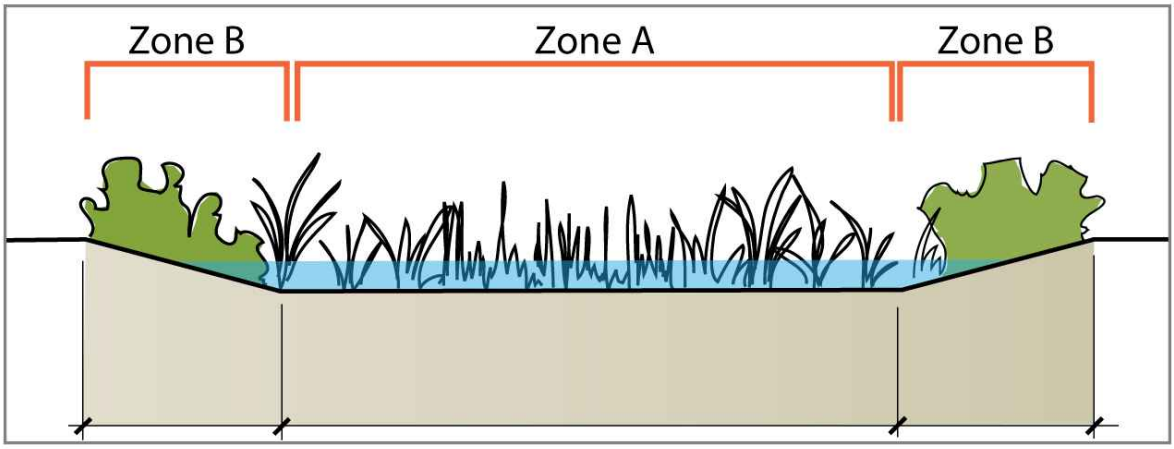
Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	OVERFLOW STRUCTURE COLLAR USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-20 SHEET 1 OF 1



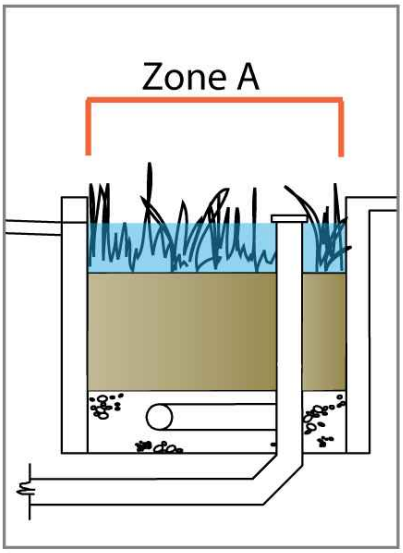
LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	IMPERMEABLE LINER CONNECTION USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-21 SHEET 1 OF 1

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



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



Scientific & Common Name	Size		Light Preference			Water Tolerance		CA Native	Notes
	Height	Width	Sun	Part	Shade	Drought	Inundation		
 **Grass / Grasslike**									
Carex flacca Blue Sedge	12"	Spreading	X	X		X	X		Use only in poor infiltration areas where inundation may be longer than 72-hours.
Helictotrichon sempervirens Blue Oat Grass	36"	30"	X	X		X	X		Needs irrigation.
Juncus patens 'Elk Blue' Elk Blue California Gray Rush	2'	Clumping	X	X		X	X	X	Use only in poor infiltration areas where inundation may be longer than 72-hours.
Liriope muscari Aztec Grass	15"	15"		X	X	X	X		Needs irrigation. Best in mass plantings.
 **Perennials**									
Achillea millefolium Yarrow	1-3'	2'	X	X		X	X	X	
Eschscholzia californica California Poppy								X	
Encelia farinosa Brittlebush	3'	4'	X	X		X	X	X	
Physalis crassifolia Ground Cherry	18"	3'		X	X	X	X	X	
Rudbeckia californica California Coneflower								X	
Solidago californica California Goldenrod								X	
 **Shrubs**									
Rhus aromatica Gro-Low Fragrant Sumac	3'	6'	X	X		X	X		
Sphaeralcea ambigua Desert Mallow	4'	4'	X	X		X	X	X	
Spirea douglasii Western Spirea	4-5'	4-5'	X	X		X	X	X	

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality
Department Name

APPROVED BY:

VERSION:
12/16/2016

ZONE A LID RECOMMENDED PLANT LIST

USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION

STANDARD PLAN NO.
SW-23

Large Shrubs and Trees

Artemisia californica California Sagebrush	5-8'	5-8'	X	X		X	X	X	For ornamental use, shrubs should be pruned or pinched back each year to maintain their form.
Cercidium microphyllum Littleleaf Palo Verde	10-15'	10-15'	X	X		X	X	X	
Cercidium floridum Palo Verde	15-20'	15-20'	X	X	X	X		X	
Chilopsis linearis Desert Willow	15-20'	15-20'		X	X	X	X	X	
Forestiera neomexicana New Mexico Privet	18'	12'	X	X		X	X	X	
Larrea tridentata Creosote Bush	6'	8'	X	X		X	X	X	
Prosopis glandulosa torreyana Honey Mesquite	30'	30'	X	X		X		X	Great in poor soils. Do not place near irrigated areas.
Prosopis pubescens Screwbean Mesquite	25'	25'	X	X		X	X	X	
Salix gooddingii San Joaquin Willow	20-30'	20-30'	X			X	X	X	

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality
Department Name

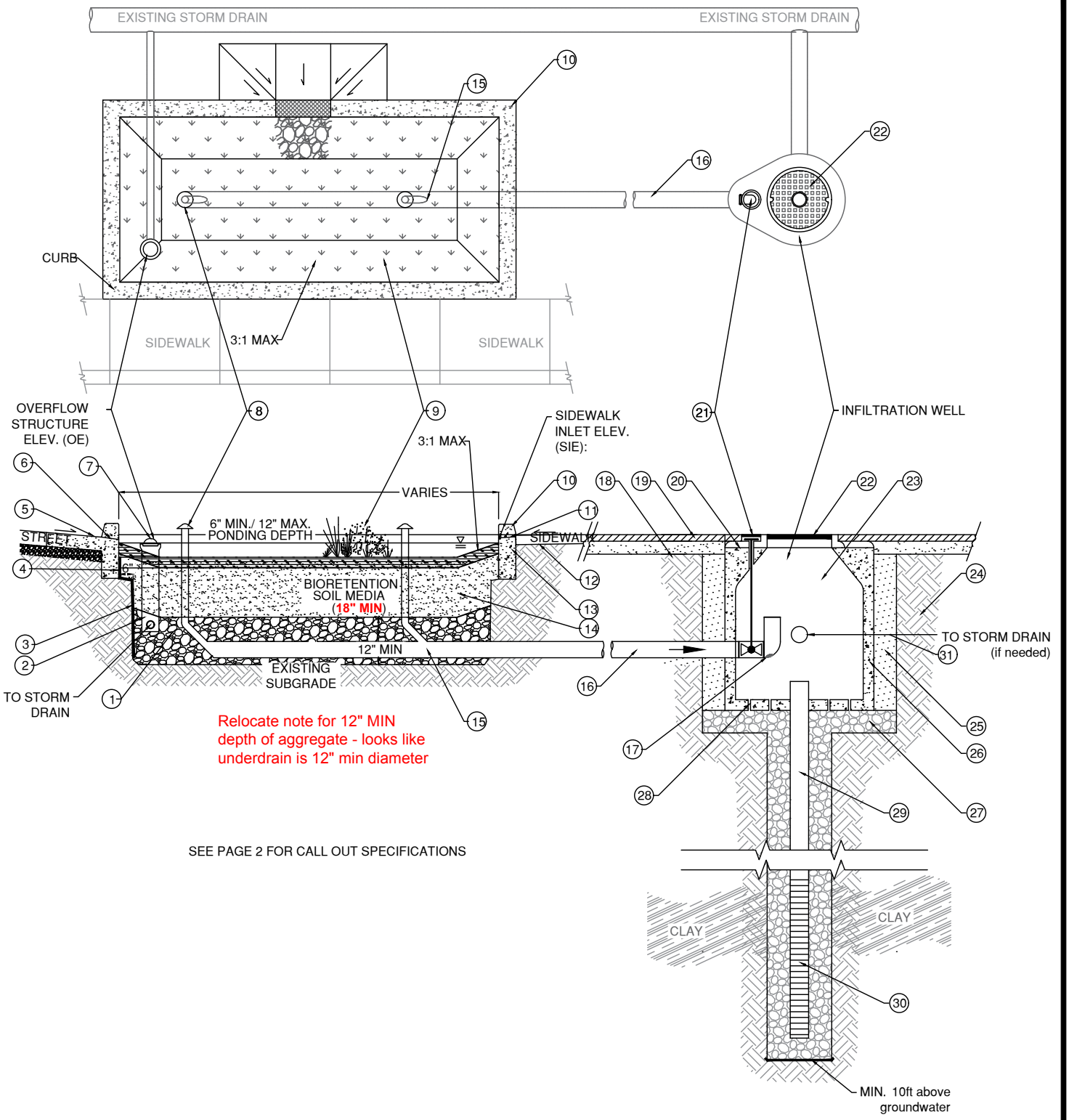
APPROVED BY:

VERSION:
12/16/2016

ZONE A LID RECOMMENDED PLANT LIST

USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION

STANDARD PLAN NO.
SW-23



SEE PAGE 2 FOR CALL OUT SPECIFICATIONS

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

Municipality Department Name	APPROVED BY: VERSION: 12/16/2016	DRYWELL STORMWATER BMP USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-24 SHEET 1 OF 2

SPECIFICATIONS

1. 12” DEEP OPEN GRADED WASHED STONE (TYPICALLY 3/4” TO 1-1/2” (ASTM #4 STONE) OR 1” TO 2” (ASTM #3 STONE).
2. BRIDGING LAYER(S) PER LIDI BIORETENTION TECHNICAL SPECIFICATIONS (BTS). DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE. DO NOT USE FILTER FABRIC BETWEEN BIOFILTER SOIL MATERIAL (BSM) AND AGGREGATE.
3. 30 ML LINER MAY BE REQUIRED TO AVOID LATERAL INFILTRATION BELOW STREET; SUBJECT TO GEOTECHNICAL RECOMMENDATIONS.
4. MAINTAIN 6” MINIMUM BENCH OF NATIVE SOIL FOR SUPPORT OF ADJACENT SIDEWALK/ROAD (TYPICAL).
5. CURB AND GUTTER DETAIL 110.
6. CURB INLET DETAIL 120, GUTTER INLET ELEV (GIE). LOCATE ENERGY DISSIPATION COBBLE PADS AS SPECIFIED IN INLET DETAILS.
7. OVERFLOW STRUCTURE REQUIRED FOR IN-LINE SYSTEMS WITHOUT OVERFLOW BYPASS, DETAIL 140.
8. MAINTENANCE PIPES - 4” MIN. DIA. VERTICAL PVC PIPES CONNECTED TO UNDERDRAIN. PLACED AT START AND 3 FEET BEFORE END OF UNDERDRAIN. REQUIRES DIRECTIONAL SWEEP BEND. THREADED AND CAPPED
9. VEGETATION - PLANT SELECTION AND MULCH (OPTIONAL) PER BIORETENTION TECHNICAL SPECIFICATIONS.
10. 4” MIN. EXPOSED WALL HEIGHT
11. SIDEWALK DRAINAGE NOTCH 1” LOWER THAN SIDEWALK, SLOPED TO FACILITY
12. SEE PLANS FOR SIDEWALK RESTORATION
13. DEEP CURB DETAIL
14. BIORETENTION SOIL MEDIA (BSM). SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS (BTS). SPECIFICATION SHOULD AVOID COMPOST OR OTHER MATERIAL KNOWN TO LEACH NUTRIENTS.
15. UNDERDRAIN, MIN. 4” DIA. PVC SDR 35 PERFORATED PIPE OR LARGER AS NEEDED TO CONVEY PEAK TREATED FLOWRATE WITH MINIMAL HEAD LOSS, SEE CONSTRUCTION NOTES.
16. 8” INLET PIPE OR OTHER.
17. LOW FLOW ORIFICE. (SEE DESIGN NOTE 11).
18. STABILIZED BACKFILL - TWO-SACK SLURRY MIX.
19. SIDEWALK PER MUNICIPAL STANDARDS.
20. COMPACTED BASE MATERIAL.
21. ACCESS HATCH WITH SHUT OF VALVE SWITCH. CONNECTED TO SHUT OF VALVE IN INLET PIPE.
22. MAINTENANCE HOLE COS TYPE 204-204 MH A OR B. ¾” I.D. MIN OBSERVATION PORT.
23. MANHOLE CONE - MODIFIED FLAT BOTTOM.
24. EXISTING SOILS. (SEE CONSTRUCTION NOTE 4, 8).
25. COMPACTED BACKFILL
26. PRE-CAST OR INSITU CAST CONTROL VAULT (SEE DESIGN NOTE 8)
27. ROCK - WASHED, SIZED BETWEEN 3/8” AND 1-1/2"
28. PERFORATED BASE OF CONTROL VAULT
29. DRILLED SHAFT WITH 6” WELDED STEEL OR THREADED PVC CASING (SEE DESIGN NOTE 13 & CONSTRUCTION NOTE 7,8)
30. 6 - 8” O.D. WELDED WIRE STAINLESS STEEL WELL SCREEN OR THREADED PVC SLOTTED SCREEN. SCREEN LENGTH + LENGTH + SLOT WIDTH TO BE DETERMINED IN ACCORDANCE WITH LOCAL CONSTRAINTS .I.E. DISTANCE BETWEEN CLAY LAYER AND MIN. 10FT ABOVE SEASONAL HIGH GROUNDWATER LEVEL
31. PVC STORMDRAIN CONNECTOR PIPE. SAME DIAMETER AS INFLOW PIPE TO CONTROL VAULT.

DESIGN NOTES

1. ADDITIONAL DESIGN GUIDANCE FOR BIOFILTRATION SYSTEM PROVIDED IN LIDI BIORETENTION TECHNICAL SPECIFICATIONS (BTS) DOCUMENT.
2. BOTTOM WIDTH - PROVIDE 2 FT MINIMUM FLAT BREGENALL
3. OTTOM WITH A MAX 3:1 SLOPE FOR SURFACE FINISHING WITHIN BIOFILTRATION SYSTEM
4. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3” DEEP LAYER OF ¾” (NO. 4) OPEN-GRADED AGGREGATE.
5. PROVIDE SPOT ELEVATIONS AT INLETS ON CIVIL PLANS (FE, OE, GIE, SIE). SEE DETAIL 120.
6. EDGE CONDITION WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, WALL, AND SIDEWALK DETAILS MAY BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS.
7. PROVIDE MONITORING WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS.
8. LONGITUDINAL SLOPE 6% WITH CHECK DAMS.
9. IF CHECK DAMS ARE NEEDED, SEE CONCRETE CHECK DAM DETAIL 121.
10. VARIATIONS IN DRY WELL DESIGN SHOULD BE MADE TO ACCOMMODATE STORAGE VOLUME DESIGN AND TO SUIT LOCAL CONDITIONS AND CONSTRAINTS.
11. IN AREAS WITHOUT A STORMDRAIN, THE SYSTEM SHOULD ONLY BE CONSTRUCTED WHERE THE MAINTENANCE HOLE SURFACE INVERT IS ABOVE THE BIOFILTER OVERFLOW ELEVATION.
12. ALTERNATIVE VAULT LOCATIONS POSSIBLE INCLUDING WITHIN THE BIOFILTER FOOTPRINT.
13. VALVE CAN BE MOVED TO THE BIOFILTER IF DESIRED. REQUIRES STRUCTURAL SUPPORT.
14. ALTERNATIVE PRODUCTS SUCH AS VENDOR-SUPPLIED DRY WELL PRODUCTS MAY BE USED AS A SUBSTITUTE PROVIDED THAT THE ALTERNATIVE PRODUCT IS EQUAL.
15. THIS DESIGN IS LIKELY TO QUALIFY AS A CLASS V WELL SUBJECT TO REGISTRATION WITH USEPA.

Attachment C

Recommended Changes to LIDI Bioretention Detail Notes

Number of Detail	Construction Notes	Design Notes
SW-1, SW-3 (PLANTER, NO UNDERDRAIN)	1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND SOIL. 2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM. 3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE~~,~~ AND SOIL~~, AND MULCH~~ DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS. ~~4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN 6" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.~~ 5. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING. 6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS. 7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS. 8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL SYSTEM IS ONLINE, CONSTRUCTION IN DRAINAGE AREA TO FACILITY IS COMPLETED AND VEGETATION IS ESTABLISHED.	1. ALL BIORETENTION ELEMENT WIDTHS TO BE DETERMINED BASED ON SIZING. ADDITIONAL DESIGN GUIDANCE PROVIDED IN BIORETENTION TECHNICAL SPECIFICATIONS DOCUMENT [OR INSERT NAME OF LOCAL OR COUNTYWIDE GUIDANCE DOCUMENT OR CASQA BMP HANDBOOK]. 2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM, USING DETAIL SW-19 OR BROOKS STYLE GRATED CURB VALVE BOX OR CATCH BASIN. ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND METHODS (I.E., CURB CUTS, SIDEWALK UNDERDRAIN, WEIR, ETC.). ~~3. PROVIDE SPOT ELEVATIONS AT INLETS ON CIVIL PLANS (FE, OE, GIE, SIE), PER DETAIL SW-15.~~ 4. SITE CONDITIONS WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND SIDEWALK DETAILS TO BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS. 5. PROVIDE ~~MONITORING~~ OBSERVATION WELL IN ~~EACH~~ FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS [OR INSERT NAME OF LOCAL OR COUNTYWIDE GUIDANCE DOCUMENT OR CASQA BMP HANDBOOK], IF REQUIRED. 6. ON LONGITUDINAL SLOPE, USE CHECK DAMS (DETAILS SW-17, SW-18) 7. USE AND DEPTH OF AGGREGATE DETERMINED BY FACILITY SIZING (MINIMUM 12"). IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3" DEEP CHOKING LAYER OF EITHER CALTRANS COURSE AGGREGATE 1/2" (NO. 4) OR 3/4" X (NO. 4) OPEN-GRADED AGGREGATE. 8. BIORETENTION SOIL MEDIA (BSM) ~~SPECIFICATION~~ PER ~~BIORETENTION TECHNICAL~~BASMAA REGIONAL BIOTREATMENT SOIL SPECIFICATIONS (REV. 1/29/16). 9. PLANT SELECTION AND MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS OR OTHER LOCAL OR COUNTYWIDE GUIDANCE DOCUMENT. ~~10. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.~~ 11. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS - AVOID DECORATIVE USE. 12/14. DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE.
SW-2, SW-4 (SLOPED SIDES, NO UNDERDRAIN)	SAME AS SW-1 & SW-3	SAME AS SW-1 & SW-3, PLUS: 12. NATIVE SIDE SLOPE TO BE DETERMINED BY GEOTECHNICAL CONDITIONS. 13. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE ~~MULCH LAYER~~FREEBOARD ELEVATION.

Commented [JCB1]: No underdrain in SW-1, 2, 3 and 4

Number of Detail	Construction Notes	Design Notes
SW-5, SW-7 (PLANTER, WITH UNDERDRAIN	SAME AS SW-1 & SW-3, EXCEPT INCLUDE: 4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN ~~6~~2" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.	SAME AS SW-1 & SW-3, PLUS: 5. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND.
SW-6, SW-8 (SLOPED SIDES, WITH UNDERDRAIN)	SAME AS SW-1 & SW-3, EXCEPT INCLUDE: 4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN ~~6~~2" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.	SAME AS SW-1 & SW-3, PLUS: 5. PROVIDE CAPPED, THREADED PVC CLEANOUT FOR UNDERDRAIN, 4" MIN. DIA. WITH SWEEP BEND. 13. NATIVE SIDE SLOPE TO BE DETERMINED BY GEOTECHNICAL CONDITIONS. 14. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE ~~MULCH LAYER~~FREEBOARD ELEVATION.
SW-9	1. FINISH ALL EXPOSED CONCRETE SURFACES. 2. LAYBACK SLOPE AS FLAT AS POSSIBLE UNTIL TOP WIDTH PRODUCES 1:1 SLOPE & 24" BOTTOM WIDTH. AS PLANTER GETS WIDER MAINTAIN 1:1 SLOPE AND INCREASE BOTTOM WIDTH WIDER THAN 24". ALTERNATIVE TRENCH WALL CONFIGURATIONS MAY BE PROPOSED BY THE PROJECT GEOTECHNICAL ENGINEER (I.E., VERTICAL SHORING, REINFORCED TRENCH SIDEWALL) THAT DO NOT REQUIRE SIDEWALK SUPPORT FROM THE LIGHTLY COMPACTED BSM.	1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER PLANTER WALL SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY. 2. EDGE CONDITION WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER. 3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY. ~~4. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.~~
SW-9A	SAME AS SW-9	1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER PLANTER WALL SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY. 2. EDGE CONDITION WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER. ~~1~~3. ~~SPECIAL~~ CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY. ~~2~~4. PROVIDE OPENINGS IN CURB (MINIMUM 12" WIDE) TO ALLOW FOR SURFACE DRAINAGE TO BIORETENTION AREAS IF DEDICATED INLET NOT USED. INLET WITH GRATE (SW-16) MAY BE USED WITH CONCRETE VEHICLE ACCESS STRIP. SPACING TO BE DETERMINED BY PROJECT ENGINEER BASED ON DESIGN STORM TO MINIMIZE PONDING AGAINST CURB ~~FOR MEDIAN ISLAND APPLICATION~~.
SW-10	SAME AS SW-9	1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER PLANTER WALL SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY. 2. EDGE CONDITION WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, GUTTER, AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.

Commented [JCB2]: Need to explain more clearly and show on detail.

Commented [JCB3]: Repeat of #1

Number of Detail	Construction Notes	Design Notes
		3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY. ~~2~~4. WHEN SIDEWALK DRAINS TO PLANTER, PROVIDE 4" - 6" WIDE NOTCH OPENINGS, 1" BELOW SIDEWALK, SLOPED TO FACILITY, PER BIORETENTION PLANTER DETAILS. SPACE OPENINGS TO CONVEY FLOWS. PROVIDE MINIMUM 2" COVER BETWEEN DRAINAGE NOTCH OPENING AND DOWELS. ~~4. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.~~ 5. WHEN STREET OR PARKING AREA DRAINS TO PLANTER, SEE SW-13 OR SW-14 FOR CURB INLETS. SPACE OPENINGS TO CONVEY FLOWS.
SW-11	NO COMMENTS	NO COMMENTS
SW-12	NO COMMENTS	NO COMMENTS
SW-13	NO COMMENTS	NO COMMENTS
SW-14	1. AFTER CONSTRUCTION OF CURB CUT INLET, PLACE SAND BAGS AT GUTTER OPENINGS TO KEEP STORM FLOWS FROM ENTERING FACILITY UNTIL VEGETATION IS ESTABLISHED AND CONSTRUCTION IN DRAINAGE AREA IS COMPLETED.	1. FOR USE WITH ~~STORMWATER~~ BIORETENTION ~~FACILITIES~~PLANTERS WITH VERTICAL SIDE WALLS~~FLAT BOTTOMS~~. (Other notes are OK)
SW-15	SAME EDITS AS SW-14	1. FOR USE WITH ~~STORMWATER~~ BIORETENTION FACILITIES WITH SIDE SLOPES. (Other notes are OK)
SW-16	SAME EDITS AS SW-14	1. FOR USE WITH ~~STORMWATER~~ BIORETENTION FACILITIES WITH SLOPED SIDES OR VERTICAL SIDE WALLS~~FLAT BOTTOMS~~.
SW-17	~~1. DO NOT WORK DURING RAIN OR UNDER WET CONDITIONS.~~ ~~2. KEEP ALL HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.~~	2. BEST SUITED FOR FACILITIES WITH LESS THAN 6% AND GREATER ~~< OF <=~~ THAN 2% LONGITUDINAL SLOPE.
SW-18	1. EMBED #3 REBAR 3" INTO CURB AND PLANTER WALL. ~~1. DO NOT WORK DURING RAIN OR UNDER WET CONDITIONS.~~ ~~2. KEEP ALL HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.~~	NO COMMENTS
SW-19	NO COMMENTS	NO COMMENTS
SW-20	NO COMMENTS	NO COMMENTS
SW-21	NO COMMENTS	NO COMMENTS
SW-22	PERVIOUS PAVEMENT – SHOULD BE REPLACED WITH DETAIL PER REVISED PERVIOUS PAVEMENT SPECS (TM #2)	
SW-23	PLANTING ZONES AND LIST – DID NOT REVIEW	

Commented [JCB4]: Repeat of #1

Commented [JB5]: All facilities should have flat bottoms.

Commented [JB7]: Not sure if this was the intended note, but it is consistent with tech specs.

Commented [JB6]: These notes are already included in the bioretention facility drawings and are not specific to this detail.

Commented [JB8]: These notes are already included in the bioretention facility drawings and are not specific to this detail.

Number of Detail	Construction Notes	Design Notes
SW-24	1. 12” MINIMUM DEEP OPEN GRADED WASHED STONE (TYPICALLY 3/4” TO 1-1/2” (ASTM #4 STONE) OR 1” TO 2” (ASTM #3 STONE). 2. ~~BRIDGING LAYER(S) PER LIDI BIORETENTION TECHNICAL SPECIFICATIONS (BTS).~~ DO NOT USE FILTER FABRIC BETWEEN BSM AND AGGREGATE. ~~DO NOT USE FILTER FABRIC BETWEEN BIOFILTER SOIL MATERIAL (BSM) AND AGGREGATE.~~ 3. 30 ML LINER ON SIDES MAY BE REQUIRED TO AVOID LATERAL INFILTRATION BELOW STREET; SUBJECT TO GEOTECHNICAL RECOMMENDATIONS. 4. MAINTAIN 6” MINIMUM BENCH OF NATIVE SOIL FOR SUPPORT OF ADJACENT SIDEWALK/ROAD (TYPICAL). 5. CURB AND GUTTER DETAIL ~~110~~SW-9. 6. CURB INLET DETAIL ~~120~~SW-15, GUTTER INLET ELEV (GIE). LOCATE ENERGY DISSIPATION COBBLE PADS AS SPECIFIED IN INLET DETAILS. 7. OVERFLOW STRUCTURE REQUIRED FOR IN-LINE SYSTEMS WITHOUT OVERFLOW BYPASS, DETAIL ~~140~~SW-19. 8. ~~MAINTENANCE PIPES~~CLEAN OUTS - 4” MIN. DIA. VERTICAL PVC PIPES CONNECTED TO UNDERDRAIN. PLACED AT START AND 3 FEET BEFORE END OF UNDERDRAIN. REQUIRES DIRECTIONAL SWEEP BEND. THREADED AND CAPPED. 9. VEGETATION - PLANT SELECTION AND MULCH ~~(OPTIONAL)~~ PER BIORETENTION TECHNICAL SPECIFICATIONS. 10. 4” MIN. EXPOSED WALL HEIGHT 11. SIDEWALK DRAINAGE NOTCH 1” LOWER THAN SIDEWALK, SLOPED TO FACILITY 12. SEE PLANS FOR SIDEWALK RESTORATION 13. DEEP CURB DETAIL SW-10 14. BIORETENTION SOIL MEDIA (BSM). SPECIFICATION PER BIORETENTION TECHNICAL SPECIFICATIONS (BTS). ~~SPECIFICATION SHOULD AVOID COMPOST OR OTHER MATERIAL KNOWN TO LEACH NUTRIENTS~~. ~~15~~16. UNDERDRAIN, MIN. 4” DIA. PVC SDR 35 PERFORATED PIPE OR LARGER AS NEEDED TO CONVEY PEAK TREATED FLOWRATE WITH MINIMAL HEAD LOSS, SEE CONSTRUCTION NOTES. ~~16~~15. 8” INLET PIPE OR OTHER. 17. LOW FLOW ORIFICE. (SEE DESIGN NOTE 11). 18. STABILIZED BACKFILL - TWO-SACK SLURRY MIX. 19. SIDEWALK PER MUNICIPAL STANDARDS. 20. COMPACTED BASE MATERIAL.	1. ADDITIONAL DESIGN GUIDANCE FOR BIOFILTRATION SYSTEM PROVIDED IN LIDI BIORETENTION TECHNICAL SPECIFICATIONS (BTS) DOCUMENT. 2. BOTTOM WIDTH - PROVIDE 2 FT MINIMUM FLAT BREGENALL 3. BOTTOM WITH A MAX 3:1 SLOPE FOR SURFACE FINISHING WITHIN BIOFILTRATION SYSTEM 4. IF CALTRANS CLASS 2 PERMEABLE IS NOT AVAILABLE, SUBSTITUTE CLASS 3 PERMEABLE WITH AN OVERLYING 3” DEEP LAYER OF ¾” (NO. 4) OPEN-GRADED AGGREGATE. 5. PROVIDE SPOT ELEVATIONS AT INLETS ON CIVIL PLANS (FE, OE, GIE, SIE). SEE DETAIL SW-15~~120~~. 6. EDGE CONDITION WILL VARY FOR NEW AND RETROFIT PROJECTS. CURB, WALL, AND SIDEWALK DETAILS MAY BE MODIFIED FOR PROJECT BY CIVIL AND GEOTECHNICAL ENGINEERS. 7. PROVIDE ~~MONITORING~~ OBSERVATION WELL IN EACH FACILITY, PER BIORETENTION TECHNICAL SPECIFICATIONS, IF REQUIRED. 8. LONGITUDINAL SLOPE UP TO 6% ~~WITH~~ IF CHECK DAMS USED. 9. IF CHECK DAMS ARE NEEDED, SEE CONCRETE CHECK DAM DETAIL SW-18~~121~~. 10. VARIATIONS IN DRY WELL DESIGN SHOULD BE MADE TO ACCOMMODATE STORAGE VOLUME DESIGN AND TO SUIT LOCAL CONDITIONS AND CONSTRAINTS. 11. IN AREAS WITHOUT A STORMDRAIN, THE SYSTEM SHOULD ONLY BE CONSTRUCTED WHERE THE MAINTENANCE HOLE SURFACE INVERT IS ABOVE THE BIOFILTER OVERFLOW ELEVATION. 12. ALTERNATIVE VAULT LOCATIONS POSSIBLE INCLUDING WITHIN THE BIOFILTER FOOTPRINT. 13. SHUT OFF VALVE CAN BE MOVED TO THE BIOFILTER IF DESIRED. REQUIRES STRUCTURAL SUPPORT. 14. ALTERNATIVE PRODUCTS SUCH AS VENDOR-SUPPLIED DRY WELL PRODUCTS MAY BE USED AS A SUBSTITUTE PROVIDED THAT THE ALTERNATIVE PRODUCT IS EQUAL.

Commented [JB9]: Not consistent with other bioretention details - should be Caltrans Class 2 Perm

Commented [JB16]: What does this mean?

Commented [JCB10]: Duplicative

Commented [JB17]: Don't think I would recommend this - maybe better discussed within the technical specifications?

Commented [JB11]: Order of notes 15 and 16 should be switched. Also, unclear why a 4-in underdrain needs to drain to an 8-in inlet pipe.

Commented [JB12]: Does not seem to relate at all to Design Note 11

Commented [JB13]: Unclear

Number of Detail	Construction Notes	Design Notes
	21. ACCESS HATCH WITH SHUT OFF VALVE SWITCH. CONNECTED TO SHUT OFF VALVE IN INLET PIPE.	
	22. MAINTENANCE HOLE COS TYPE 204-204 MH A OR B. ¾" I.D. MIN OBSERVATION PORT.	
	23. MANHOLE CONE - MODIFIED FLAT BOTTOM.	
	24. EXISTING SOILS. (SEE CONSTRUCTION NOTE 4, 8).	
	~~25~~26. COMPACTED BACKFILL	
	~~26~~25. PRE-CAST OR INSITU CAST CONTROL VAULT (SEE DESIGN NOTE 8)	
	27. ROCK - WASHED, SIZED BETWEEN 3/8" AND 1-1/2"	
	28. PERFORATED BASE OF CONTROL VAULT	
	29. DRILLED SHAFT WITH 6" WELDED STEEL OR THREADED PVC CASING (SEE DESIGN NOTE 13 & CONSTRUCTION NOTE 7,8)	
	30. 6 - 8" O.D. WELDED WIRE STAINLESS STEEL WELL SCREEN OR THREADED PVC SLOTTED SCREEN. SCREEN LENGTH + LENGTH + SLOT WIDTH TO BE DETERMINED IN ACCORDANCE WITH LOCAL CONSTRAINTS .I.E. DISTANCE BETWEEN CLAY LAYER AND MIN. 10FT ABOVE SEASONAL HIGH GROUNDWATER LEVEL	
	31. PVC STORMDRAIN CONNECTOR PIPE. SAME DIAMETER AS INFLOW PIPE TO CONTROL VAULT.	

Commented [JB14]: Notes 25 and 26 are switched. Note 25 does not seem to relate at all to Design Note 8.

Commented [JB15]: Unclear what notes this is referring to