Green Stormwater Infrastructure Handbook
Part 2

Guidance for Integrating Green Stormwater Infrastructure in Public Streetscapes, Parking Lots and Parks

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Prepared for the
Santa Clara Valley Urban Runoff
Pollution Prevention Program
by EOA, Inc.

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CREDITS

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EOA, as the Program management consultant, coordinated and compiled the information and was responsible for the overall preparation of this document. The Program gratefully acknowledges the public agencies whose Green Stormwater Infrastructure guidance documents provided valuable information for this document, including:

- Sustainable Green Streets and Parking Lots Design Guidebook (San Mateo Countywide Water Pollution Prevention Program), 2009
- Green Streets Design Manual and Appendices (City of Philadelphia Water Department), 2011
- Urban Street Design Guide (National Association of City Transportation Officials), 2013
- Greening DC Streets – A Guide to Green Infrastructure in the District of Columbia, 2014
- Green Stormwater Infrastructure Design Specifications (City of Philadelphia Water Department), 2014
- Stormwater Management Guidelines City Heights Urban Greening Plan (City of San Diego), 2014
- Washington DC DOT Green Infrastructure Standards (2014)
- Sustainable Streets Plan and Design Guidelines (City of San Mateo), 2015
- Separated Bicycle Lane Planning and Design Guide (Massachusetts Department of Transportation), 2015
- Green Streets Design Criteria (County of San Diego), 2016
- Stormwater Management Requirements and Design Guidelines (San Francisco Public Utilities Commission), 2016, including Appendix B Green Stormwater Infrastructure Typical Details and Specifications
- Green Infrastructure Design Details (City of New York City) 2016
- Stormwater Management Manual (City of Portland), 2016
- Bioretention Engineering Standards: Details and Technical Specifications (Central Coast Low Impact Development Initiative), 2017
- Urban Street Stormwater Guide (National Association of City Transportation Officials), 2017
- Silva Cell Fact Sheet (DeepRoot Green Infrastructure, LLC), 2017

Cover page images (clockwise from top left) – Hacienda Avenue in Campbell, Martha Gardens Green Alleys in San Jose, Rosita Park Neighborhood Stormwater Curb Extension in Los Altos, and Southgate Neighborhood in Palo Alto. Green Streets-Blue Bay Logo courtesy of the City of San Jose.

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Chapter 1

Introduction

This Chapter describes the purpose of Part 2 of the GSI Handbook and provides an overview of its contents.

The Green Stormwater Infrastructure (GSI) Handbook was written to assist municipal staff, designers, engineers and developers with implementation of the municipalities' GSI Plans to meet the requirements of the San Francisco Bay Region Municipal Regional Stormwater NPDES Permit (MRP). This is a companion document to the Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP) Guidance for Implementing Stormwater Requirements for New Development and Redevelopment Projects (C.3 Stormwater Handbook) which includes details and guidance for stormwater treatment control measures. The complete GSI Handbook includes two parts. Part 1, General Guidelines, provides guidelines for overall streetscape and project design that integrates stormwater capture and treatment measures into the range of functions associated with projects in the public right-of-way. Part 2, Details and Specifications (this document), includes typical details in Chapter 2 and design specifications and guidance in Chapter 3.

All design details and specifications provided in Part 2 have been reviewed by SCVURPPP and were found to be comprehensive examples of GSI measure design details and specifications. These details and specifications offer good indications of elements that should be included in design details. The examples from other jurisdictions may not be directly applicable to SCVURPPP requirements in their current iteration. For example, the biotreatment soil mix may not conform to SCVURPPP C.3 Handbook specifications. The SCVURPPP typical details provided in Part 2 were adopted from the San Francisco Public Utilities Commission (SFPUC) and revised based on comments received on the Draft GSI Handbook Part 2. All details and specifications are provided as guidance and must be modified prior to use for construction purposes to reflect site conditions and local requirements. Municipalities may reference, revise, and/or adopt the design details and specifications in Part 2 for GSI Plans and specific projects in their jurisdictions. Individual details and specifications should be modified to accommodate specific project conditions and local ordinances.

Chapter 2

Typical Details

This Chapter provides typical details for the GSI measures discussed in Part 1 of the Handbook.

SCVURPPP has reviewed typical details for Green Stormwater Infrastructure (GSI) measures from combined and separate storm sewer systems in the United States and Australia and has compiled applicable details for member agencies to reference, revise, and/or adopt as appropriate for their GSI Plans and projects.

The details provided are **TYPICAL** details rather than standard details and should **NOT** be used for construction purposes. Designers should modify materials, dimensions, configurations, and/or notes for GSI measures based on specific project conditions and local requirements.

The typical details are organized by GSI measure type, and then by source (municipality, agency, or organization). The GSI measure categories that are included in this section are pervious pavement, stormwater planter, stormwater curb extension, parking lot bioretention, infiltration, and tree wells. GSI measure components, such as edge controls, inlets, outlets, utilities, underdrains, etc., are listed separately within each type section. Depending on the source of the detail, there may be designer notes provided. Typical details were selected to show multiple configurations and views to assist designers in developing their own specific details. All details are provided in PDF format in the section that follows. Many details are also available in AutoCAD format, as indicated below.

To easily access PDFs of the specific details noted in the tables below you must first be viewing the electronic file of Part 2 that includes the Attachments. Then, click on the detail title to be directed to that page. To access the AutoCAD files available for individual design details, click on the “Yes” next to the desired detail title, and you will be directed to a webpage on the SCVURPPP website where the file is stored. From the webpage, you can download the CAD drawing.

The SCVURPPP typical details listed in the table below were adopted from the San Francisco Public Utilities Commission (SFPUC) Green Infrastructure Typical Details, with permission. SCVURPPP revised the SFPUC details to be appropriate for municipalities with separate storm drain systems, to align with C.3 Stormwater Handbook design guidance, and to address comments received on the Draft GSI Handbook Part 2.

2.1 PERVIOUS PAVEMENT

Component	Detail Title	AutoCAD Available
Santa Clara Valley Urban Runoff Pollution Prevention Program		
General	PP 1.1 Pervious Pavement Designer Notes (1 of 2)	Yes
General	PP 1.2 Pervious Pavement Designer Notes (2 of 2)	Yes
General	PP 1.3 Key Map	Yes
Pavers	PP 2.1 Material Sections - Permeable Interlocking Concrete Pavers	Yes
Concrete	PP 3.1 Material Sections - Pervious Concrete	Yes
Asphalt	PP 4.1 Material Sections - Porous Asphalt	Yes

2.2 PERVIOUS PAVEMENT COMPONENTS

Component	Detail Title	AutoCAD Available
Santa Clara Valley Urban Runoff Pollution Prevention Program		
Edge Controls	PC 1.1 Edge Treatment - Designer Notes	Yes
Edge Controls	PC 1.2 Edge Treatment - Key Map	Yes
Edge Controls	PC 1.3 Edge Treatments - Vehicular Applications	Yes
Edge Controls	PC 1.4 Edge Treatments - Pedestrian Applications (1 Of 2)	Yes
Edge Controls	PC 1.5 Edge Treatments - Pedestrian Applications (2 Of 2)	Yes
Edge Controls	PC 1.6 Edge Treatments - Paver At Structures	Yes
Check Dams	PC 2.1 Subsurface Check Dams - Designer Notes	Yes
Check Dams	PC 2.2 Subsurface Check Dams	Yes
Overflow	PC 3.1 Subsurface Overflows and Underdrains - Designer Notes	Yes
Overflow	PC 3.2 Subsurface Underdrain without Check Dam	Yes
Underdrain	PC 3.3 Subsurface Underdrain with Check Dam	Yes
Underdrain	PC 3.4 Underdrain Pipe	Yes
Utility	GC 2.6 Utility Crossings - Permeable Pavement	Yes
Utility	GC 2.7 Utility Crossings - Pavement Sections (1 Of 2)	Yes
Utility	GC 2.8 Utility Crossings - Pavement Sections (2 Of 2)	Yes
San Francisco Public Utilities Commission		
Observation	GC 4.3 Observation Port - Permeable Pavement	Yes

2.3 STORMWATER PLANTER

Component	Detail Title	AutoCAD Available
Santa Clara County Urban Runoff Pollution Prevention Program		
General	BP 1.1 Bioretention Planter - Designer Notes (1 Of 2)	Yes
General	BP 1.2 Bioretention Planter - Designer Notes (2 Of 2)	Yes
With Parking	BP 2.1 Stormwater Planter with Parking - Plan	Yes
With Parking	BP 2.2 Stormwater Planter with Parking - Sections	Yes
Without Parking	BP 3.1 Stormwater Planter Without Parking - Plan	Yes
Without Parking	BP 3.2 Stormwater Planter Without Parking - Sections	Yes
Sloped sides	BB 1.1 Bioretention Area Designer Notes	Yes
Sloped sides	BB 2.1 Bioretention Area Roadside Section	Yes
Sloped sides	BB 2.2 Bioretention Basin Parcel Section	Yes
Central Coast Low Impact Development Initiative		
Sloped with Parking	SW-1 Street Slope-Sided Bioretention, With Parking, With Underdrain	Yes
Sloped with Parking	SW-1A Street Slope-Sided Bioretention, With Parking, No Underdrain	Yes
Planter with Parking	SW-2 Street Bioretention Planter Box, With Parking, With Underdrain	Yes
Planter with Parking	SW-2A Street Bioretention Planter Box, With Parking, No Underdrain	Yes
Sloped no Parking	SW-3 Street Slope-Sided Bioretention, No Parking, With Underdrain	Yes
Sloped no Parking	SW-3A Street Slope-Sided Bioretention, No Parking, No Underdrain	Yes
Planter no Parking	SW-4 Street Bioretention Planter Box, No Parking, With Underdrain	Yes
Planting no Parking	SW-4A Street Bioretention Planter Box, No Parking, No Underdrain	Yes
Philadelphia		
With & No parking & Bus Stop	SP-01 Stormwater Planter Placement Diagram	Yes

2.4 STORMWATER CURB EXTENSION

Component	Detail Title	AutoCAD Available
Santa Clara Valley Urban Runoff Pollution Prevention Program		
In-Street	BP 4.1 Stormwater Curb Extension - Alt 1 - Bulb out only	Yes
Planting Strip	BP 4.2 Stormwater Curb Extension - Alt 2 – Bulb out with Widened Planter	Yes
Planting Strip	BP 4.3 Stormwater Curb Extension - Alt 3 - (Alt 2 with Inline Curb Cuts)	Yes
Corner	BP 4.4 Stormwater Curb Extension - Alt 4 - Bulbout at Intersection	Yes
Corner	BP 4.5 Stormwater Curb Extension - Alt 5 – (Alt 2 at Intersection)	Yes
Corner	BP 4.6 Stormwater Curb Extension - Alt 6 (Alt 4 with Widened Planter)	Yes
BASMAA		
Corner	C-1.1 Sloped Sides, Inline Overflow Structure, Curb Cut Inlet Type A	Yes
Corner	C-1.2 Walled Bioretention on Both Sides of Corner, Curb Cut Inlets Type A & B	Yes
Corner	C-1.3 Sloped and Walled Sides, Curb Cut Type B, Curb Cut Overflow Only	Yes
In-Street	C-1.4 Midblock Bulbout with Raised Bike Lane and Pedestrian Crossing	Yes
Corner	S-A-A Sloped Sides/No Curb Walls	Yes
Corner	S-B-B Walls on Both Sides, Utility Main Protection	Yes
In-Street	S-C-C Raised Bike Lane, Overflow Structure	Yes
Central Coast Low Impact Development Initiative		
In Street	SW-5 Street Bioretention Bulb Out, No Parking, No Underdrain	Yes
In Street	SW-5.1 Street Bioretention Bulb Out, Mid-Block Crossing Plan View	Yes
Philadelphia		
Corner, In-Street, Bus Stop	SB-01 Stormwater Bump-out Placement Diagram	Yes
Bus Stop	SB-04 Stormwater Bump-out (Bus Stop)	Yes

2.5 PARKING LOT BIORETENTION

Component	Detail Title	AutoCAD Available
Central Coast Low Impact Development Initiative		
Parking Lot	SW-6 Parking Lot Slope-Sided Bioretention, With Underdrain	Yes
Parking Lot	SW-6A Parking Lot Slope-Sided Bioretention, No Underdrain	Yes
Parking Lot	SW-7 Parking Lot Bioretention Planter Box, With Underdrain	Yes
Parking Lot	SW-7A Parking Lot Bioretention Planter Box, No Underdrain	Yes

2.6 STORMWATER TREE WELL FILTER

Component	Detail Title	AutoCAD Available
Philadelphia		
Tree Well Filter	TT-01 Stormwater Tree Trench	Yes
Tree Well Filter	ST-01 Stormwater Tree	Yes
Tree Well Filter	5.2.1 Trees (Tree Pit)	Yes
DeepRoot Green Infrastructure		
Structural Support	Figure 1: Silva Cell Component	
Structural Support	Figure 2: Silva Cell Typical Application	
Inlet	Figure 3: Silva Cell Hydraulic Components	
Inlet	Figure 4: Silva Cell Inlet Details	

2.7 BIORETENTION COMPONENTS

Component	Detail Title	AutoCAD Available
Santa Clara Valley Urban Runoff Pollution Prevention Program		
Edge Treatment	BC 1.1 Edge Treatments – Designer Notes	Yes
Edge Treatment	BC 1.2 Edge Treatments – Vehicular Applications (1 of 2)	Yes
Edge Treatment	BC 1.3 Edge Treatments – Vehicular Applications (2 of 2)	Yes
Edge Treatment	BC 1.4 Edge Treatments – Pedestrian Applications (1 of 2)	Yes
Edge Treatment	BC 1.5 Edge Treatments – Pedestrian Applications (2 of 2)	Yes

Component	Detail Title	AutoCAD Available
Edge Treatment	BC 1.6 Edge Treatments – Lateral Bracing (1 of 2)	Yes
Edge Treatment	BC 1.7 Edge Treatments – Lateral Bracing (2 of 2)	Yes
Inlet	BC 2.1 Inlets – Designer Notes	Yes
Inlet	BC 2.2 Inlets – Curb Cut With Gutter Modification	Yes
Inlet	BC 2.2.1 Inlets – Rounded Curb Cut	Yes
Inlet	BC 2.3 Inlets - Curb Cut At Bulb Out	Yes
Inlet	BC 2.4 Inlets - Curb Cut With Trench Drain	Yes
Outlet	BC 3.1 Outlets - Designer Notes	Yes
Outlet	BC 3.2 Outlets - Curb Cut	Yes
Outlet	BC 3.3 Outlets - Curb Cut With Trench Drain	Yes
Outlet	BC 3.4 Outlets - Overflow Structures	Yes
Underdrain	BC 5.1 Underdrains - Designer Notes	Yes
Underdrain	BC 5.2 Underdrains	Yes
Check Dam	BC 6.1 Check Dams - Designer Notes	Yes
Check Dam	BC 6.2 Check Dams	Yes
Utility	GC 2.3 Utility Crossings - Bioretention	Yes
Utility	GC 2.4 Utility Crossings - Bioretention Sections (1 of 2)	Yes
Utility	GC 2.5 Utility Crossings - Bioretention Sections (2 of 2)	Yes
Observation	GC 4.2 Observation Ports - Bioretention	Yes
Monitoring	BC 7.1 Outlet Monitoring - Designer Notes	Yes
Monitoring	BC 7.2 Outlet Monitoring - External Access Structure	Yes
Monitoring	BC 7.3 Outlet Monitoring - Internal Catch Basin Monitoring	Yes
Central Coast Low Impact Development Initiative		
Inlet	SW-17 Curb Cut Inlet for Planters	Yes
Inlet	SW-18 Curb Cut Inlet for Slope Sided Bioretention Facility	Yes
Inlet	SW-19 Inlet with Grate	Yes
Check Dam	SW-20 Gravel Check Dam	Yes
Check Dam	SW-21 Concrete Check Dam	Yes
Overflow	SW-22 Overflow Structure with Beehive Grate	Yes
Overflow	SW-22A Overflow Structure Collar	Yes
Overflow	SW-23 Overflow Structure with Square Grate	Yes
Edge Treatment	SW-24 Impermeable Liner Connection	Yes
Washington DC DOT		
Inlet and Outlets	621.40 Inlet and Outlet for Curb Extension Bioretention	

Component	Detail Title	AutoCAD Available
Inlet	621.41 Curb Cut with Splash Pad - 1	
Inlet	621.42 Curb Cut with Splash Pad - 2	
Inlet	621.43 Curb Cut Metal Trench Drain Cover - 1	
Inlet	621.44 Curb Cut Metal Trench Drain Cover - 2	
Inlet	621.45 Metal Plate over Curb Cut	
Check Dam	621.60 Concrete Check Dam	
Check Dam	621.61 Rock Check Dams	
Check Dam	621.62 Plastic Lumber Check Dam	
Check Dam	621.63 Acrylic Sheet Check Dam	
Check Dam	621.64 Alternate Permeable Pavement Check Dams	
Philadelphia		
Inlet	2.1.4 Trench Drain	Yes
Inlet	2.5.1 Wheel Guard	No
Inlet	2.5.2 Gutter Apron	Yes
Inlet (energy dissipation)	4.1.1 Splash Pad	Yes
Portland		
Utilities	SW-316A Meter & Hydrant Locations	
Utilities	SW-316B Meter and Hydrant Locations (1' Step-out)	
Utilities	SW-324 Meter and Hydrant Locations	
Liner	SW-360 Liner Attachment & Pipe Boot Detail	
Moreland, Australia		
Edge Treatment	SK006 Raingarden Edge Treatment - Materials	

2.8 INFILTRATION FACILITIES

Component	Detail Title	AutoCAD Available
San Francisco Public Utilities Commission		
Notes	SI 1.1 Designer Notes (1 of 2)	Yes
Notes	SI 1.2 Designer Notes (2 of 2)	Yes
Gallery	SI 2.1 Infiltration Gallery - Large System - Plan	Yes
Gallery	SI 2.2 Infiltration Gallery - Large System - Section	Yes
Dry Well	SI 3.1 Dry Well - Small System - Plan	Yes
Dry Well	SI 3.2 Dry Well - Small System - Section	Yes
Central Coast Low Impact Development Initiative		
Dry Well	SW-27 Drywell Stormwater BMP	Yes
New York City		
Dry Well	GI-303 Suggested Guidelines For R.O.W. Stormwater Greenstreet Type 1a-With Stone Columns Layout	
Dry Well	GI-304 Suggested Guidelines For R.O.W. Stormwater Greenstreet Type 1a-With Stone Columns Layout	

2.9 GENERAL COMPONENTS

Component	Detail Title	AutoCAD Available
Santa Clara Valley Urban Runoff Pollution Prevention Program		
Liner	GC 1.1 Liners - Designer Notes	Yes
Liner	GC 1.2 Liners - Liners And Attachments	Yes
Utility	GC 2.1 Utility Crossings - Designer Notes (1 of 2)	Yes
Utility	GC 2.2 Utility Crossings - Designer Notes (2 of 2)	Yes
Utility	GC 2.9 Utility Crossings - Liner Penetrations	Yes
Utility	GC 2.10 Utility Crossings - Wall Penetrations (1 of 2)	Yes
Utility	GC 2.11 Utility Crossings - Wall Penetrations (2 of 2)	Yes
Utility	GC 2.12 Utility Crossings - Utility Trench Dam	Yes
San Francisco Public Utilities Commission		
Utility	GC 3.1 Utility Conflicts - Designer Notes	Yes
Utility	GC 3.2 Utility Conflicts - Street/Traffic Light Poles (1 of 2)	Yes
Utility	GC 3.3 Utility Conflicts - Street/Traffic Light Poles (2 of 2)	Yes
Santa Clara Valley Urban Runoff Pollution Prevention Program		
Utility	GC 3.4 Utility Conflicts - Parking Meters	Yes
Observation	GC 4.1 Observation Port - Designer Notes	Yes
Cleanout	GC 5.1 Cleanouts	Yes
Philadelphia		
Area Protection	1.1.1 Fencing	
Central Coast Low Impact Development Initiative		
Curb	SW-12 - Curb and Gutter	Yes
Curb	SW-13 - Deep Curb	Yes
Curb	SW-14 - Thickened Edge Sidewalk	Yes
Curb	SW-15 - Flush Curb at Sidewalk	Yes
Curb	SW-16 - Parking Lot Edge Options	Yes
Moreland, Australia		
Area Protection	SK007 Raingarden Fencing	

PERVIOUS PAVEMENT

PURPOSE:

PERVIOUS PAVEMENT (PAVEMENT) CONTROLS PEAK FLOWS AND VOLUMES OF STORMWATER RUNOFF VIA INFILTRATION THROUGH THE PAVEMENT SURFACE, STORAGE IN THE PAVEMENT SECTION, INFILTRATION INTO NATIVE SOIL, AND OVERFLOW THROUGH OPTIONAL SUBSURFACE OUTLETS (WHERE REQUIRED). RUNOFF IS TREATED AS IT INFILTRATES INTO UNDERLYING NATIVE SOIL. PER MS4 PERMIT, OUTFLOW FROM PERMEABLE PAVEMENT IS CONSIDERED UNTREATED.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN, SECTION DRAWINGS, AND CALCULATE DEPTH TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. ALL PAVEMENT SYSTEMS MUST BE DESIGNED BY A LICENSED ENGINEER IN ACCORDANCE WITH AASHTO, INTERLOCKING CONCRETE PAVER INSTITUTE DESIGN MANUAL, OR CALTRANS DESIGN MANUAL BASED ON SITE-SPECIFIC CONDITIONS INCLUDING TRAFFIC LOADS AND SUBGRADE CONDITIONS. PAVEMENT SECTIONS SET FORTH IN THESE TYPICAL DETAILS ARE PROVIDED TO REPRESENT THE ANTICIPATED RANGE OF DESIGN REQUIREMENTS, BASED ON "GOOD" AND "POOR" SOIL CHARACTERIZATIONS NORMALLY ENCOUNTERED IN MUNICIPALITY. **ACTUAL SECTION DEPTHS MUST BE DETERMINED AS DESCRIBED IN GUIDELINE #3, BELOW**. SEE TABLES BELOW FOR TRAFFIC LOADING AND EFFECTIVE ROADBED SOIL RESILIENT MODULUS ASSUMPTIONS USED IN DEVELOPING THESE TYPICAL SECTIONS.
3. TRAFFIC LOADING ASSUMPTIONS:

DESIGN ASSUMPTION	MODERATE VEHICULAR	LIGHT VEHICULAR	PEDESTRIAN
EQUIVALENT SINGLE AXLE LOADS*	2,000,000	40,000	800
TRAFFIC INDEX (TI)**	10	6.5	4
* SEE AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES FOR DEFINITIONS			
** SEE CALTRANS HIGHWAY DESIGN MANUAL FOR DEFINITIONS			

SUBGRADE ASSUMPTIONS:

DESIGN ASSUMPTION	GOOD SOILS	POOR SOILS
EFFECTIVE ROADBED SOIL RESILIENT MODULUS, M (PSI)*	6,800	3,700
CALIFORNIA R-VALUE, R **	33.3	15.6
DRAINAGE COEFFICIENT, m *	1.15	0.75
LAYER COEFFICIENT, a * FOR OPEN GRADED AGGREGATE BASE	0.08	
* SEE AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES FOR DEFINITIONS		
** SEE CALTRANS HIGHWAY DESIGN MANUAL FOR DEFINITIONS		

4. GEOTECHNICAL EVALUATION OF SUBGRADE SOILS TO VERIFY THEIR STRUCTURAL SUITABILITY FOR PERVIOUS PAVEMENT INSTALLATIONS IS REQUIRED.
5. GEOTECHNICAL EVALUATION OF SEASONAL HIGH GROUND. WATER LEVEL IS REQUIRED TO VERIFY MINIMUM 5 FT. SEPARATION BETWEEN BASE OR RESERVOIR COURSE AND GROUNDWATER.
6. THE PERVIOUS PAVEMENT FACILITY MUST BE DESIGNED TO PROVIDE SUFFICIENT SUBSURFACE STORAGE IN THE PAVEMENT SECTION TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS. THE SECTION THICKNESS WILL BE A FUNCTION OF THE SUBGRADE INFILTRATION RATE (DRAINAGE COEFFICIENT), SUBGRADE SLOPE, AND THE HEIGHT AND SPACING OF SUBSURFACE CHECK DAMS. SEE **PC 2.1** AND **PC 2.2**.
7. ENTIRE PAVEMENT BASE SECTION MAY BE USED TO MEET SUBSURFACE STORAGE REQUIREMENTS.
8. SUBSURFACE STORAGE DRAWDOWN TIME (I.E. TIME FOR MAXIMUM SUBSURFACE STORAGE VOLUME TO INFILTRATE INTO SUBGRADE AFTER THE END OF A STORM) SHOULD NOT EXCEED 48 HOURS. DRAWDOWN TIME IS CALCULATED AS THE MAXIMUM SUBSURFACE PONDING DEPTH DIVIDED BY THE NATIVE SOIL INFILRATION RATE.
9. THE DESIGNER MUST ENSURE THAT THE PAVEMENT EDGES ARE RESTRAINED AND THAT WATER IS CONTAINED IN THE PAVEMENT SECTION AS NEEDED TO PROTECT ADJACENT PAVEMENT SECTIONS OR STRUCTURES. SEE EDGE TREATMENTS (**PC 1.1** THROUGH **PC 1.6**) FOR GUIDANCE ON DESIGN OF THESE COMPONENTS.
10. THE DESIGNER MUST EVALUATE UTILITY SURVEYS FOR POTENTIAL UTILITY CROSSINGS OR CONFLICTS. REFER TO **GC 2.1** - **GC 2.12** FOR UTILITY CROSSING DETAILS AND **GC 1.4** - **GC 4.4** FOR UTILITY CROSSING CONFLICT DETAILS OR OTHER MUNICIPAL DETAILS.
11. ALL PERVIOUS PAVEMENT DESIGN MUST COMPLY WITH MUNICIPAL STANDARDS ACCESSIBILITY/ADA REQUIREMENTS.

RELATED COMPONENTS	
EDGE TREATMENTS:	PC 1.1 - PC 1.6
CHECK DAMS:	PC 2.1 - PC 2.2
OVERFLOWS:	PC 3.1 - PC 3.3
LINERS:	GC 1.1 GC 1.2
UTILITY CROSSINGS:	GC 2.1 - GC 2.12
UTILITY CONFLICTS:	GC 3.1 GC 3.4
OBSERVATION PORTS:	GC 4.1 - GC 4.3
CLEANOUTS:	GC 5.1

RELATED SPECIFICATIONS	SFPUC CSI NO.*
PERMEABLE/POROUS UNIT PAVERS: - PERMEABLE /POROUS UNIT PAVERS - JOINT FILLER AGGREGATE - PAVEMENT BASE - EDGE RESTRAINTS - GEOTEXTILE FOR SOIL SEPARATION	32 14 43
PERVIOUS CONCRETE PAVEMENT: - PERVIOUS CONCRETE - PAVEMENT BASE - GEOTEXTILE FOR SOIL SEPARATION	32 13 43
POROUS ASPHALT PAVEMENT: - POROUS ASPHALT - PAVEMENT BASE - GEOTEXTILE FOR SOIL SEPARATION	32 12 43

*REFER TO SCVURPPP GSI HANDBOOK PART 2 FOR SFPUC SPECIFICATIONS

NOTES: PP 1.1, PP 1.2 | KEY MAP: PP 1.3 | SECTIONS: PP 2.1, PP 3.1, PP 4.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PP 1.1

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

PERVIOUS PAVEMENT
DESIGNER NOTES (1 OF 2)

DWG NO. PP 1.1

LAYOUT REQUIREMENTS:

1. ALL PERVIOUS PAVEMENT DESIGN MUST COMPLY WITH MUNICIPAL STANDARD ACCESSIBILITY/ADA REQUIREMENTS.
2. THE ALLOWABLE CATCHMENT AREA CONTRIBUTING RUN-ON TO A PERVIOUS PAVEMENT FACTILITY IS A MAXIMUM OF 2:1 RATIO OF AREA CONTRIBUTING RUN-ON TO PERVIOUS PAVEMENT AREA.
3. WHEN DESIGNED TO ACCEPT RUN-ON FROM OTHER CATCHMENT AREAS, PERVIOUS PAVEMENT AREAS MUST BE PROTECTED FROM SEDIMENTATION WHICH CAN CAUSE CLOGGING AND DIMINISHED FACILITY PERFORMANCE. THE FOLLOWING REQUIREMENTS APPLY FOR RUN-ON CONTRIBUTIONS:
   - RUN-ON FROM LAWN, LANDSCAPE OR OTHER ERODIBLE SURFACES IS DISCOURAGED. IF MINOR RUN-ON FROM LAWN OR LANDSCAPE AREAS IS UNAVOIDABLE, THOSE ERODIBLE AREAS MUST BE FULLY STABILIZED.
   - CONCENTRATED RUN-ON SHOULD BE DISPERSED PRIOR TO DISCHARGE TO A PERVIOUS PAVEMENT FACILITY.
   - IF SUBSURFACE DELIVERY IS USED (I.E, ACTS AS AN INFILTRATION DEVICE) PRETREATMENT AND FLOW DISTRIBUTION ARE REQUIRED.
4. WEARING COURSE FOR PAVERS SHALL BE SET $\frac{1}{4}$ INCH HIGHER THAN FINAL ELEVATION TO ALLOW FOR SETTLING AFTER CONSTRUCTION.
5. WEARING COURSE SHALL HAVE A MINIMUM SURFACE SLOPE OF 0.5% TO ALLOW FOR SURFACE OVERFLOW AND A MAXIMUM SURFACE SLOPE AS LISTED BELOW:
   a. POROUS ASPHALT SURFACE: = 5 PERCENT SLOPE
   b. PERVIOUS CONCRETE SURFACE: = 10 PERCENT SLOPE
   c. PERMEABLE PAVERS OR PERMEABLE INTERLOCKING PAVERS: = 10 PERCENT SLOPE (PER MANUFACTURER'S RECOMMENDATION)
   d. SLOPES EXCEEDING 2% TYPICALLY REQUIRE SUBSURFACE CHECKDAMS.
6. WHILE THERE IS NO MAXIMUM SLOPE FOR THE SUBGRADE UNDER THE PERVIOUS PAVEMENT COURSES, THERE MAY BE ENGINEERING CHALLENGES ASSOCIATED WITH SUBSURFACE CHECK DAM REQUIREMENTS ON SUBGRADE SLOPES EXCEEDING 5%. SEE SUBSURFACE CHECK DAMS (**PC 2.1** AND **PC 2.2**).
7. PERMEABLE GEOTEXTILES MAY BE USED ALONG BASE AND SIDES. IMPERMEABLE LINERS MAY BE USED ALONG SIDES. IMPERMEABLE LINERS MAY NOT BE USED ALONG BASE.
8. REFER TO SECTION 6.10 OF THE SCVURPPP C.3 STORMWATER HANDBOOK (2024) FOR MORE DETAILED INFORMATION REGARDING SITING AND DESIGN GUIDELINES FOR PERVIOUS PAVEMENT.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ PERVIOUS PAVEMENT SPECIFICATIONS AND/OR PAVER TYPE AND GAP WIDTH
- ☐ PERVIOUS PAVEMENT WIDTH AND LENGTH
- ☐ ELEVATIONS AND CONTROL POINTS AT EVERY CORNER OR POINT OF TANGENCY
- ☐ THICKNESS OF EACH LAYER IN THE PAVEMENT SECTION
- ☐ JOINT SPACING AND TYPE
- ☐ SUBGRADE SLOPE
- ☐ SUBSURFACE CHECK DAM SPACING, HEIGHT, AND TYPE
- ☐ ELEVATIONS OF EACH PIPE INLET AND OUTLET INVERT
- ☐ TYPE AND DESIGN OF PERVIOUS PAVEMENT COMPONENTS (E.G., EDGE TREATMENTS, GEOTEXTILES, LINERS, OUTLETS, UNDERDRAINS, etc.)
- ☐ TREE PROTECTION PLAN
- ☐ SUBSURFACE UNDERDRAIN
- ☐ DETAIL OF PAVEMENT EDGE SHOWING STRUCTURAL SUPPORT AND TRANSITION TO ADJACENT SURFACE

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES		KEY MAP	SECTIONS		
PP 1.1	PP 1.2	PP 1.3	PP 2.1	PP 3.1	PP 4.1

Santa Clara Valley Urban Runoff Pollution Prevention Program

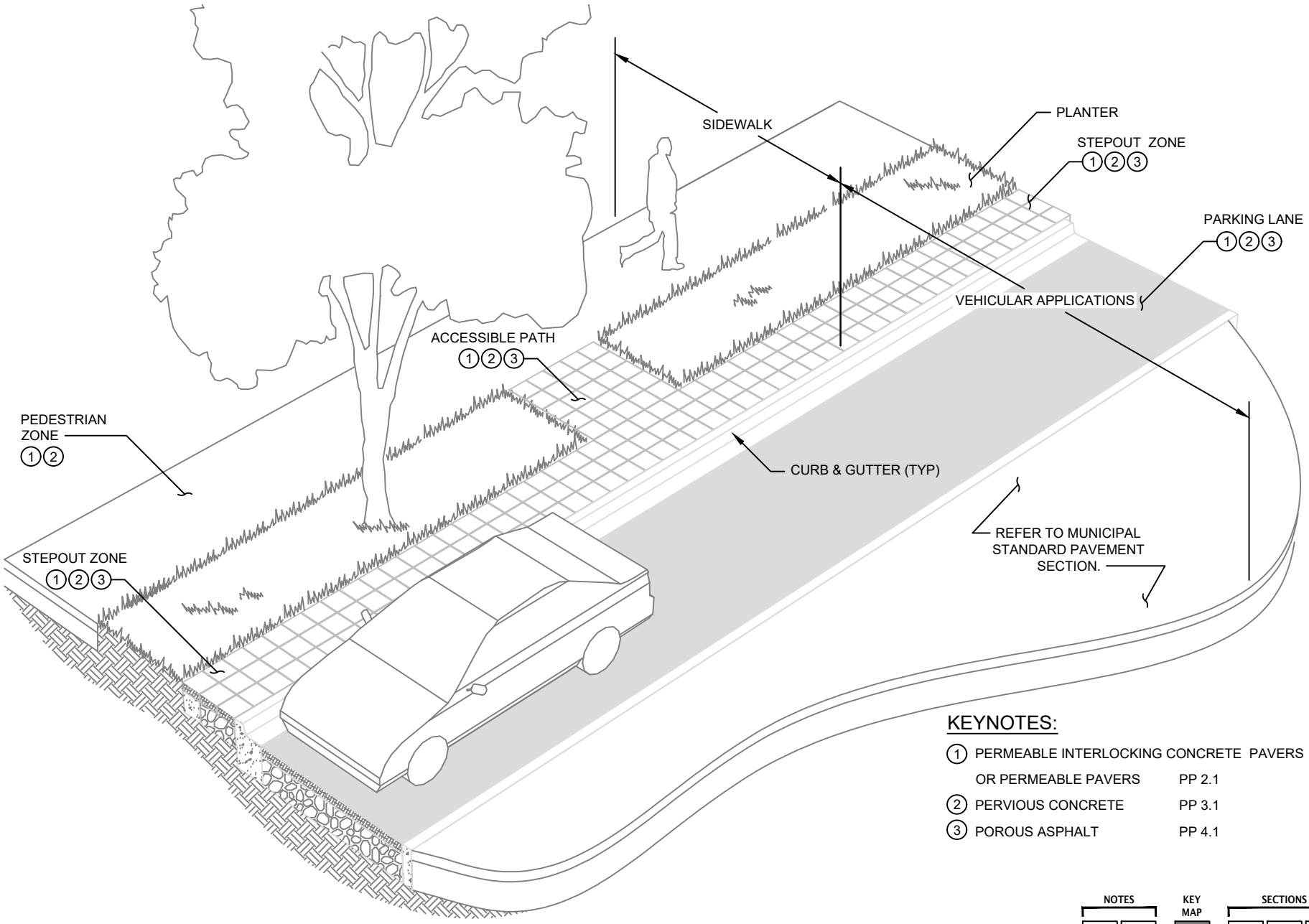
GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PP 1.2

DATE: OCTOBER 2024
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PERVIOUS PAVEMENT
DESIGNER NOTES (2 OF 2)

DWG NO. **PP 1.2**



KEYNOTES:

1. PERMEABLE INTERLOCKING CONCRETE PAVERS OR PERMEABLE PAVERS — PP 2.1
2. PERVIOUS CONCRETE — PP 3.1
3. POROUS ASPHALT — PP 4.1

NOTES		KEY MAP	SECTIONS		
PP 1.1	PP 1.2	PP 1.3	PP 2.1	PP 3.1	PP 4.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

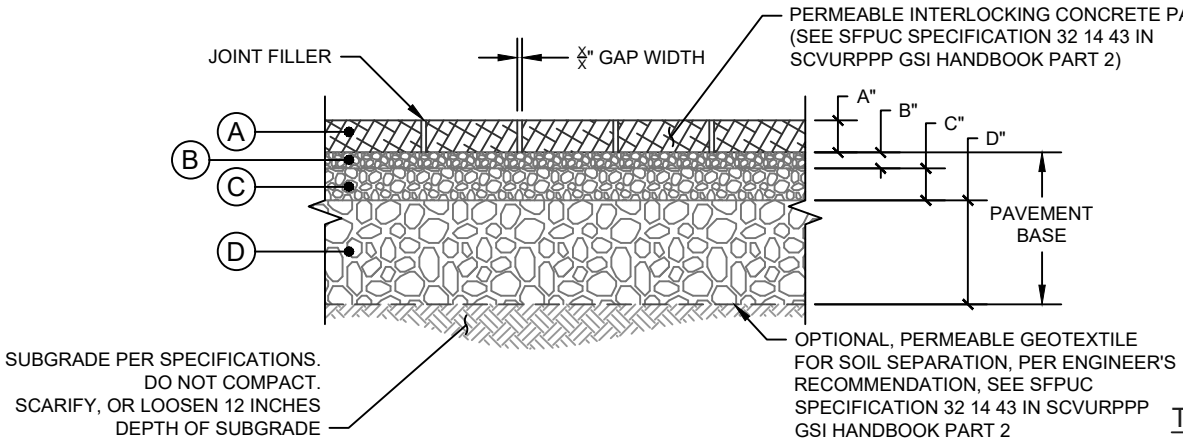
GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PP 1.3

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REVISED:

PERVIOUS PAVEMENT
KEY MAP

DWG NO. PP 1.3



PERMEABLE INTERLOCKING CONCRETE PAVERS (1)

MINIMUM MATERIAL THICKNESS (IN) GUIDANCE:

LAYER	MATERIAL TYPE*	MODERATE VEHICULAR		LIGHT VEHICULAR		PEDESTRIAN	
		GOOD SOILS**	POOR SOILS**	GOOD SOILS**	POOR SOILS**	GOOD SOILS**	POOR SOILS**
(A)	PERMEABLE INTERLOCKING CONCRETE PAVERS	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8
(B)	LEVELING COURSE ASTM NO. 8	2	2	2	2	2	2
(C)	BASE COURSE ASTM NO. 57	6	6	6	4	4	4
(D)	RESERVOIR COURSE ASTM NO. 2, 3, OR 57	22	28	-	10	-	-

* MATERIAL FINER THAN NO. 100 SIEVE SHALL NOT EXCEED 2 PERCENT FOR ANY AGGREGATE LAYER (LICENSED PROFESSIONAL TO SELECT AGGREGATE).

** "GOOD" AND "POOR" SOIL CLASSIFICATIONS BASED ON AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES. SEE DESIGNER NOTES FOR SUBGRADE ASSUMPTIONS. (LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASED ON SITE CONDITIONS).

*** FOR HEAVY VEHICLE TRAFFIC, LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASED ON EXPECTED LOADS AND SITE CONDITIONS.

TYPICAL JOINT FILLER AGGREGATE SIZE:

GAP WIDTH (IN)	JOINT FILLER AGGREGATE*
3/8 OR 1/2	ASTM NO. 8
1/4	ASTM NO. 9 OR 89

* PROVIDED FOR REFERENCE ONLY, FOLLOW MANUFACTURER'S RECOMMENDATIONS

PERVIOUS PAVERS REFER TO PAVERS THAT ALLOW WATER TO FLOW THROUGH ACTUAL UNIT PAVER WHILE PERMEABLE INTERLOCKING CONCRETE PAVERS REFER TO PAVER SYSTEMS THAT ONLY ALLOW WATER TO PASS THROUGH JOINTS.

CONSTRUCTION NOTES:

1. SEE PERMEABLE INTERLOCKING CONCRETE PAVER SPECIFICATIONS FOR WEARING COURSE, PAVEMENT BASE, SUBGRADE, AND OTHER REQUIREMENTS FOR PERMEABLE INTERLOCKING CONCRETE PAVER FACILITIES.
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO MUNICIPAL UTILITY STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSINGS AND UTILITY CONFLICTS.
3. IF UNDERDRAIN IS REQUIRED, DESIGN AND PLACEMENT IS PER ENGINEER'S RECOMMENDATION. SEE **PC 3.1-3.4**.
4. SEE **PC 1.1-1.6** FOR EDGE TREATMENT.

NOTES: PP 1.1 | PP 1.2
KEY MAP: PP 1.3
SECTIONS: PP 2.1 | PP 3.1 | PP 4.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

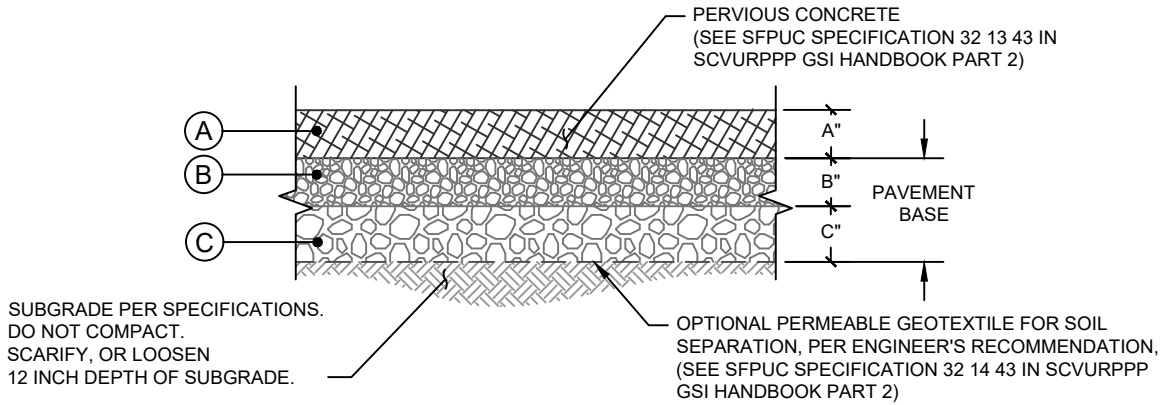
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PP 2.1

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

PERVIOUS PAVEMENT

MATERIAL SECTIONS PERMEABLE INTERLOCKING CONCRETE PAVERS

DWG NO. PP 2.1



PERVIOUS CONCRETE (1)

MINIMUM MATERIAL THICKNESS (IN) GUIDANCE:

LAYER	MATERIAL TYPE*	MODERATE VEHICULAR		LIGHT VEHICULAR		PEDESTRIAN	
		GOOD SOILS**	POOR SOILS**	GOOD SOILS**	POOR SOILS**	GOOD SOILS**	POOR SOILS**
(A)	PERVIOUS CONCRETE	9	9.5	6.5	7	4.5	5
(B)	BASE COURSE ASTM NO. 3 OR 57	6	6	6	6	6	6
(C)	RESERVOIR COURSE ASTM NO. 2, 3, OR 57	-	-	-	-	-	-

* MATERIAL FINER THAN NO. 100 SIEVE SHALL NOT EXCEED 2 PERCENT FOR ANY AGGREGATE LAYER (LICENSED PROFESSIONAL TO SELECT AGGREGATE).

** "GOOD" AND "POOR" SOIL CLASSIFICATIONS BASED ON AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES. SEE DESIGNER NOTES FOR SUBGRADE ASSUMPTIONS. (LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASED ON SITE CONDITIONS).

***FOR HEAVY VEHICLE TRAFFIC LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASED ON EXPECTED LOAD AND SITE CONDITIONS.

CONSTRUCTION NOTES:

1. SEE PERVIOUS CONCRETE SPECIFICATIONS FOR WEARING COURSE, PAVEMENT BASE, SUBGRADE, AND OTHER REQUIREMENTS FOR PERVIOUS CONCRETE FACILITIES.
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO MUNICIPAL UTILITY STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSINGS AND UTILITY CONFLICTS.
3. IF UNDERDRAIN IS REQUIRED, DESIGN AND PLACEMENT IS PER ENGINEER'S RECOMMENDATION. SEE **PC 3.1-3.4**.
4. SEE **PC 1.1-1.6** FOR EDGE TREATMENT.
5. RESERVOIR COURSE THICKNESS SHOULD BE DETERMINED BASED ON CALCULATED WATER QUALITY DESIGN VOLUME STORAGE REQUIREMENTS AND STRUCTURAL REQUIREMENTS FOR EXPECTED LOAD.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES		KEY MAP	SECTIONS		
PP 1.1	PP 1.2	PP 1.3	PP 2.1	PP 3.1	PP 4.1

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

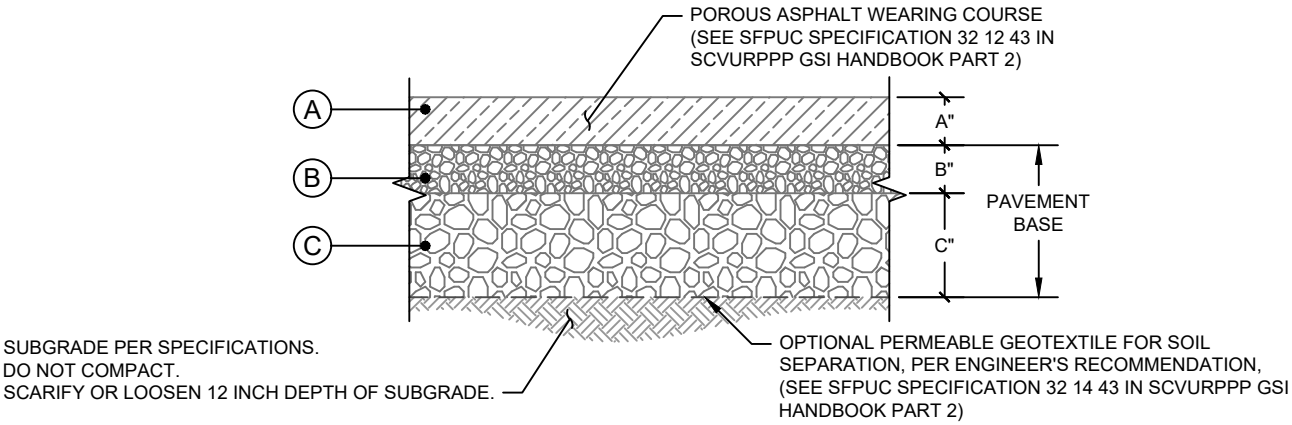
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PP 3.1

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VERSION: 2.0
REVISED:

PERVIOUS PAVEMENT

MATERIAL SECTIONS
PERVIOUS CONCRETE

DWG NO. PP 3.1



POROUS ASPHALT 1

MINIMUM MATERIAL THICKNESS (IN) GUIDANCE:

LAYER	MATERIAL TYPE*	MODERATE VEHICULAR		LIGHT VEHICULAR		PEDESTRIAN	
		GOOD SOILS**	POOR SOILS**	GOOD SOILS**	POOR SOILS**	GOOD SOILS**	POOR SOILS**
A	POROUS ASPHALT	6	8	4	4	3	4
B	BASE COURSE ASTM NO. 57	6	6	5	4	6	4
C	RESERVOIR COURSE ASTM NO. 2, 3, OR 57	10	19	-	11	-	8

* MATERIAL FINER THAN NO. 100 SIEVE SHALL NOT EXCEED 2 PERCENT FOR ANY AGGREGATE LAYER (LICENSED PROFESSIONAL TO SELECT AGGREGATE).

** "GOOD" AND "POOR" SOIL CLASSIFICATIONS BASED ON AASHTO GUIDE FOR DESIGN OF PAVEMENT STRUCTURES. SEE DESIGNER NOTES FOR SUBGRADE ASSUMPTIONS. (LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASED ON SITE CONDITIONS).

***FOR HEAVY VEHICLE TRAFFIC LICENSED PROFESSIONAL MUST CALCULATE REQUIRED DEPTH BASE ON EXPECTED LOAD AND SITE CONDITIONS.

CONSTRUCTION NOTES:

1. SEE POROUS ASPHALT SPECIFICATIONS FOR WEARING COURSE, PAVEMENT BASE, SUBGRADE, AND OTHER REQUIREMENTS FOR POROUS ASPHALT FACILITIES.
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO MUNICIPAL UTILITY STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSINGS AND UTILITY CONFLICTS.
3. IF UNDERDRAIN IS REQUIRED, DESIGN AND PLACEMENT IS PER ENGINEER'S RECOMMENDATION, SEE **PC 3.1-3.4**.
4. SEE **PC 1.1-1.6** FOR EDGE TREATMENT.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES		KEY MAP	SECTIONS		
PP 1.1	PP 1.2	PP 1.3	PP 2.1	PP 3.1	PP 4.1

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PP 4.1

DATE: OCTOBER 2024
VERSION: 2.0
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PERVIOUS PAVEMENT
MATERIAL SECTIONS
POROUS ASPHALT

DWG NO. PP 4.1

PERVIOUS PAVEMENT COMPONENTS

PURPOSE:

EDGE TREATMENTS ARE USED TO STABILIZE AND PROVIDE STRUCTURAL INTEGRITY AT THE EDGE OF THE PERVIOUS PAVEMENT AND CONTAIN WATER WITHIN THE PERVIOUS PAVEMENT SECTION.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. ALL EDGE TREATMENT SYSTEMS MUST BE DESIGNED BY A LICENSED ENGINEER BASED ON SITE SPECIFIC CONDITIONS.
3. MINIMUM EDGE TREATMENT EMBEDMENT KEY DEPTHS ARE SPECIFIED TO PREVENT LATERAL SEEPAGE UNDER THE EDGE TREATMENT AND INTO ADJACENT PAVEMENT SECTIONS. DEEPER EMBEDMENT MAY BE REQUIRED UNDER SOME CONDITIONS.
4. FOR DEEP PAVEMENT SECTIONS, EDGE TREATMENT NOT REQUIRED TO EXTEND MORE THAN 12 INCHES BELOW WEARING COURSE PROVIDED REQUIREMENTS AT INTERFACE WITH IMPERMEABLE PAVEMENTS ARE SATISFIED.
5. USE THE EDGE TREATMENT KEY MAP ON **PC 1.2** TO IDENTIFY WHERE EACH TYPE OF EDGE TREATMENT IS REQUIRED OR ALLOWED.
6. IF TREES ARE PRESENT WITHIN CONSTRUCTION AREA PREPARE A TREE PROTECTION PLAN IN CONSULTATION WITH MUNICIPAL ARBORIST.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ EDGE TREATMENT TYPE AND MATERIAL
- ☐ EDGE TREATMENT WIDTH AND HEIGHT
- ☐ EMBEDMENT KEY DEPTH IF DIFFERENT THAN THE PROVIDED MINIMUMS

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION PC 1.1

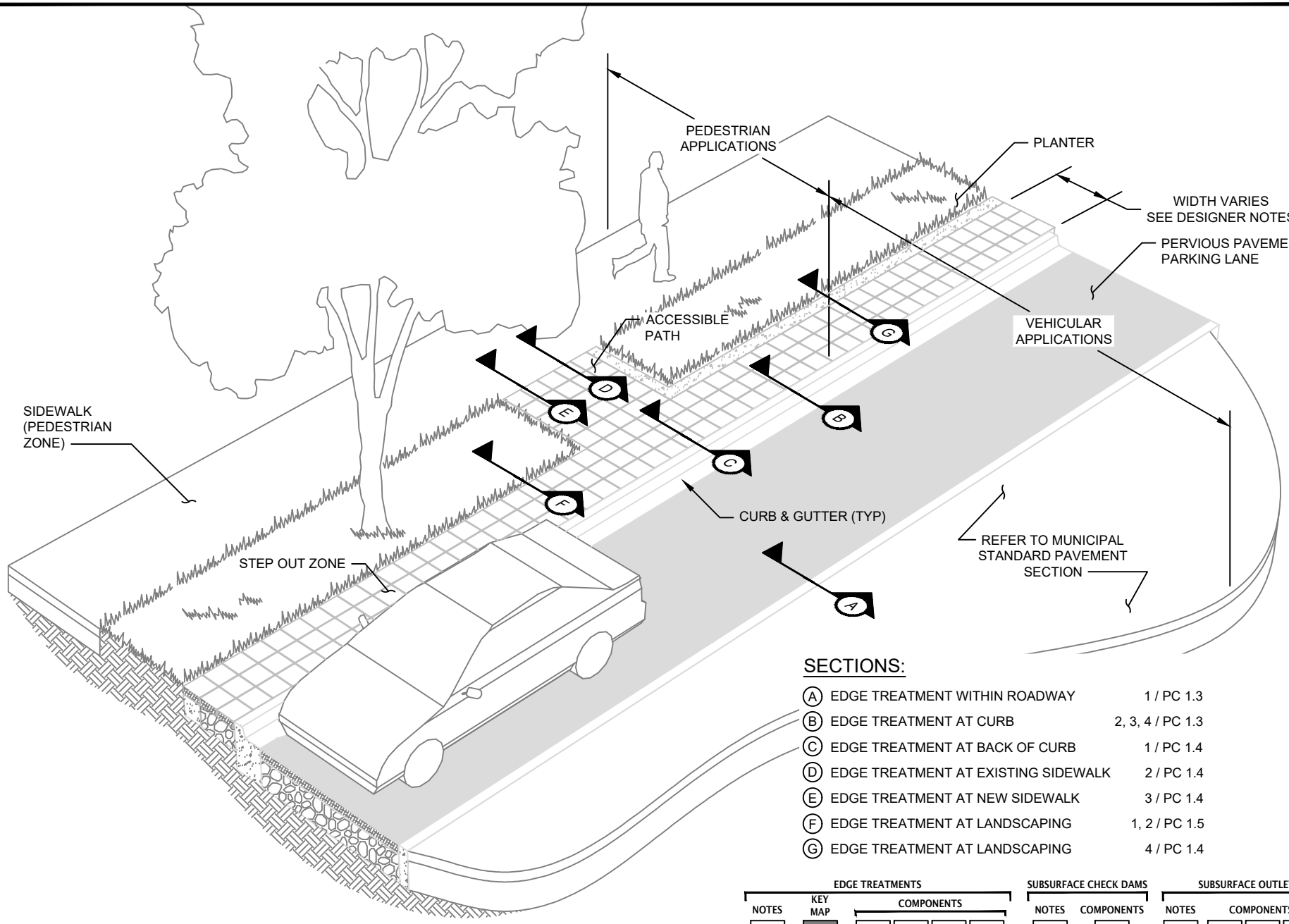
DATE: OCTOBER 2024
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REVISED:

PAVEMENT COMPONENTS

EDGE TREATMENT DESIGNER NOTES

DWG NO. PC 1.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



SECTIONS:

(A)	EDGE TREATMENT WITHIN ROADWAY	1 / PC 1.3
(B)	EDGE TREATMENT AT CURB	2, 3, 4 / PC 1.3
(C)	EDGE TREATMENT AT BACK OF CURB	1 / PC 1.4
(D)	EDGE TREATMENT AT EXISTING SIDEWALK	2 / PC 1.4
(E)	EDGE TREATMENT AT NEW SIDEWALK	3 / PC 1.4
(F)	EDGE TREATMENT AT LANDSCAPING	1, 2 / PC 1.5
(G)	EDGE TREATMENT AT LANDSCAPING	4 / PC 1.4

EDGE TREATMENTS							SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS					NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6		PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

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Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

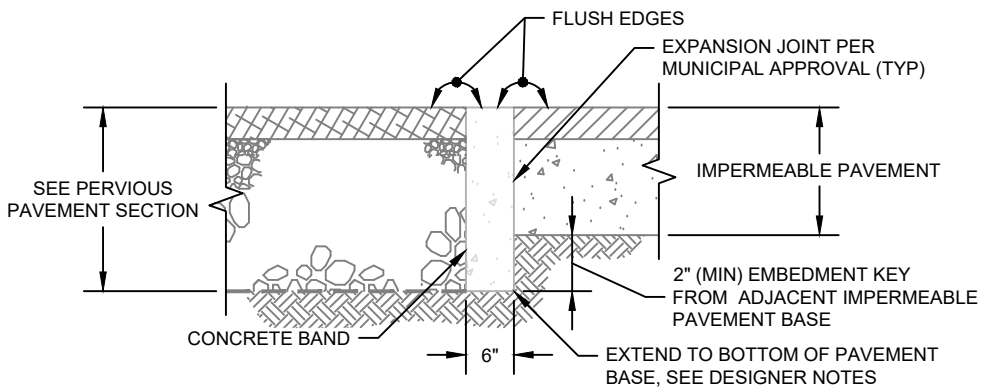
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VERSION: 2.0
REVISED:

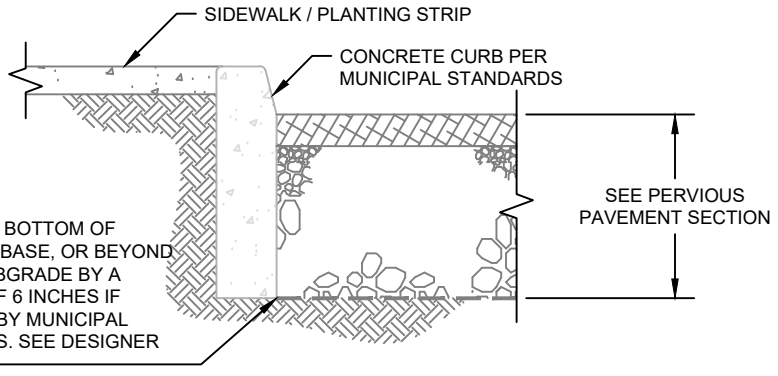
PAVEMENT COMPONENTS

EDGE TREATMENT KEY MAP

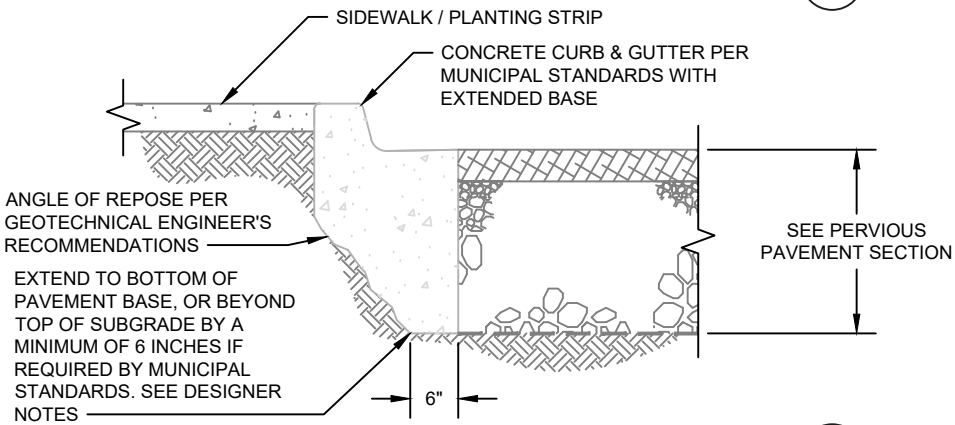
DWG NO. PC 1.2



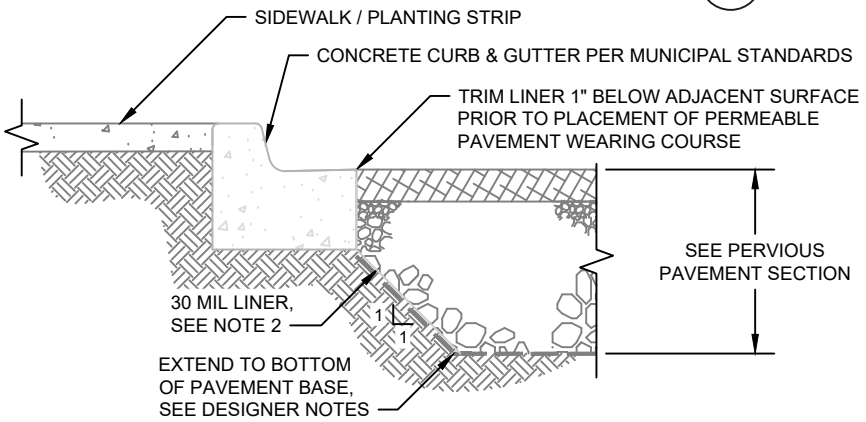
CONCRETE BAND WITHIN PAVED AREA — 1



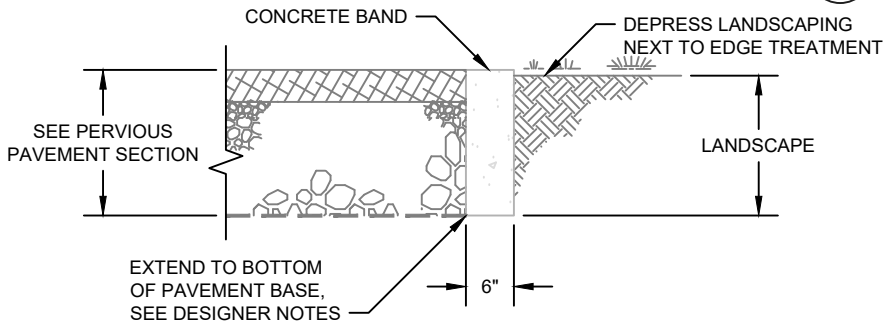
DEEPENED STANDARD CURB — 2



DEEPENED STANDARD CURB AND GUTTER — 3



IMPERMEABLE LINER AT STANDARD CURB AND GUTTER — 4



CONCRETE BAND AT LANDSCAPE — 5

CONSTRUCTION NOTES:

1. ALL MATERIAL REINFORCEMENT, AND WORKMANSHIP FOR EDGE TREATMENTS, SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. LINER SHALL BE HDPE CONFORMING TO GEOSYNTHETIC RESEARCH INSTITUTE (GRI) GM13 OR LLDPE CONFORMING TO GRI GM 17.
3. DETAIL 4 REQUIRES REVIEW BY LICENSED GEOTECHNICAL AND STRUCTURAL ENGINEERS FOR APPLICABILITY IN PUBLIC RIGHT-OF-WAY.

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PC 1.3

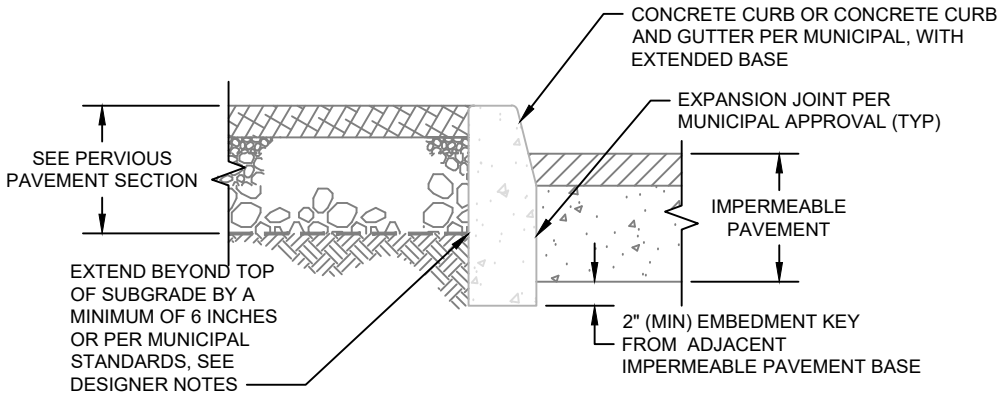
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PAVEMENT COMPONENTS

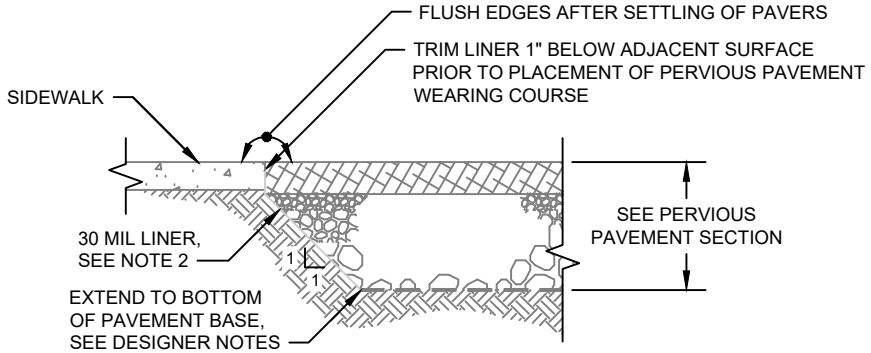
EDGE TREATMENTS
VEHICULAR APPLICATIONS

DWG NO. PC 1.3

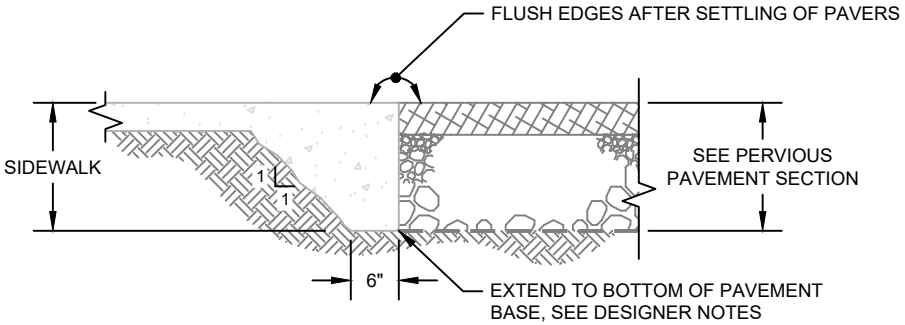
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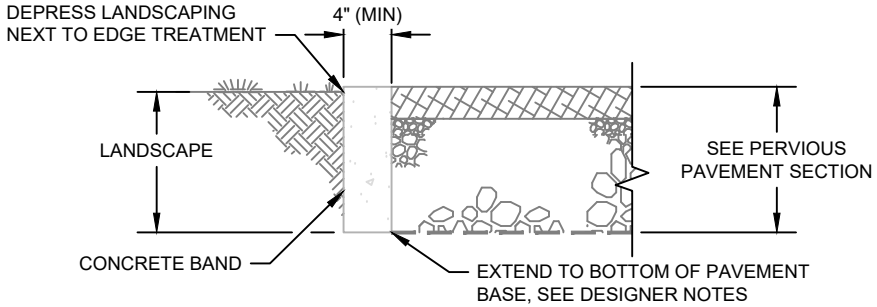
DEEPENED STANDARD CURB / CURB AND GUTTER 1



IMPERMEABLE LINER AT EXISTING SIDEWALK 2



THICKENED EDGE AT NEW SIDEWALK 3



CONCRETE BAND AT LANDSCAPE 4

CONSTRUCTION NOTES:

1. ALL MATERIAL REINFORCEMENT, AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. LINER SHALL BE HDPE CONFORMING TO GEOSYNTHETIC RESEARCH INSTITUTE (GRI) GM13 OR LLDPE CONFORMING TO GRI GM 17.
3. LINER DESIGN MUST BE REVIEWED BY A GEOTECHNICAL AND STRUCTURAL ENGINEER.
4. PROTECT EXISTING TREES AND TREE ROOTS PER ARBORIST RECOMMENDATIONS (FOR EXAMPLE WITHIN THE DRIP LINE).

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

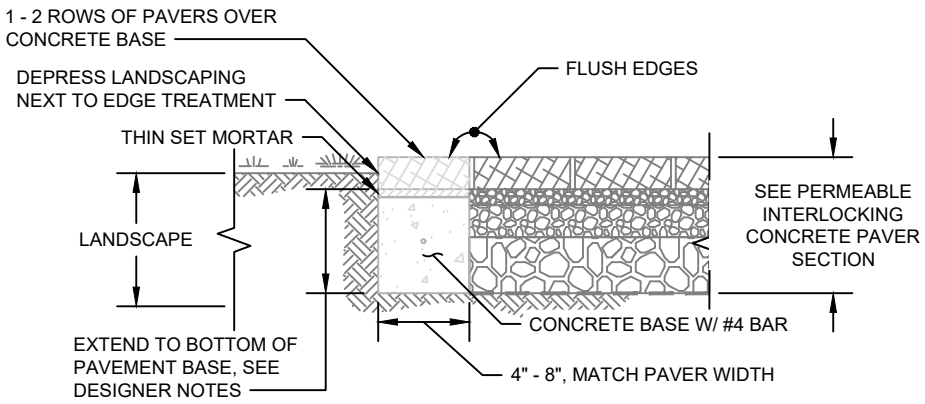
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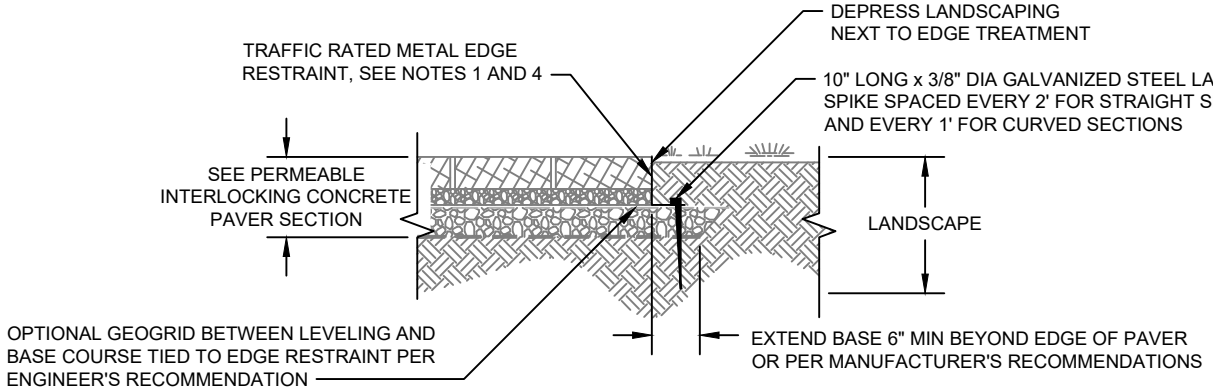
PAVEMENT COMPONENTS
EDGE TREATMENTS
PEDESTRIAN APPLICATIONS (1 OF 2)

DWG NO. PC 1.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



MORTARED PAVER AT LANDSCAPE 1



METAL PAVER EDGE AT LANDSCAPE 2

CONSTRUCTION NOTES:

1. ALL MATERIAL REINFORCEMENT, AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. COORDINATE WITH MUNICIPALITY IF STEEL IS REQUIRED OR ALLOWED IN RIGHT OF WAY.
3. PROTECT EXISTING TREES AND TREE ROOTS PER ARBORIST RECOMMENDATIONS (FOR EXAMPLE WITHIN THE DRIP LINE).
4. SET METAL EDGE 1/2" (MAX) BELOW EDGE OF PAVER.

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

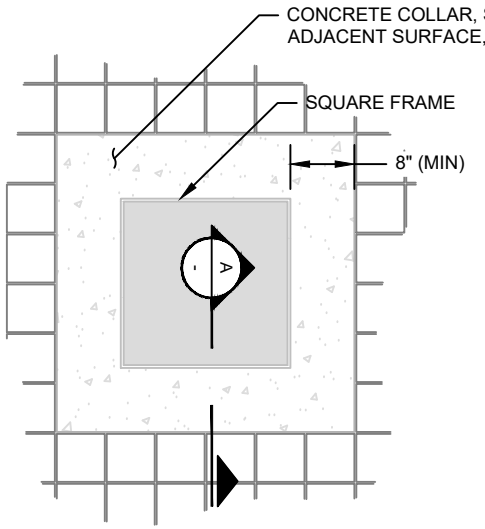
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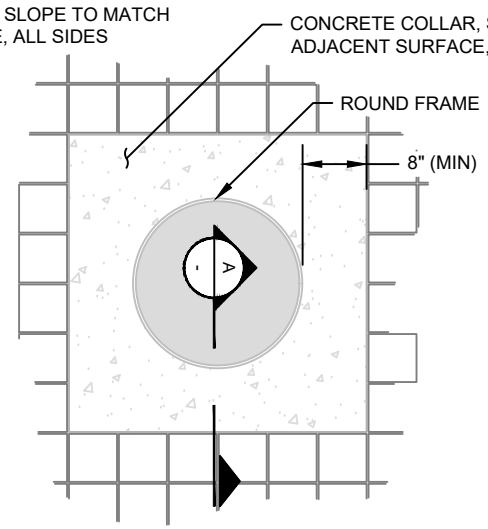
PAVEMENT COMPONENTS
EDGE TREATMENTS
PEDESTRIAN APPLICATIONS (2 OF 2)

DWG NO. PC 1.5

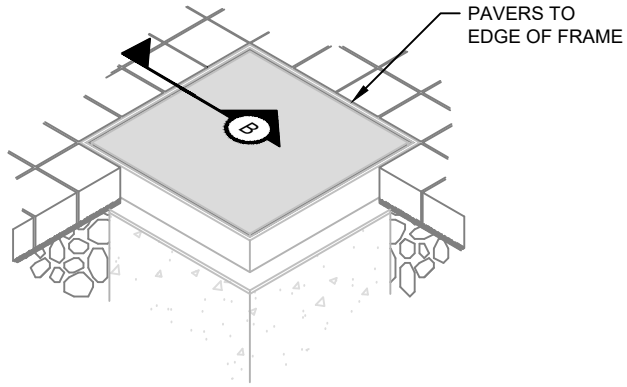
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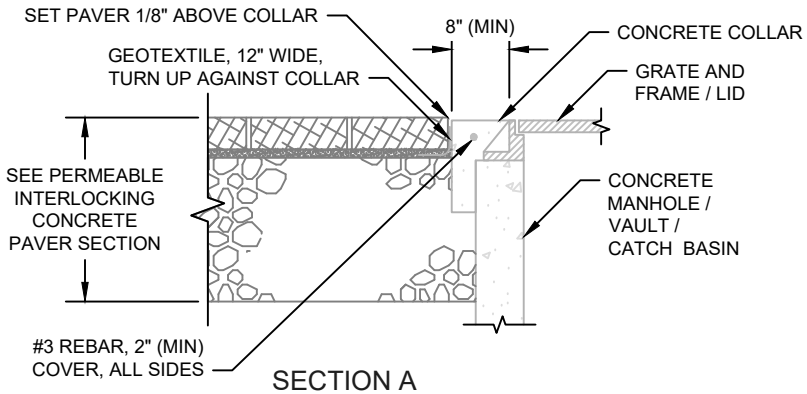
PLAN - SQUARE FRAME



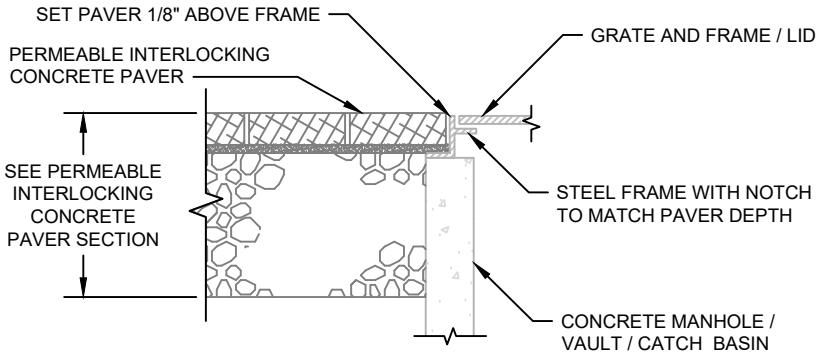
PLAN - ROUND FRAME



ISOMETRIC - SQUARE FRAME



SECTION A



SECTION B

PERMEABLE INTERLOCKING CONCRETE PAVER EDGE AT STRUCTURE - VEHICULAR APPLICATIONS (1)

PERMEABLE INTERLOCKING CONCRETE PAVER EDGE AT STRUCTURE - PEDESTRIAN APPLICATIONS (2)

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. PROTECT EXISTING TREES AND TREE ROOTS PER ARBORIST RECOMMENDATIONS (FOR EXAMPLE WITHIN THE DRIP LINE).

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PC 1.6

DATE: OCTOBER 2024
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PAVEMENT COMPONENTS

EDGE TREATMENTS
PAVER AT STRUCTURES

DWG NO. **PC 1.6**

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PURPOSE:

PERVIOUS PAVEMENT FACILITIES MUST BE DESIGNED TO PROVIDE SUBSURFACE STORAGE OF STORMWATER TO ALLOW TIME FOR THE WATER TO INFILTRATE INTO THE UNDERLYING SOIL. SLOPED FACILITIES ON POOR SOILS HAVE AN INCREASED POTENTIAL FOR LATERAL FLOWS THROUGH THE STORAGE RESERVOIR COURSE ALONG THE TOP OF THE RELATIVELY IMPERMEABLE SUBGRADE SOIL. THIS REDUCES THE STORAGE AND INFILTRATION CAPACITY OF THE PAVEMENT SYSTEM. SUBSURFACE DETENTION STRUCTURES, OR CHECK DAMS, CAN BE INCORPORATED INTO THE SUBGRADE AND ALIGNED PERPENDICULAR TO THE LONGITUDINAL SUBGRADE SLOPE TO CREATE PONDING IN THE AGGREGATE STORAGE RESERVOIR COURSE TO DETAIN SUBSURFACE FLOW, INCREASE INFILTRATION, AND REDUCE STRUCTURAL PROBLEMS ASSOCIATED WITH SUBGRADE EROSION ON SLOPES.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. WHILE THE DESIGNER MUST DETERMINE IF CHECK DAMS ARE NECESSARY BASED ON SITE-SPECIFIC CONDITIONS, SOME GENERAL GUIDELINES ARE PROVIDED BELOW:

SUBGRADE SOILS	SUBGRADE SLOPE	RUNON FROM OTHER AREAS	CHECK DAM REQUIRED
TYPE A/B	ANY	ALLOWED	NO
TYPE C/D	≤ 2%	NOT ALLOWED	NO
	≤ 2%	ALLOWED	NO*
	> 2%	ALLOWED	YES

* RECOMMENDED FOR SUBSURFACE FLOW PATHS OVER 50 FEET

3. THE DESIGNER MUST ESTABLISH THE HEIGHT AND SPACING OF THE CHECK DAMS BASED ON THE SUBGRADE SLOPE AND THE STORAGE DEPTH REQUIRED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS. THE AVERAGE DEPTH OF SUBSURFACE STORAGE ACROSS THE FACILITY AREA MUST MEET THE REQUIRED STORAGE DEPTH. REFER TO CHECK DAM SPACING GUIDANCE ON THIS DRAWING FOR CHECK DAM SPACING CALCULATIONS.
4. MAXIMUM CHECK DAM HEIGHT IS GOVERNED BY 48 HOUR DRAWDOWN REQUIREMENT AND NATIVE SOIL INFILTRATION RATE. SEE **PP 1.1** FOR ADDITIONAL GUIDANCE.
5. THE AREA OF SUBBASE COVERED BY IMPERMEABLE CHECK DAM MATERIAL SHOULD BE EXCLUDED FROM HYDROLOGIC PERFORMANCE CALCULATIONS WHEN THE AREA IS SIGNIFICANT (GREATER THAN 10 PERCENT) RELATIVE TO THE PAVEMENT AREA.
6. THE DESIGNER MUST ENSURE THAT THE RESERVOIR COURSE DEPTH IS SUFFICIENT TO ACCOMMODATE THE HEIGHT OF THE CHECK DAMS WITH THE REQUIRED MINIMUM CLEARANCE.
7. CONVEYANCE CALCULATIONS ARE REQUIRED TO EVALUATE THE NEED FOR SUBSURFACE OUTLETS (E.G., PERFORATED UNDERDRAIN PIPES SET AT THE DESIGN SUBSURFACE PONDING DEPTH) AND DOWNSLOPE OVERFLOW SYSTEM. REFER TO **PC 3.1**.
8. LOCATE CHECK DAMS TO MINIMIZE IMPACT TO UTILITY ACCESS.
9. LOCATE PERVIOUS CONCRETE CONTROL JOINTS AT CHECK DAM LOCATIONS WHEN CHECK DAM EXTENDS INTO THE STRUCTURAL PAVEMENT SECTION.
10. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ CHECK DAM TYPE AND MATERIAL
- ☐ CHECK DAM ELEVATION, HEIGHT, AND WIDTH
- ☐ CHECK DAM SPACING
- ☐ CHECK DAM CLEARANCE (MEASURED FROM BOTTOM OF WEARING COURSE)

CHECK DAM SPACING GUIDANCE:

TYPICAL MAXIMUM SPACING, $L_{SPACING,\ MAX}$ (FEET) :

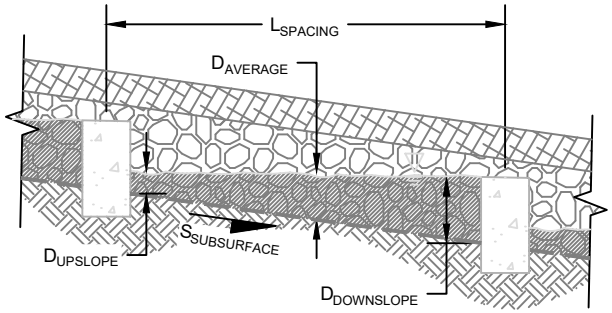
$$L_{SPACING,\ MAX} = D_{DOWNSLOPE} \div S_{SUBSURFACE}$$

$D_{DOWNSLOPE}$ = DOWNSLOPE STORAGE DEPTH (I.E. CHECK DAM HEIGHT) (FEET)
$S_{SUBSURFACE}$ = SUBSURFACE SLOPE (FT/FT)

SPACING, $L_{SPACING}$ (WHEN $L_{SPACING} \leq L_{SPACING,\ MAX}$) :

$$L_{SPACING} = \frac{2\,(D_{AVERAGE} - D_{DOWNSLOPE})}{-\,S_{SUBSURFACE}}$$

$D_{AVERAGE}$ = AVERAGE STORAGE DEPTH (FEET)



EDGE TREATMENTS: NOTES PC 1.1; KEY MAP PC 1.2; COMPONENTS PC 1.3, PC 1.4, PC 1.5, PC 1.6
SUBSURFACE CHECK DAMS: NOTES PC 2.1; COMPONENTS PC 2.2
SUBSURFACE OUTLETS: NOTES PC 3.1; COMPONENTS PC 3.2, PC 3.3, PC 3.4

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Santa Clara Valley *Urban Runoff* Pollution Prevention Program

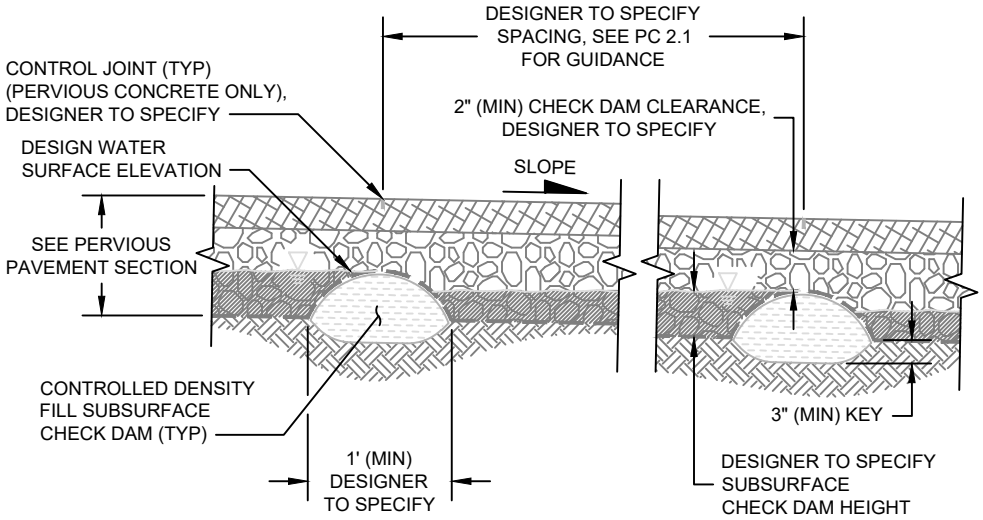
GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PC 2.1

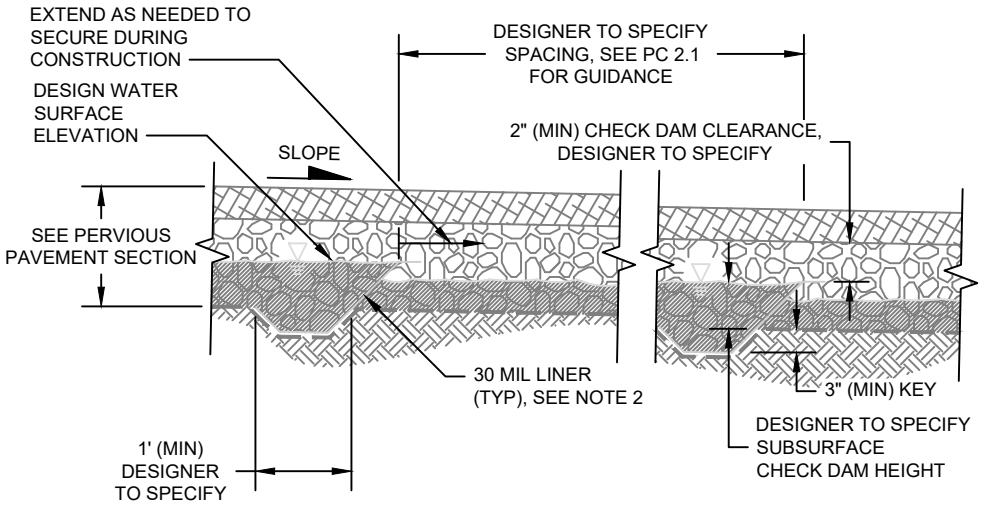
DATE: OCTOBER 2024
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REVISED:

PAVEMENT COMPONENTS
SUBSURFACE CHECK DAMS
DESIGNER NOTES

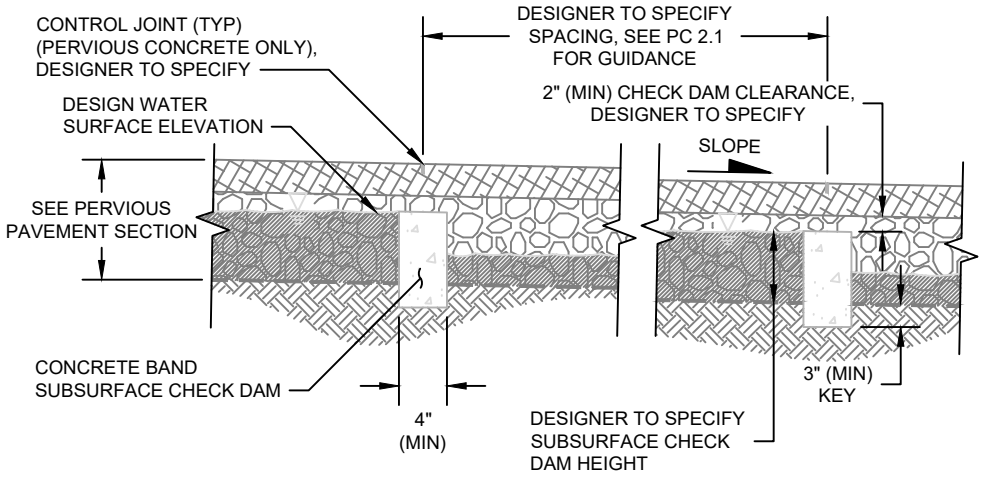
DWG NO. PC 2.1



CONTROLLED DENSITY FILL SUBSURFACE CHECK DAM 1



IMPERMEABLE LINER SUBSURFACE CHECK DAM 2



CONCRETE BAND SUBSURFACE CHECK DAM 3

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CHECK DAMS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. SEE GC 1.2, NOTE 2.
3. CONTROLLED DENSITY FILL SHALL BE 100 - 150 PSI STRENGTH WITH A WATER CONDUCTIVITY OF 1.0 X 10-6 CM/SEC (MAX) OR PER MUNICIPAL STANDARD. SEE GC 2.12.

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PC 2.2

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

PAVEMENT COMPONENTS
SUBSURFACE CHECK DAMS

DWG NO. PC 2.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

PURPOSE:

PERVIOUS PAVEMENT SUBSURFACE OVERFLOWS AND/OR UNDERDRAINS ARE DESIGNED TO CONVEY EXCESS FLOW TO AN APPROVED DISCHARGE POINT. FOR **SUBSURFACE OVERFLOW** CONFIGURATIONS, THE OVERFLOW RISER ELEVATION IS SET AT THE MAXIMUM DESIGN PONDING DEPTH IN THE PAVEMENT BASE. FOR **SUBSURFACE UNDERDRAIN** CONFIGURATIONS, THE UNDERDRAIN OUTLET ELEVATION IS SET AT THE MAXIMUM DESIGN PONDING DEPTH. WHEN CHECK DAMS ARE REQUIRED, THE CHECK DAM IS SET AT THE MAXIMUM DESIGN PONDING DEPTH IN THE PAVEMENT BASE. IN BOTH CASES, THE UNDERDRAIN IS LOCATED IN AN UNDERDRAIN TRENCH. WATER BELOW THE OVERFLOW RISER, UNDERDRAIN OUTLET ELEVATION, OR CHECK DAM ELEVATION IS TEMPORARILY STORED AND INFILTRATED INTO THE UNDERLYING SUBGRADE. UNDERDRAINS ARE ONLY RECOMMENDED WHEN AN AVAILABLE DAYLIGHT CONDITION EXISTS.

DESIGNER NOTES & GUIDELINES:

1. DESIGNERS MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. OVERFLOW IS TYPICALLY PROVIDED BY A SUBSURFACE SLOTTED OVERFLOW PIPE(S) (PREFERRED) OR PERFORRATED PIPE(S) WITH DOWNSTREAM OUTLET CONTROL OR UPSTREAM CHECK DAMS SET AT THE DESIGN PONDING ELEVATION.
3. EMERGENCY OVERFLOW FOR LARGE STORM EVENTS CAN BE PROVIDED BY SURFACE SHEET FLOW UPON INUNDATION OF THE PAVEMENT SECTION (REQUIRES SURFACE CONVEYANCE SYSTEM OR OTHER RUNOFF COLLECTION METHOD).
4. THE DESIGNER MUST CONSIDER THE FLOW PATH OF WATER WHEN THE PERMEABLE PAVEMENT SECTION IS FULLY SATURATED TO THE MAXIMUM DESIGN DEPTH TO CONFIRM THERE ARE NO UNANTICIPATED DISCHARGE LOCATIONS (E.G., INTERSECTING UTILITY TRENCHES) AND TO ENSURE THE DESIGN PROVIDES EMERGENCY OVERFLOW CONVEYANCE TO AN APPROVED DISCHARGE POINT.
5. CONVEYANCE CALCULATIONS MAY BE REQUIRED TO DESIGN THE OVERFLOW / UNDERDRAIN PIPE DIAMETER AND PIPE SPACING TO SATISFY MUNICIPAL HYDRAULIC REQUIREMENTS.
6. IF SITE CONSTRAINTS NECESSITATE USE OF OVERFLOW PIPE IN AN AREA SUBJECT TO VEHICULAR TRAFFIC OR OTHER LOADING, APPROPRIATE COVER DEPTH AND PIPE MATERIAL MUST BE DESIGNED.
7. WEARING COURSE MAY BE USED TO FULFILL MINIMUM COVER REQUIREMENTS PROVIDED WEARING COURSE IS RIGID PAVEMENT.
8. OBSERVATION PORTS ARE OPTIONAL PER LOCAL JURISDICTION BUT REQUIRED FOR LARGE SYSTEM COLLECTING RUNOFF FROM ADJACENT AREAS. REFER TO GC 4.1 AND GC 4.3.
9. OVERFLOW / UNDERDRAIN PIPES MUST BE EQUIPPED WITH CLEANOUTS. REFER TO **GC 5.2**.
10. INSTALL OVERFLOW PIPES AT DOWNGRADIENT END OF PAVEMENT. OVERFLOWS NOT REQUIRED AT EACH CHECK DAM LOCATION.
11. PIPE MATERIAL SHALL BE DESIGNED PER MUNICIPAL CODE.
12. AN OUTLET ORIFICE CONTROL DEVISE MAY BE INSTALLED TO FURTHER DETAIN OUTFLOW AND MAXIMIZE INFILTRATION. ENGINEER SHALL DESIGN, DETAIL, SPECIFY, AND CONDUCT SUPPLEMENTAL PERFORMANCE CALCULATIONS AS NEEDED.
13. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ OVERFLOW / UNDERDRAIN PIPE MATERIAL, DIAMETER, AND COVER DEPTH
- ☐ OVERFLOW / UNDERDRAIN PIPE INVERT ELEVATION AND SLOPE
- ☐ OVERFLOW / UNDERDRAIN PIPE ALIGNMENT AND DISCHARGE LOCATION

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PC 3.1

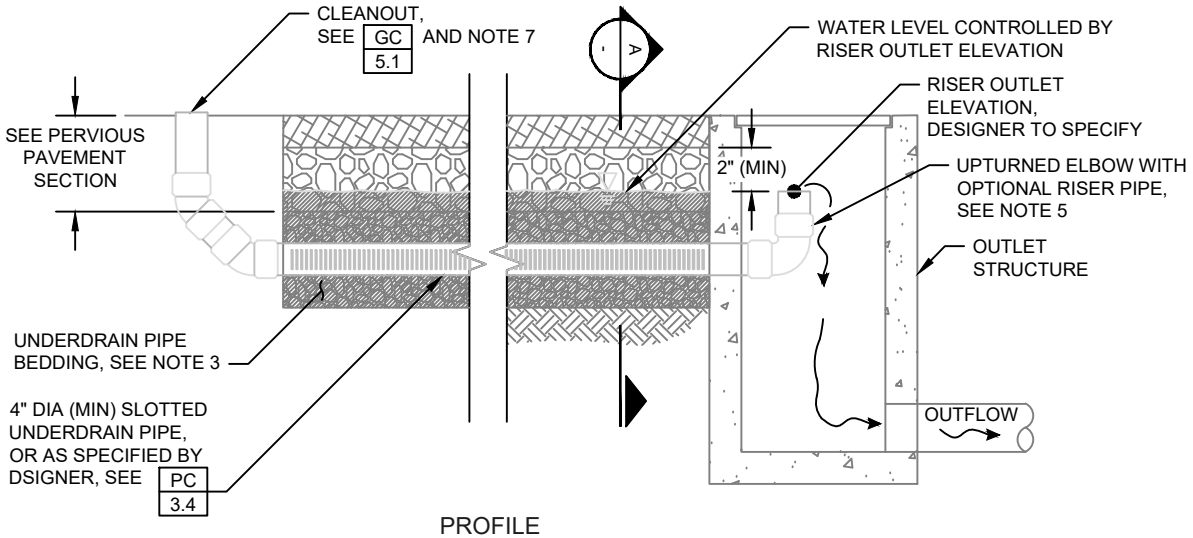
DATE: OCTOBER 2024
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PAVEMENT COMPONENTS

SUBSURFACE OVERFLOWS AND UNDERDRAINS DESIGNER NOTES

DWG NO. PC 3.1

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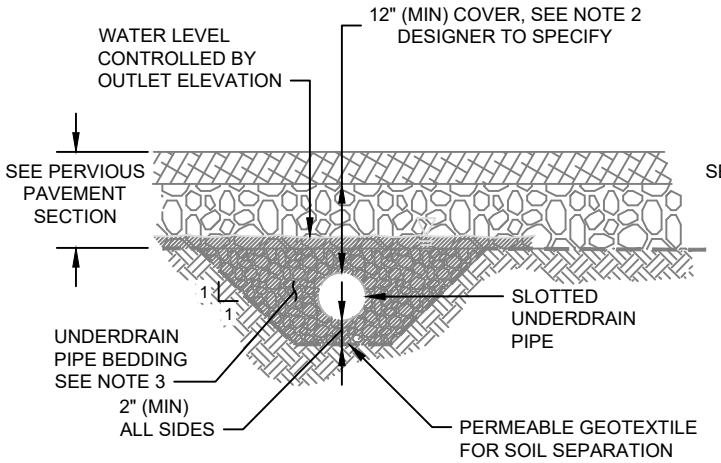


PROFILE

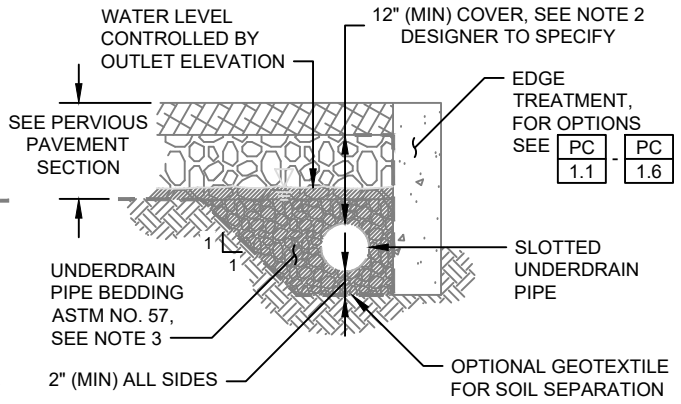
OVERFLOW CONTROL STRUCTURE WITH RISER 1

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR UNDERDRAIN STRUCTURES SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. LOCATE UNDERDRAIN PIPE BELOW STRUCTURAL PAVEMENT BASE DEPTH.
3. UNDERDRAIN PIPE BEDDING SHALL BE ASTM NO. 57 CONFORMING TO THE REQUIREMENTS OF GRAVEL BASE MATERIAL FOR PAVEMENTS, UNLESS OTHERWISE SPECIFIED.
4. FOR LONG RISER, USE 2 45-DEGREE ELBOWS OR LONG SWEEP ELBOW PER JURISDICTION.
5. DESIGNER SHALL SPECIFY NUMBER OF CLEANOUTS BASED ON LENGTH OF UNDERDRAIN.
6. SLOTTED UNDERDRAIN PIPE IS PREFERRED BUT DESIGNER MAY SPECIFY PERFORATED PIPE.
7. CONSIDER EASE OF ACCESSIBILITY BY EQUIPMENT FOR SERVICING WHEN PLACING CLEANOUT.



TRENCH



TRENCH WITH EDGE

UNDERDRAIN PIPE TRENCH SECTION A

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PC 3.2

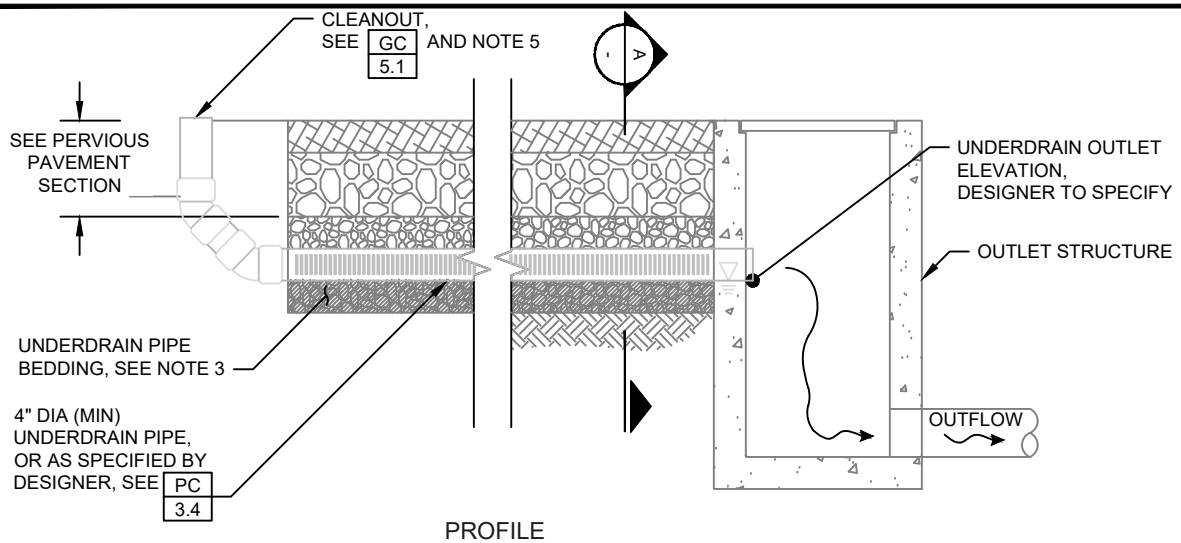
DATE: OCTOBER 2024
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PAVEMENT COMPONENTS

SUBSURFACE UNDERDRAIN WITHOUT CHECK DAM

DWG NO. PC 3.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

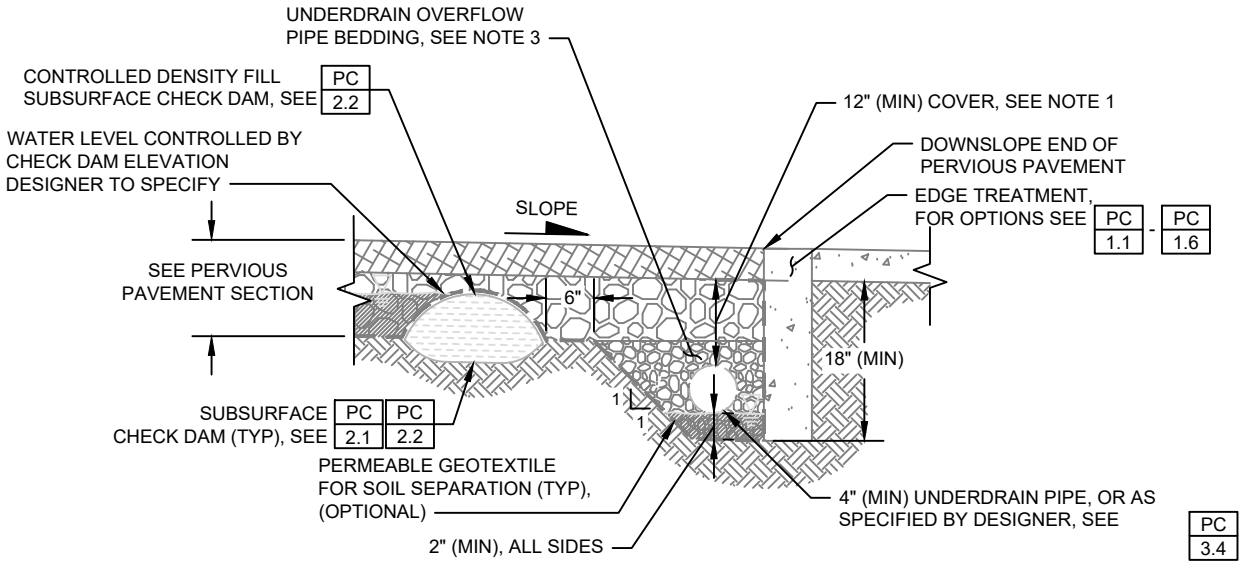


PROFILE

UNDERDRAIN WITH CHECK DAM-CONTROLLED PONDING (1)

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR OVERFLOW STRUCTURES SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. LOCATE UNDERDRAIN PIPE BELOW STRUCTURAL PAVEMENT BASE DEPTH.
3. UNDERDRAIN PIPE BEDDING SHALL BE ASTM NO. 57 CONFORMING TO THE REQUIREMENTS OF GRAVEL BASE MATERIAL FOR PAVEMENTS, UNLESS OTHERWISE SPECIFIED.
4. SLOTTED UNDERDRAIN PIPE IS PREFERRED BUT DESIGNER MAY SPECIFY PERFORATED PIPE.
5. CONSIDER EASE OF ACCESSIBILITY BY EQUIPMENT FOR SERVICING WHEN PLACING CLEANOUT.



CHECK DAM-CONTROLLED WITH UNDERDRAIN (A)

EDGE TREATMENTS							SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS					NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6		PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PC 3.3

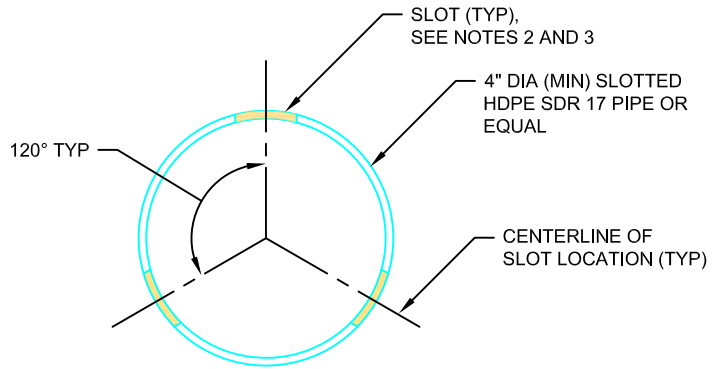
DATE: OCTOBER 2024
VERSION: 2.0
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PAVEMENT COMPONENTS

SUBSURFACE UNDERDRAIN WITH CHECK DAM

DWG NO. PC 3.3

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



SLOTTED UNDERDRAIN PIPE 2

CONSTRUCTION NOTES:

1. UNDERDRAIN PIPE SHALL BE SLOTTED HDPE SDR 17 OR ACCEPTABLE SUBSTITUTE MATERIAL (SUCH AS PERFORATED PIPE) PER ENGINEERS SPECIFICATION. SINGLE WALL AND DUAL WALL CORRUGATED HDPE PIPE (AASHTO M252 AND M294 TYPES C, S, AND D) ARE NOT ACCEPTABLE.
2. ALL PERFORATIONS SHALL BE SLOTTED TYPE, MEASURING 0.032 INCH WIDE (MAX), SPACED AT 0.25 INCH (MIN), AND PROVIDING A MINIMUM INLET AREA OF 5.0 SQUARE INCH PER LINEAR FOOT OF PIPE.
3. PERFORATIONS SHALL BE ORIENTED PERPENDICULAR TO LONG AXIS OF PIPE, AND EVENLY SPACED AROUND CIRCUMFERENCE AND LENGTH OF PIPE.

EDGE TREATMENTS						SUBSURFACE CHECK DAMS		SUBSURFACE OUTLETS			
NOTES	KEY MAP	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS		
PC 1.1	PC 1.2	PC 1.3	PC 1.4	PC 1.5	PC 1.6	PC 2.1	PC 2.2	PC 3.1	PC 3.2	PC 3.3	PC 3.4

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

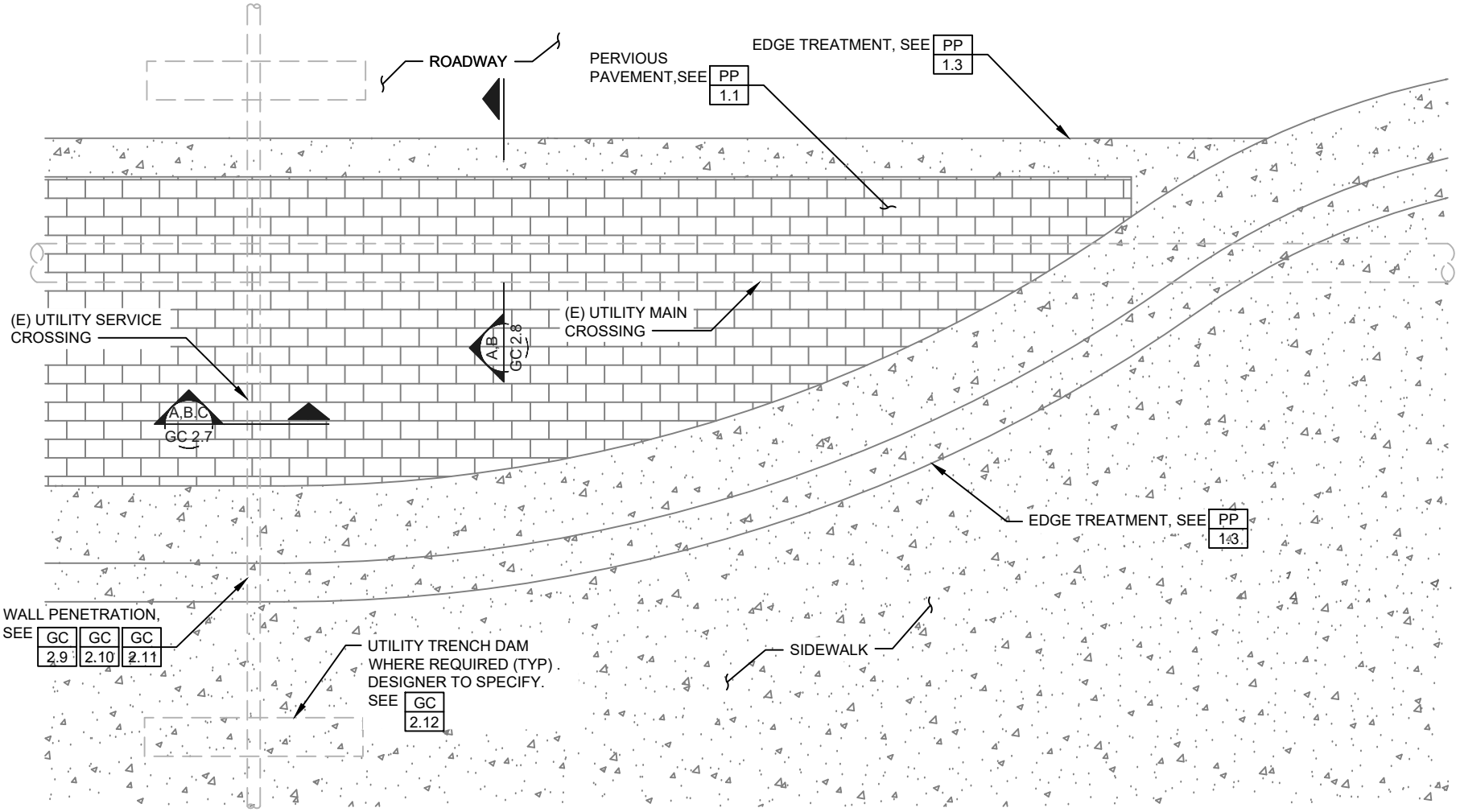
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION PC 3.4

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PAVEMENT COMPONENTS
UNDERDRAIN PIPE

DWG NO. PC 3.4

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CONSTRUCTION NOTES:

1. ABANDONED UTILITIES WITHIN FOOTPRINT OF FACILITY AND OBSERVED DURING CONSTRUCTION MUST BE REMOVED. COORDINATE WITH MUNICIPAL OR PRIVATE OWNER AND ENGINEER.
2. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.

NOTES		BIORETENTION			PERVIOUS PAVEMENT			WALL PENETRATIONS			TRENCH DAM
GC 2.1	GC 2.2	GC 2.3	GC 2.4	GC 2.5	GC 2.6	GC 2.7	GC 2.8	GC 2.9	GC 2.10	GC 2.11	GC 2.12

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

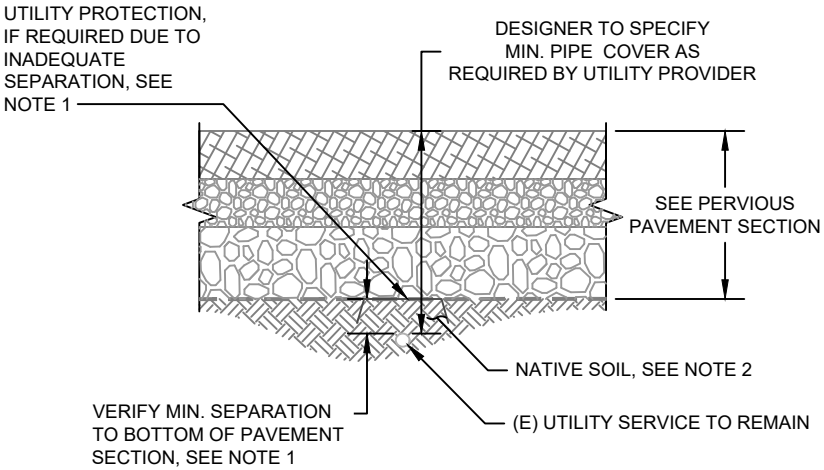
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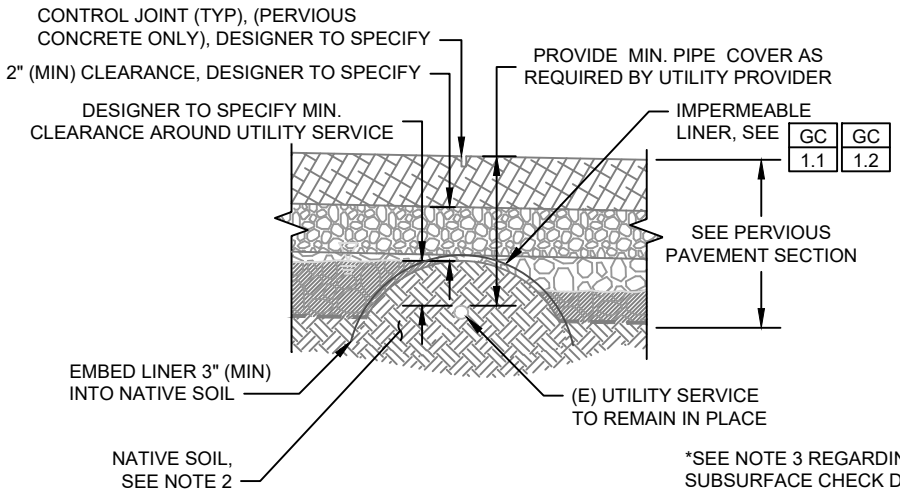
GENERAL COMPONENTS

UTILITY CROSSINGS
PERVIOUS PAVEMENT

DWG NO. GC 2.6



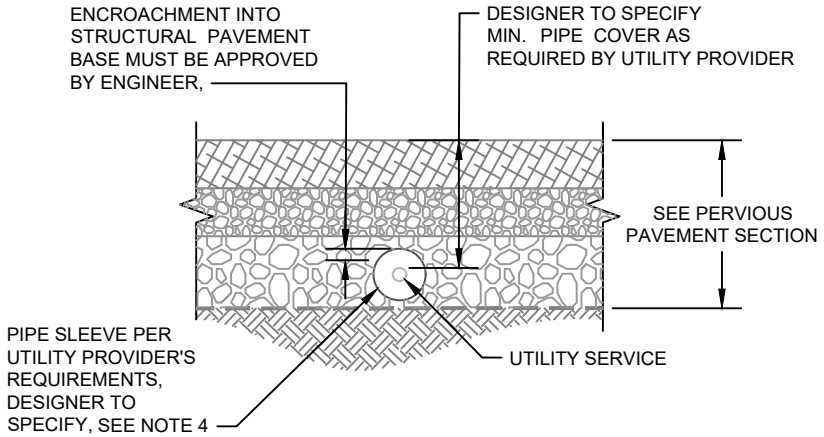
SHALLOW UTILITY SERVICE UNDER PERVIOUS PAVEMENT — A



SHALLOW UTILITY SERVICE WITHIN SUBSURFACE CHECK DAM — B

CONSTRUCTION NOTES:

1. CONTRACTOR SHALL LOCATE AND DETERMINE DEPTH OF EXISTING UTILITY WITHIN THE FOOTPRINT OF THE PERVIOUS PAVEMENT FACILITY WHILE LIMITING THE AMOUNT OF DISTURBANCE TO THE SOIL/BACKFILL MATERIAL OVER AND AROUND THE UTILITY PIPE. IF ELECTROMAGNETIC UTILITY LOCATING, POTHOLING, OR OTHER METHOD REVEALS THAT THE UTILITY PIPE DOES NOT MEET THE REQUIRED SETBACK FROM THE BOTTOM OF THE PERVIOUS PAVEMENT SECTION, THE UTILITY PROVIDER MAY REQUIRE THAT PROTECTION MEASURES, SUCH AS THOSE SHOWN ON THIS PLAN, BE IMPLEMENTED.
2. EXISTING UTILITIES AND NATIVE SOIL AROUND EXISTING UTILITIES SHOULD REMAIN IN PLACE WHERE POSSIBLE. IF A PORTION OR ALL OF THE UTILITY IS UNCOVERED DURING EXCAVATION OR EXISTING SOIL WITHIN 1 FOOT OF THE KNOWN EXISTING UTILITY IS SCARIFIED, NATIVE SOIL OR APPROVED ENGINEERED BACKFILL SHALL BE CAREFULLY PLACED AND COMPACTED AROUND THE UTILITY PER THE UTILITY PROVIDER'S REQUIREMENTS.
3. THE CHECK DAM SPACING AND HEIGHT SPECIFIED ON THE DESIGN PLANS MUST BE MAINTAINED. IF THE CHECK DAM PROTECTING THE EXISTING UTILITY WILL IMPACT THE CHECK DAM SPACING SPECIFIED ON THE PLANS, COORDINATE WITH ENGINEER.
4. UTILITY PROVIDER MAY ALLOW SHALLOW UTILITY SERVICES TO BE LEFT IN PLACE AND WRAPPED WITH A WATERTIGHT WRAP OR TAPE IN LIEU OF A SLEEVE. THIS SHOULD BE APPROVED PRIOR TO THE START OF CONSTRUCTION.



SLEEVED UTILITY SERVICE WITHIN PERVIOUS PAVEMENT — C

NOTES		BIORETENTION			PERVIOUS PAVEMENT			WALL PENETRATIONS			TRENCH DAM
GC 2.1	GC 2.2	GC 2.3	GC 2.4	GC 2.5	GC 2.6	GC 2.7	GC 2.8	GC 2.9	GC 2.10	GC 2.11	GC 2.12

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

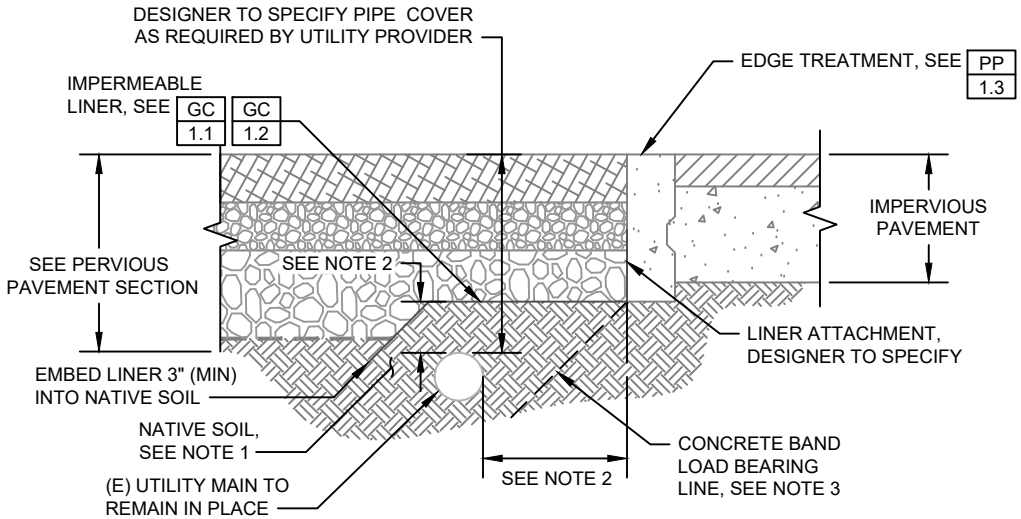
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.7

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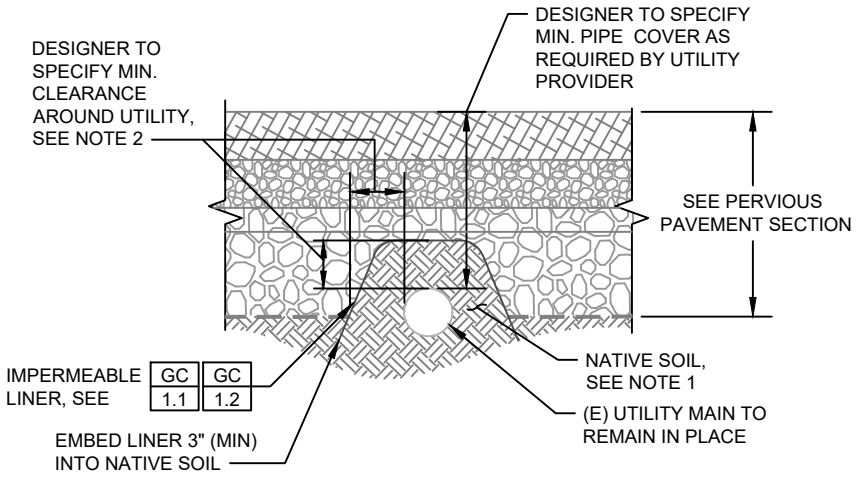
GENERAL COMPONENTS

UTILITY CROSSINGS PERVIOUS PAVEMENT SECTIONS (1 OF 2)

DWG NO. GC 2.7



UTILITY MAIN WITHIN PERVIOUS PAVEMENT AND ADJACENT TO EDGE RESTRAINT (A)



UTILITY MAIN WITHIN PERVIOUS PAVEMENT (B)

CONSTRUCTION NOTES:

1. EXISTING UTILITIES AND NATIVE SOIL AROUND EXISTING UTILITIES SHOULD REMAIN IN PLACE WHERE POSSIBLE. IF A PORTION OR ALL OF THE UTILITY IS UNCOVERED DURING EXCAVATION OR EXISTING SOIL WITHIN 1 FOOT OF THE KNOWN EXISTING UTILITY IS SCARIFIED, NATIVE SOIL OR APPROVED ENGINEERED BACKFILL SHALL BE CAREFULLY PLACED AND COMPACTED AROUND THE UTILITY PER THE UTILITY PROVIDER'S REQUIREMENTS.
2. PROVIDE THE MINIMUM CLEARANCE AROUND THE UTILITY MAIN AND SETBACKS FROM STRUCTURAL ELEMENTS PER THE UTILITY PROVIDER'S REQUIREMENTS.
3. UTILITY MAINS SHALL NOT BE SUBJECT TO LOADING FROM NEW CURBS/WALLS. LOAD BEARING LINES TO BE DETERMINED BY THE GEOTECHNICAL ENGINEER.

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.8

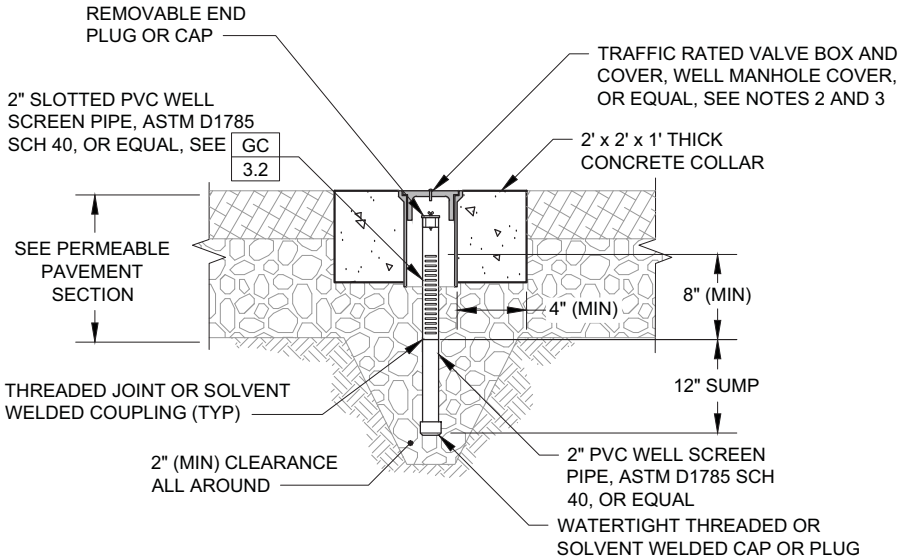
DATE: OCTOBER 2024
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REVISED:

GENERAL COMPONENTS

UTILITY CROSSINGS PERVIOUS PAVEMENT SECTIONS (2 OF 2)

DWG NO. GC 2.8

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



PVC WELL SCREEN OBSERVATION PORT (1)

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR OBSERVATION PORTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. COVER SHALL BE TRAFFIC RATED WITH TAMPER RESISTANT LOCKING MECHANISM. COVER SHALL INCLUDE CASTING OF STANDARD TRIANGLE SYMBOL, "TEST WELL", "MONITORING WELL", OR EQUAL.
3. OBSERVATION PORT COVERS AND LIDS MUST COMPLY WITH SAN FRANCISCO DPW STANDARD ACCESSIBILITY REQUIREMENTS.
4. WELL SCREEN SLOTS SHALL BE 0.032 INCHES WIDE (MAX), SPACED AT 0.25 INCH (MIN), AND PROVIDE A MINIMUM INLET AREA OF 2.0 SQUARE INCH PER LINEAR FOOT OF PIPE.
5. ALL FITTINGS SHALL BE SOIL TIGHT, UNLESS NOTED OTHERWISE.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES: GC 4.1
COMPONENTS: GC 4.2, GC 4.3

STORMWATER PLANTER (BIORETENTION)

PURPOSE:

BIORETENTION PLANTERS CAPTURE AND TREAT STORMWATER RUNOFF VIA SURFACE AND SUBSURFACE STORAGE, FILTRATION THROUGH BIOTREATMENT SOIL, AND INFILTRATION INTO NATIVE SOIL WHERE FEASIBLE. BIORETENTION PLANTERS TYPICALLY HAVE VERTICAL SIDES, AND MAY HAVE UNDERDRAINS AND IMPERMEABLE LINERS ON THE SIDES AND/OR BOTTOM OF FACILITY IF NEEDED, BASED ON SOIL CONDITIONS AND GEOTECHNICAL CONSIDERATIONS. BIORETENTION PLANTERS MAY ALSO BE REFERRED TO AS STORMWATER PLANTERS OR STORMWATER CURB EXTENSIONS (ALSO KNOWN AS BULB-OUTS) DEPENDING ON THEIR LOCATION IN THE STREETSCAPE.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. PLANTER SURFACE AREA AND PONDING DEPTH MUST BE SIZED TO MEET C.3.D SIZING REQUIREMENTS.
3. FACILITY DRAWDOWN TIME (i.e., TIME FOR SURFACE PONDING TO DRAIN THROUGH THE ENTIRE SECTION INCLUDING AGGREGATE STORAGE AFTER THE END OF A STORM) REQUIREMENTS:
   - 48 HOUR (PREFERRED) TO 72 HOUR MAXIMUM FACILITY DRAWDOWN
4. THE PLANTER WALL SLOPE IS TYPICALLY DESIGNED TO MATCH THE LONGITUDINAL SLOPE OF THE ADJACENT ROADWAY/SIDEWALK. THE FACILITY SUBGRADE, HOWEVER, SHOULD BE FLAT. CHECK DAMS MAY BE USED TO TERRACE FACILITIES TO PROVIDE SUFFICIENT PONDING FOR HIGHER-SLOPED INSTALLATIONS. DESIGNER MUST SPECIFY CHECK DAM HEIGHT AND SPACING. REFER TO **BC 6.1** AND **BC 6.2** FOR GUIDANCE ON CHECK DAM DESIGN.
5. DEPENDING ON THE HEIGHT OF THE PROPOSED PLANTER WALL, ADDITIONAL STRUCTURAL CONSIDERATIONS MAY BE REQUIRED TO ADDRESS WALL LOADING. REFER TO **BC 1.1** THROUGH **BC 1.7** FOR GUIDANCE ON EDGE TREATMENTS.
6. THE DESIGN SHOULD MINIMIZE THE HEIGHT OF EXPOSED PLANTER WALLS BETWEEN THE TOP OF SOIL AND TOP OF CURB WALL AND CONSIDER PEDESTRIAN AND VEHICLE SAFETY, ACCESSIBILITY REQUIREMENTS, AND OVERALL AESTHETICS.
7. WHEN FACILITY CONSTRUCTION IMPACTS EXISTING SIDEWALK, ALL SAW CUTS MUST ADHERE TO MUNICIPAL REQUIREMENTS. SAW CUTS SHOULD BE ALONG SCORE LINES AND ANY DISTURBED SIDEWALK FLAGS SHOULD BE REPLACED IN THEIR ENTIRETY.
8. PLANTERS IN PUBLIC RIGHT OF WAY SHALL BE DESIGNED WITH EMERGENCY OVERFLOW TO THE STREET IN THE EVENT THE PLANTER OUTLET IS OBSTRUCTED OR CLOGGED. EMERGENCY OVERFLOW MAY BE A CURB OUTLET, PLANNED OVERLAND RELEASE OR HIGH FLOW BYPASS.
9. UP TO TWO PLANTERS MAY BE CONNECTED IN SERIES, IN LIEU OF MULTIPLE INLETS, PROVIDED THE CONNECTION IS A TRENCH DRAIN OR EQUAL SURFACE CONVEYANCE AND IS ADEQUATELY SIZED TO CONVEY FLOWS.
10. PLANTER VEGETATION MUST BE SPECIFIED BY DESIGNER PER MUNICIPAL VEGETATION PALETTE OR SCVURPPP C.3 HANDBOOK APPENDIX D PLANT LIST.
11. THE DESIGNER MUST EVALUATE UTILITY SURVEYS FOR POTENTIAL UTILITY CROSSINGS OR CONFLICTS. REFER TO MUNICIPAL UTILITY CROSSING DETAILS AND UTILITY CROSSING CONFLICT DETAILS OR SCVURPPP GSI HANDBOOK UTILITY COORDINATION SECTION.
12. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT JURISDICTIONAL ASSET PROTECTION STANDARDS. IN THE ABSENCE OF THESE STANDARDS, THE DESIGNER SHALL REFER TO SCVURPPP GSI HANDBOOK FOR GUIDANCE AND COORDINATE DIRECTLY WITH RELEVANT UTILITY PROVIDERS FOR REQUIREMENTS.
13. FREEBOARD REQUIREMENTS SHOWN SHOULD BE USED AS GUIDELINES. CHECK WITH MUNICIPALITY FOR ADDITIONAL REQUIREMENTS.
14. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT JURISDICTION ASSET PROTECTION STANDARDS. IN THE ABSENCE OF THESE STANDARDS, THE DESIGNER SHALL REFER TO SCVURPPP GSI HANDBOOK FOR GUIDANCE AND COORDINATE DIRECTLY WITH RELEVANT UTILITY PROVIDERS FOR REQUIREMENTS.
15. FREEBOARD REQUIREMENTS SHOWN SHOULD BE USED AS GUIDELINES. CHECK WITH MUNICIPALITY FOR ADDITIONAL REQUIREMENTS.
16. DRAINAGE NOTCHES, IDENTIFIED IN THE DETAILS, ALLOW FOR SIDEWALK RUNOFF TO DRAIN TO PLANTER. THEY ARE NOT INTENDED FOR LARGE FLOWS. REFER TO BP 2.2 AND BP 3.2 FOR DETAILS.
17. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

RELATED COMPONENTS		
EDGE TREATMENTS:	BC 1.1	BC 1.7
INLETS:	BC 2.1	BC 2.4
OUTLETS:	BC 3.1	BC 3.4
UNDERDRAINS:	BC 5.1	BC 5.2
CHECK DAMS:	BC 6.1	BC 6.2
LINERS:	GC 1.1	GC 1.2
UTILITY CROSSINGS:	GC 2.1	GC 2.12
UTILITY CONFLICTS:	GC 3.1	GC 3.4
OBESERVATION PORTS:	GC 4.1	GC 4.3
CLEANOUTS:		GC 5.1

NOTES		W/PARKING		W/O PARKING		BULBOUT					
		PLAN SECTIONS		PLAN SECTIONS		ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BP 1.1

DATE: OCTOBER 2024
VERSION: 2.0
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BIORETENTION PLANTER

DESIGNER NOTES (1 OF 2)

DWG NO.
BP 1.1

LAYOUT REQUIREMENTS:

1. REFER TO THE MUNICIPAL DRAWINGS AND SPECIFICATIONS FOR STEP OUT ZONE, PEDESTRIAN ZONE, PARKING SPACE AND ACCESSIBLE PATH REQUIREMENTS.
2. LOCATE CURB CUTS AND GUTTER MODIFICATIONS TO AVOID CONFLICTS WITH ACCESSIBILITY REQUIREMENTS (E.G., LOCATE OUTSIDE OF CROSSWALKS).

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ PLANTER WIDTH AND LENGTH
- ☐ DEPTH OF PONDING
- ☐ DEPTH OF FREEBOARD
- ☐ DEPTH OF BIOTREATMENT SOIL
- ☐ DEPTH AND TYPE OF AGGREGATE STORAGE
- ☐ PLANTER SURFACE ELEVATION (TOP OF BIOTREATMENT SOIL) AT UPSLOPE AND DOWNSLOPE ENDS OF FACILITY
- ☐ CONTROL POINTS AT EVERY PLANTER WALL CORNER AND POINT OF TANGENCY
- ☐ DIMENSIONS AND DISTANCE TO EVERY INLET, OUTLET, CHECK DAM, SIDEWALK NOTCH, ETC.
- ☐ ELEVATIONS OF EVERY INLET, OUTLET, STRUCTURE RIM AND INVERT, CHECK DAM, PLANTER WALL CORNER, AND SIDEWALK NOTCH
- ☐ TYPE AND DESIGN OF PLANTER COMPONENTS (E.G., EDGE TREATMENTS, INLETS/GUTTER MODIFICATIONS, UTILITY CROSSINGS, LINER, AND PLANTING DETAILS)

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES		W/PARKING		W/O PARKING		BULBOUT					
		PLAN SECTIONS		PLAN SECTIONS		ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

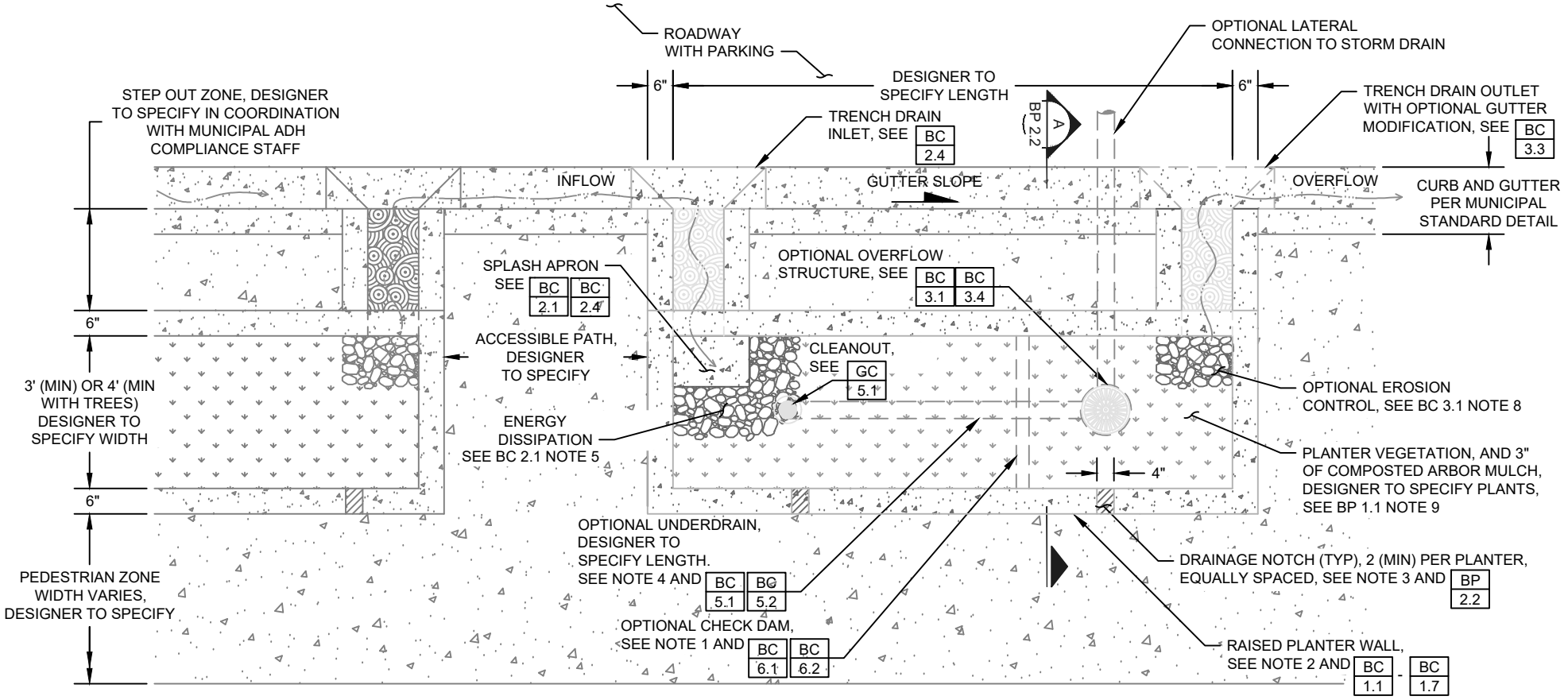
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 1.2

DATE: OCTOBER 2024
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REVISED:

BIORETENTION PLANTER

DESIGNER NOTES (2 OF 2)

DWG NO. **BP 1.2**



CONSTRUCTION NOTES:

1. CHECK DAMS (IF NEEDED) SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT MUNICIPAL STANDARDS OR SEE SCVURPPP GSI HANDBOOK UTILITY COORDINATION SECTION FOR GUIDANCE. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

NOTES		W/PARKING		W/O PARKING	BULBOUT					
		PLAN SECTIONS		PLAN SECTIONS	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1 BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 2.1

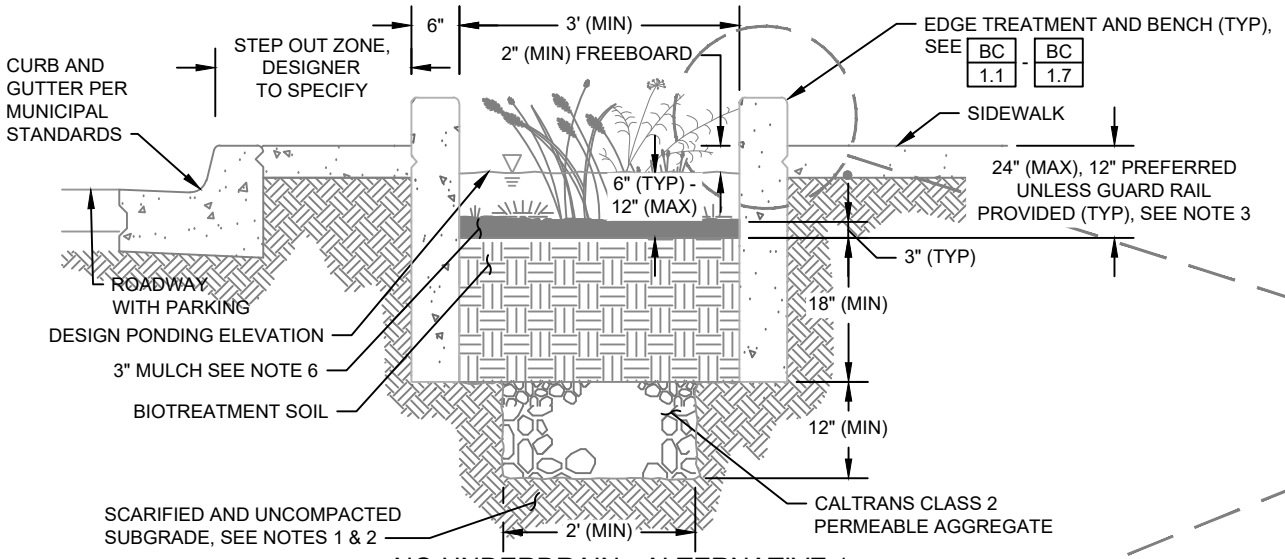
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BIORETENTION PLANTER

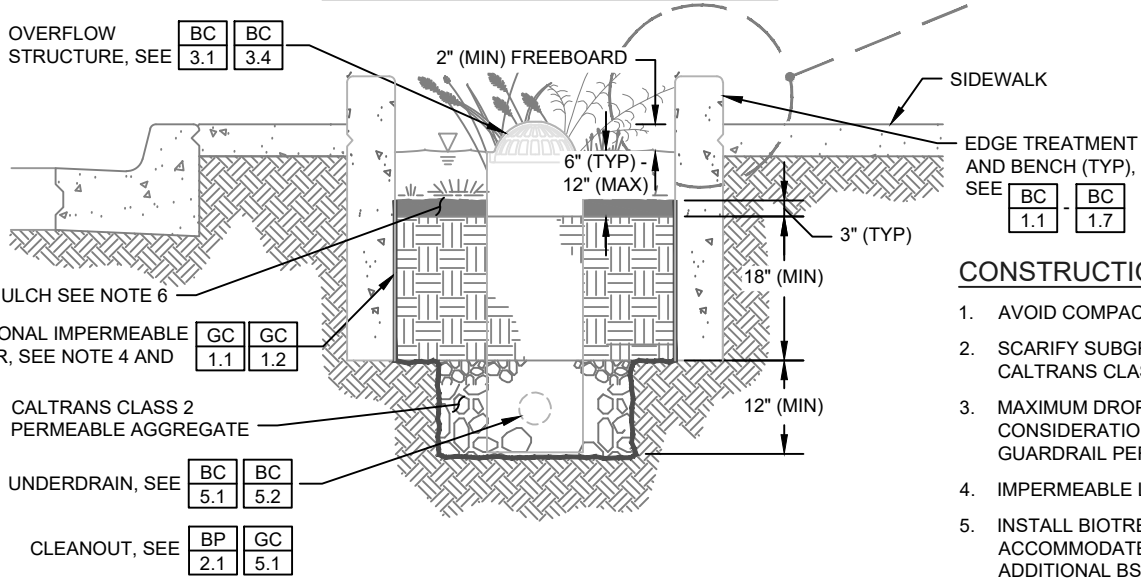
STORMWATER PLANTER WITH PARKING PLAN

DWG NO. **BP 2.1**

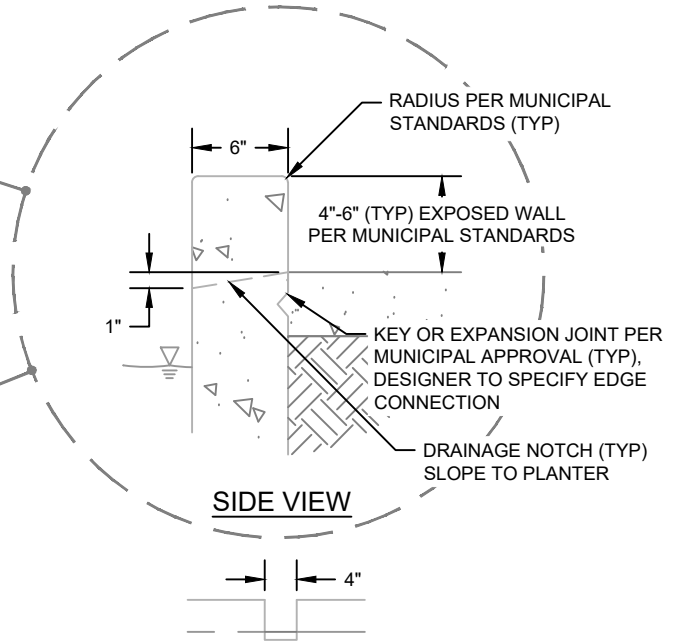
NOT FOR CONSTRUCTION - REFER TO USER GUIDE



NO UNDERDRAIN - ALTERNATIVE 1



WITH UNDERDRAIN - ALTERNATIVE 2



TYPICAL DRAINAGE NOTCH DETAIL

CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW PLANTER DURING CONSTRUCTION.
2. SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF CALTRANS CLASS 2 PERMEABLE AGGREGATE AND BIOTREATMENT SOIL MATERIAL.
3. MAXIMUM DROP FROM TOP OF SIDEWALK TO TOP OF BIOTREATMENT SOIL SHALL INCLUDE CONSIDERATIONS FOR BIOTREATMENT SOIL SETTLEMENT. ENGINEER TO EVALUATE NEED FOR GUARDRAIL PER APPLICABLE CODES.
4. IMPERMEABLE LINER SHALL ONLY BE USED WHEN STIE CONDITIONS REQUIRE USE.
5. INSTALL BIOTREATMENT SOIL MEDIA (BSM) IN EITHER TWO 10" LIFTS AND THEN WETTED TO ACCOMMODATE AN EXPECTED 2" OF SETTLING OR THREE 6" LIFTS THEN WETTED WITH ADDITIONAL BSM ADDED TO THE SURFACE AS NEEDED TO ACHIEVE A FINAL DEPTH OF 18".
6. WOOD MULCH AND ROCK MULCH OPTIONS DISCUSSED IN SCVURPPP GSI HANDBOOK SECTION 3.6 LANDSCAPE DESIGN.

NOTES		W/PARKING		W/O PARKING		BULBOUT					
		PLAN	SECTIONS	PLAN	SECTIONS	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

BIORETENTION PLANTER WITH PARKING (A)

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

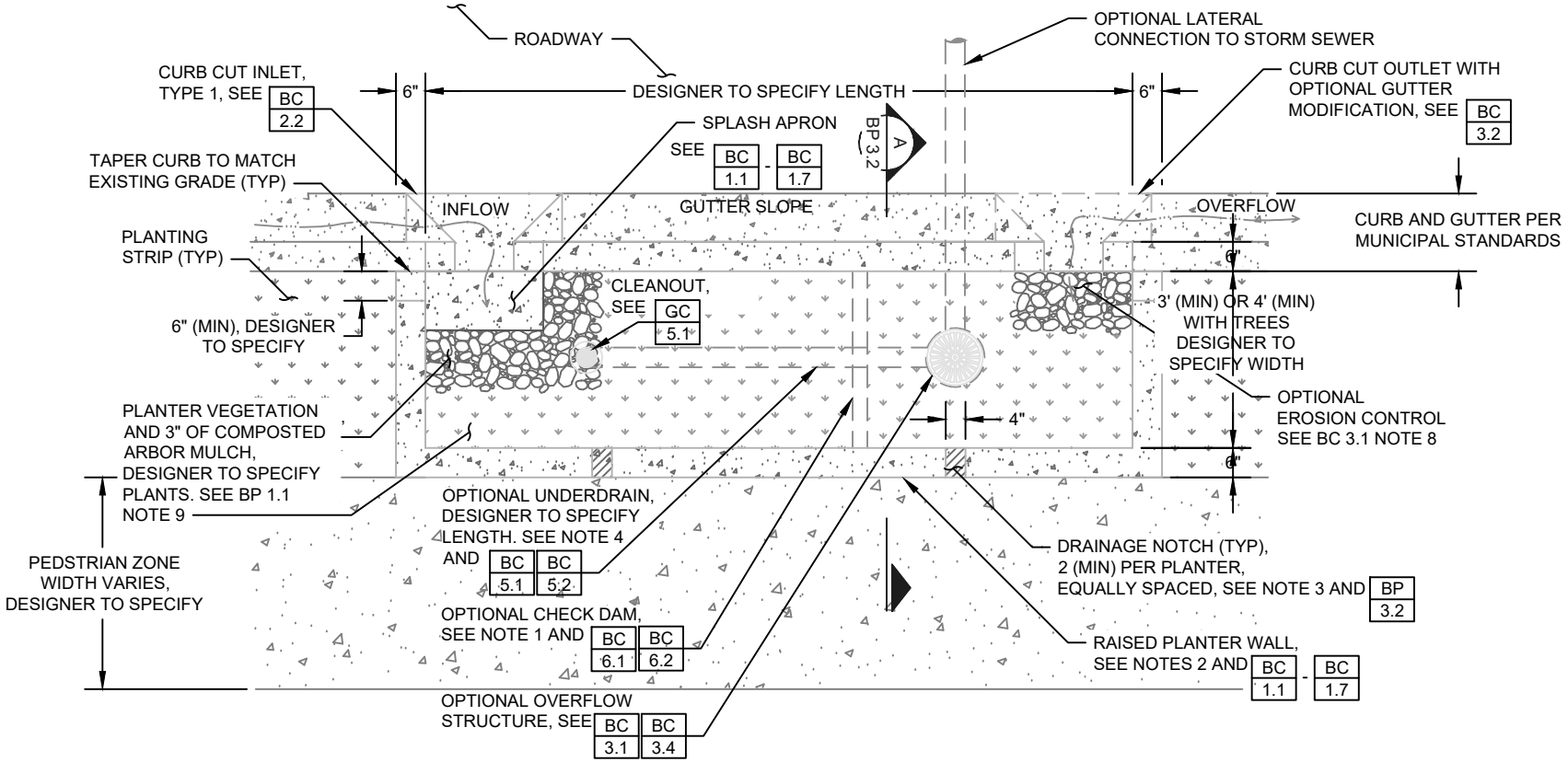
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 2.2

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BIORETENTION PLANTER

STORMWATER PLANTER WITH PARKING SECTIONS

DWG NO. BP 2.2



CONSTRUCTION NOTES:

1. CHECK DAMS SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT MUNICIPAL STANDARDS AND SCVURPPP GSI HANDBOOK UTILITY COORDINATION SECTION. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

NOTES		W/PARKING		W/O PARKING		BULBOUT					
		PLAN SECTIONS		PLAN SECTIONS		ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTY COMMISSION BP 3.1

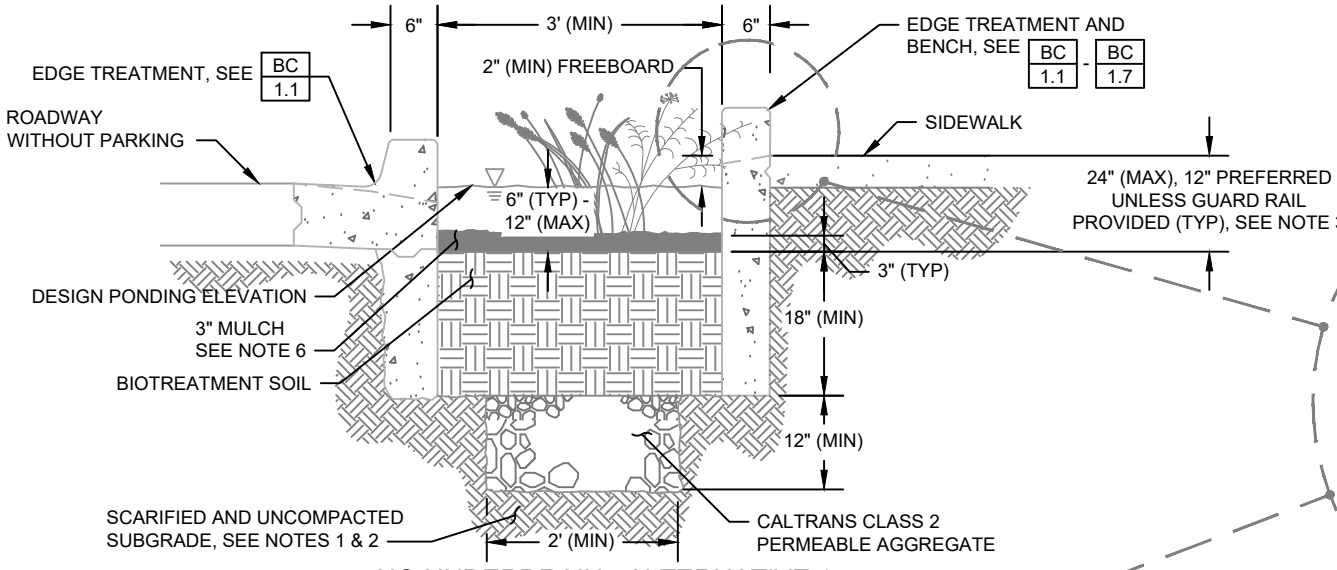
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BIORETENTION PLANTER

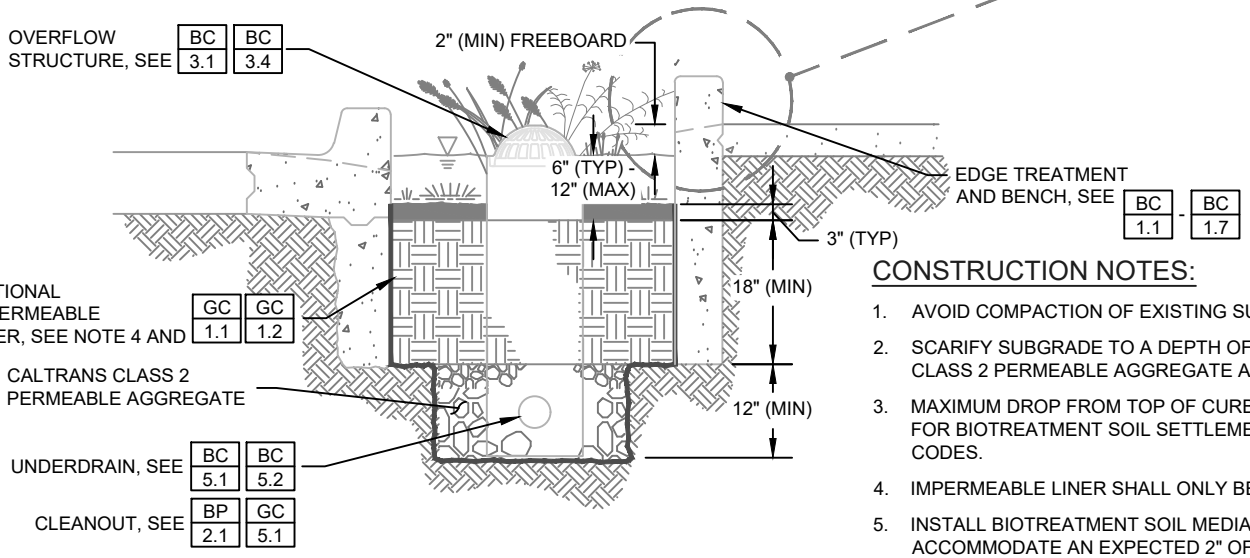
STORMWATER PLANTER WITHOUT PARKING PLAN

DWG NO. **BP 3.1**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

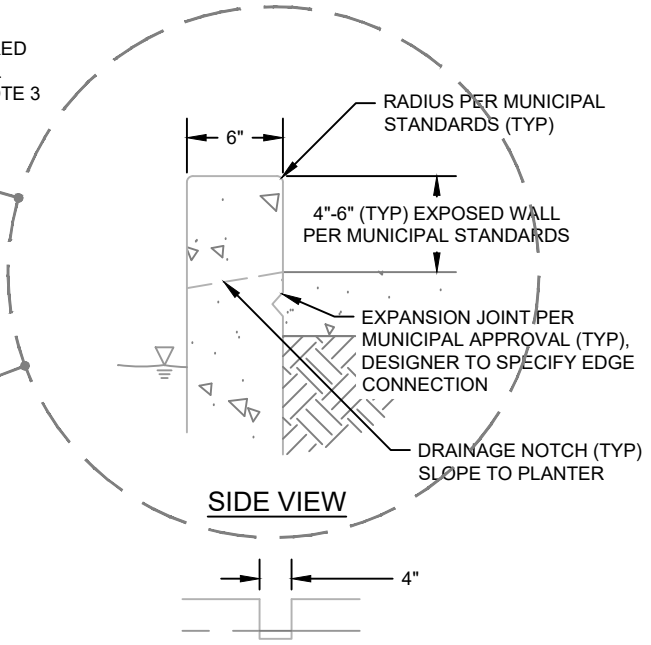


NO UNDERDRAIN - ALTERNATIVE 1



WITH UNDERDRAIN - ALTERNATIVE 2

BIORETENTION PLANTER WITHOUT PARKING (A)



TYPICAL DRAINAGE NOTCH DETAIL

CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW PLANTER DURING CONSTRUCTION.
2. SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF CALTRANS CLASS 2 PERMEABLE AGGREGATE AND BIOTREATMENT SOIL MATERIAL.
3. MAXIMUM DROP FROM TOP OF CURB TO TOP OF BIOTREATMENT SOIL SHALL INCLUDE CONSIDERATIONS FOR BIOTREATMENT SOIL SETTLEMENT. ENGINEER TO EVALUATE NEED FOR GUARDRAIL PER APPLICABLE CODES.
4. IMPERMEABLE LINER SHALL ONLY BE USED WHEN SITE CONDITIONS REQUIRE USE.
5. INSTALL BIOTREATMENT SOIL MEDIA (BSM) IN EITHER TWO 10" LIFTS AND THEN WETTED TO ACCOMMODATE AN EXPECTED 2" OF SETTLING OR THREE 6" LIFTS THEN WETTED WITH ADDITIONAL BSM ADDED TO THE SURFACE AS NEEDED TO ACHIEVE A FINAL DEPT OF 18".
6. WOOD MULCH AND ROCK MULCH OPTIONS DISCUSSED IN SCVURPPP GSI HANDBOOK LANDSCAPE SECTION.

NOTES		W/PARKING		W/O PARKING		BULBOUT					
		PLAN SECTIONS		PLAN SECTIONS		ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 3.2

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REVISED:

BIORETENTION PLANTER

STORMWATER PLANTER WITHOUT PARKING SECTIONS

DWG NO. BP 3.2

PURPOSE:

BIORETENTION BASINS CAPTURE AND TREAT STORMWATER RUNOFF VIA SURFACE AND SUBSURFACE STORAGE, FILTRATION THROUGH BIOTREATMENT SOIL, AND INFILTRATION INTO NATIVE SOIL WHERE FEASIBLE. BIORETENTION BASINS MAY HAVE UNDERDRAINS AND IMPERMEABLE LINERS ON THE SIDES AND/OR BOTTOM OF FACILITY IF NEEDED, BASED ON SOIL CONDITIONS AND GEOTECHNICAL CONSIDERATIONS.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. FACILITY SURFACE AREA AND PONDING DEPTH MUST BE SIZED TO MEET MRP PROVISION C.3.d SIZING REQUIREMENTS. CALCULATE VELOCITY OF RUNOFF TO DETERMINE SIZES AND NUMBERS OF INLET STRUCTURES.
3. FACILITY DRAWDOWN TIME (I.E., TIME FOR SURFACE PONDING TO DRAIN THROUGH THE ENTIRE SECTION INCLUDING AGGREGATE STORAGE AFTER THE END OF A STORM) REQUIREMENTS:
   - 48 HOUR (PREFERED) TO 72 HOUR MAXIMUM FACILITY DRAWDOWN.
4. AN AGGREGATE COURSE IS REQUIRED UNDER THE BIOTREATMENT SOIL. AGGREGATE SHALL BE CALTRANS CLASS 2 PERMEABLE MATERIAL.
5. THE EDGE TREATMENT SLOPE IS TYPICALLY DESIGNED TO MATCH THE SLOPE OF THE ADJACENT ROADWAY/SIDEWALK. CHECK DAMS MAY BE USED TO TERRACE FACILITIES TO PROVIDE SUFFICIENT PONDING FOR HIGHER-SLOPED INSTALLATIONS. DESIGNER MUST SPECIFY CHECK DAM HEIGHT AND SPACING. REFER TO **BC 6.1** AND **BC 6.2** FOR GUIDANCE ON CHECK DAM DESIGN.
6. THE FOLLOWING GUIDELINES APPLY TO RIGHT-OF-WAY APPLICATIONS:
   - BULBOUT CURB TRANSITIONS SHALL CONFORM TO MUNICIPAL STANDARDS.
   - WHEN FACILITY CONSTRUCTION IMPACTS EXISTING SIDEWALK, ALL SAW CUTS MUST ADHERE TO MUNICIPAL REQUIREMENTS. SAW CUTS SHOULD BE ALONG SCORE LINES AND ANY DISTURBED SIDEWALK FLAGS SHOULD BE REPLACED IN THEIR ENTIRETY.
   - DESIGNER TO SPECIFY TRANSITION OF BIORETENTION AREA TO TOP OF CURB ELEVATION BETWEEN CURB CUTS OR CONTINUOUS 6 INCH REVEAL AT CURB EDGE.
7. UP TO TWO BIORETENTION AREAS MAY BE CONNECTED IN SERIES, IN LIEU OF MULTIPLE INLETS, PROVIDED THE CONNECTION IS A TRENCH DRAIN OR EQUAL SURFACE CONVEYANCE AND IS ADEQUATELY SIZED TO CONVEY FLOWS
8. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT MUNICIPAL ASSET PROTECTION STANDARDS. IN THE ABSENCE OF THESE STANDARDS, THE DESIGNER SHALL REFER TO SCVURPPP GSI HANDBOOK UTILITY COORDINATION SECTION. SEE UTILITY CROSSINGS (**GC 2.1 - GC 2.12**) AND UTILITY CONFLICTS (**GC 3.1 - GC 3.3**).
9. FREEBOARD REQUIREMENTS SHOWN SHOULD BE USED AS GUIDELINES BUT THE DESIGNER SHALL CHECK WITH MUNICIPALITY FOR LOCAL REQUIREMENTS.
10. BIORETENTION AREA VEGETATION MUST BE SPECIFIED BY DESIGN PROFESSIONAL PER MUNICIPAL VEGETATION PALLET OR SCVURPPP C.3 HANDBOOK APPENDIX D PLANT LIST.
11. CONVEYANCE CONNECTIONS MAY BE CONFIGURED TO ACCEPT RUNOFF VIA OVERHEAD CONVEYANCE (DOWNSPOUTS, OVERHEAD RUNNELS), SURFACE FLOW (CHANNELS) OR SUBSURFACE CONVEYANCE (PIPES, TRENCH DRAINS).
12. CONVEYANCE CONNECTIONS SHALL BE SIZED AND HAVE ADEQUATE FREEBOARD TO ACCOMMODATE DRAINAGE FROM ROOF AREAS AND PREVENT OVERFLOWING.
13. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

DESIGNER CHECKLIST

(MUST SPECIFY, AS APPLICABLE):

- ☐ FACILITY WIDTH, LENGTH, SLOPES (INCLUDING SIDE, CROSS, AND LONGITUDINAL), AND SHAPE
- ☐ DEPTH OF PONDING
- ☐ DEPTH OF FREEBOARD
- ☐ DEPTH OF BIOTREATMENT SOIL
- ☐ DEPTH AND TYPE OF GRAVEL STORAGE, IF ANY
- ☐ BIORETENTION AREA SURFACE ELEVATION (TOP OF BIOTREATMENT SOIL) AT UPSLOPE AND DOWNSLOPE ENDS OF FACILITY (I.E., PROVIDE SPOT ELEVATIONS OR CONTOURS AS NEEDED)
- ☐ CONTROL POINTS AT EVERY CORNER OF FACILITY AND POINT OF TANGENCY
- ☐ HORIZONTAL CONTROL: DIMENSIONS TO OR CONTROL POINTS AT EVERY INLET, OUTLET, CHECK DAM, SIDEWALK NOTCH, ETC.
- ☐ VERTICAL CONTROL: ELEVATIONS OF EVERY INLET, OUTLET, STRUCTURE RIM AND INVERT, CHECK DAM, AND SIDEWALK NOTCH
- ☐ TYPE AND DESIGN OF FACILITY COMPONENTS (E.G., EDGE TREATMENTS, INLETS/GUTTER MODIFICATIONS, UTILITY CROSSINGS, LINER, AND PLANTING DETAILS)

LAYOUT REQUIREMENTS:

1. FOR RIGHT-OF-WAY APPLICATIONS, REFER TO THE MUNICIPAL STANDARD ACCESSIBILITY REQUIREMENTS DRAWINGS AND SPECIFICATIONS FOR CONSTRUCTION FOR STEP OUT ZONE, PEDESTRIAN ZONE, PARKING SPACE AND ACCESSIBLE PATH REQUIREMENTS.
2. LOCATE CURB CUTS AND GUTTER MODIFICATIONS TO AVOID CONFLICTS WITH ACCESSIBILITY REQUIREMENTS (E.G., LOCATE OUTSIDE OF CROSSWALKS).

RELATED COMPONENTS

EDGE TREATMENTS:	BC 1.1 - BC 1.7
INLETS:	BC 2.1 - BC 2.4
OUTLETS:	BC 3.1 - BC 3.4
UNDERDRAINS:	BC 5.1 - BC 5.2
CHECK DAMS:	BC 6.1 - BC 6.2
LINERS:	GC 1.1 - GC 1.2
UTILITY CROSSINGS:	GC 2.1 - GC 2.12
UTILITY CONFLICTS:	GC 3.1 - GC 3.4
OBSERVATION PORTS:	GC 4.1 - GC 4.3
CLEANOUTS:	GC 5.1

NOTES: BB 1.1 SECTION: BB 2.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

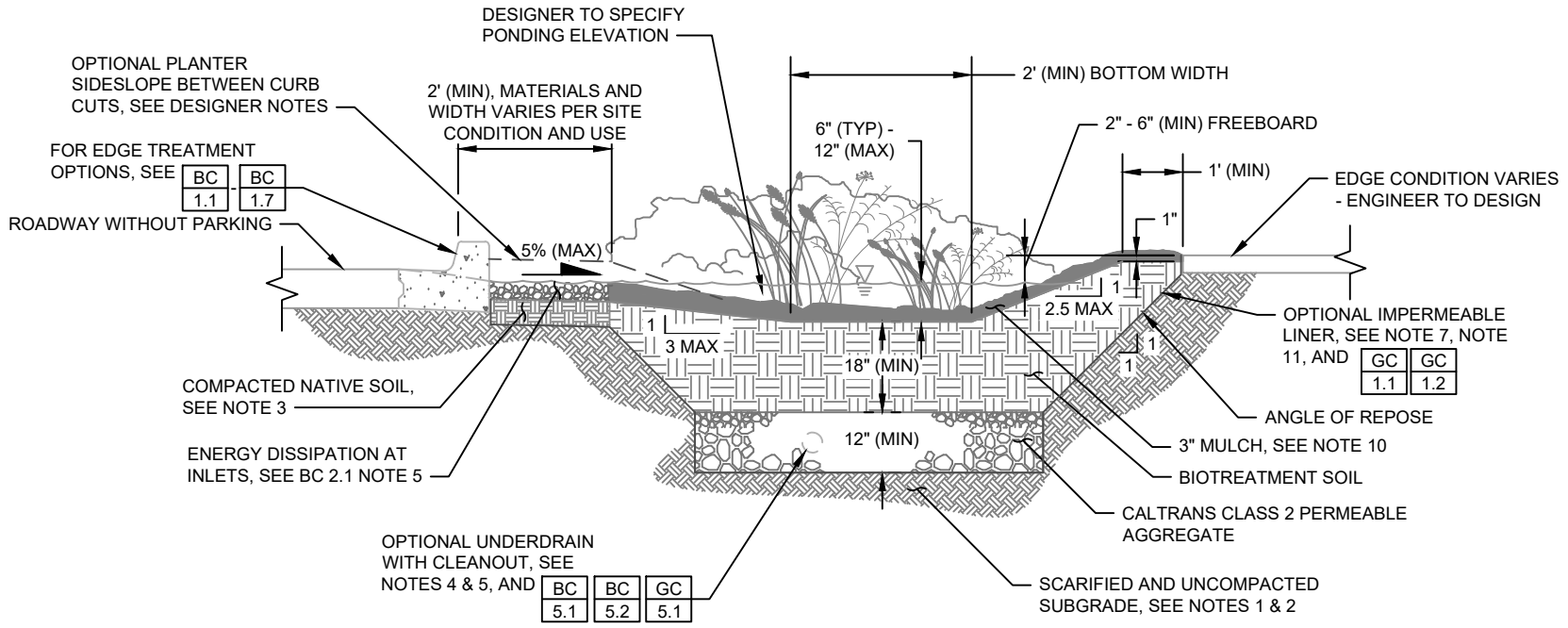
GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BB 1.1

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION AREA
DESIGNER NOTES

DWG NO. **BB 1.1**



CONSTRUCTION NOTES:

1. FOR BIORETENTION AREAS WITHOUT IMPERMEABLE LINER, AVOID COMPACTION OF EXISTING SUBGRADE BELOW BASIN.
2. FOR BIORETENTION AREAS WITHOUT IMPERMEABLE LINER, SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF CALTRANS CLASS 2 PERMEABLE AGGREGATE AND BIOTREATMENT SOIL MATERIALS.
3. COMPACT NATIVE SOIL IMMEDIATELY BEHIND CURB TO 90% OF MAXIMUM DENSITY PER STANDARD PROCTOR TEST (ASTM D698).
4. UNDERDRAIN REQUIRED FOR ALL FACILITIES WITH IMPERMEABLE LINER.
5. PROVIDE ONE CLEANOUT PER BIORETENTION AREA (MIN) FOR FACILITIES WITH UNDERDRAINS.
6. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT MUNICIPAL ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.
7. GEOTECHNICAL ENGINEER TO DETERMINE IF LINER SHALL BE USED FOR PROTECTION OF ADJACENT STRUCTURES, FACILITIES, OR IMPROVEMENTS.
8. ANGLE OF REPOSE MAY VARY BASED ON GEOTECHNICAL ENGINEER RECOMMENDATIONS.
9. INSTALL BIOTREATMENT SOIL MEDIA (BSM) IN EITHER TWO 10" LIFTS AND THEN WETTED TO ACCOMMODATE AN EXPECTED 2" OF SETTLING OR THREE 6" LIFTS THEN WETTED AND SUPPLEMENTED WITH ADDITIONAL BSM AS NEEDED TO ACHIEVE A FINAL DEPTH OF 18".
10. WOOD MULCH AND ROCK MULCH OPTIONS DISCUSSED IN SCVURPPP C.3 STORMWATER HANDBOOK APPENDIX D.
11. SEE GC 1.2, NOTE 2.

NOTES: BB 1.1 | SECTION: BB 2.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

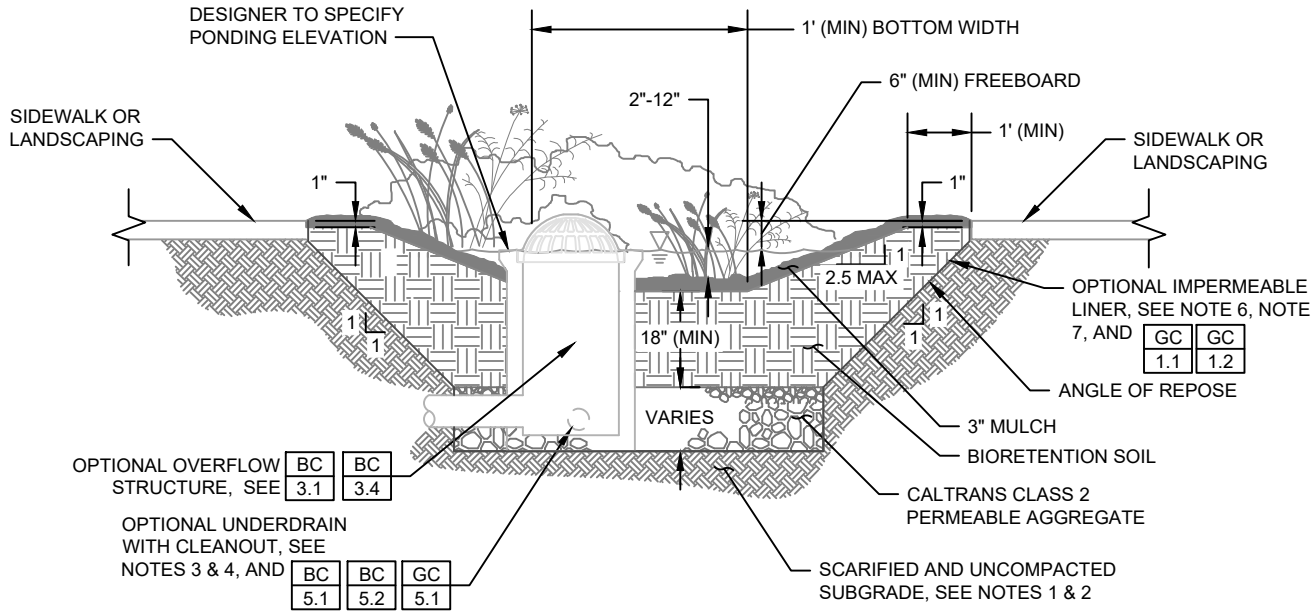
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BB 2.1

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION AREA

ROADSIDE SECTION

DWG NO. BB 2.1



CONSTRUCTION NOTES:

1. FOR BIORETENTION AREAS WITHOUT IMPERMEABLE LINER, AVOID COMPACTION OF EXISTING SUBGRADE BELOW BASIN.
2. FOR BIORETENTION AREAS WITHOUT IMPERMEABLE LINER, SCARIFY SUBGRADE TO A DEPTH OF 3 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE AND BIORETENTION SOIL MATERIALS.
3. UNDERDRAIN REQUIRED FOR ALL FACILITIES WITH IMPERMEABLE LINER.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.
6. GEOTECHNICAL ENGINEER TO DETERMINE IF LINER SHALL BE USED FOR PROTECTION OF EXISTING STRUCTURES, FACILITIES, OR IMPROVEMENTS.
7. SEE GC 1.2, NOTE 2.

NOTES	SECTIONS	
BB 1.1	BB 2.1	BB 2.2

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

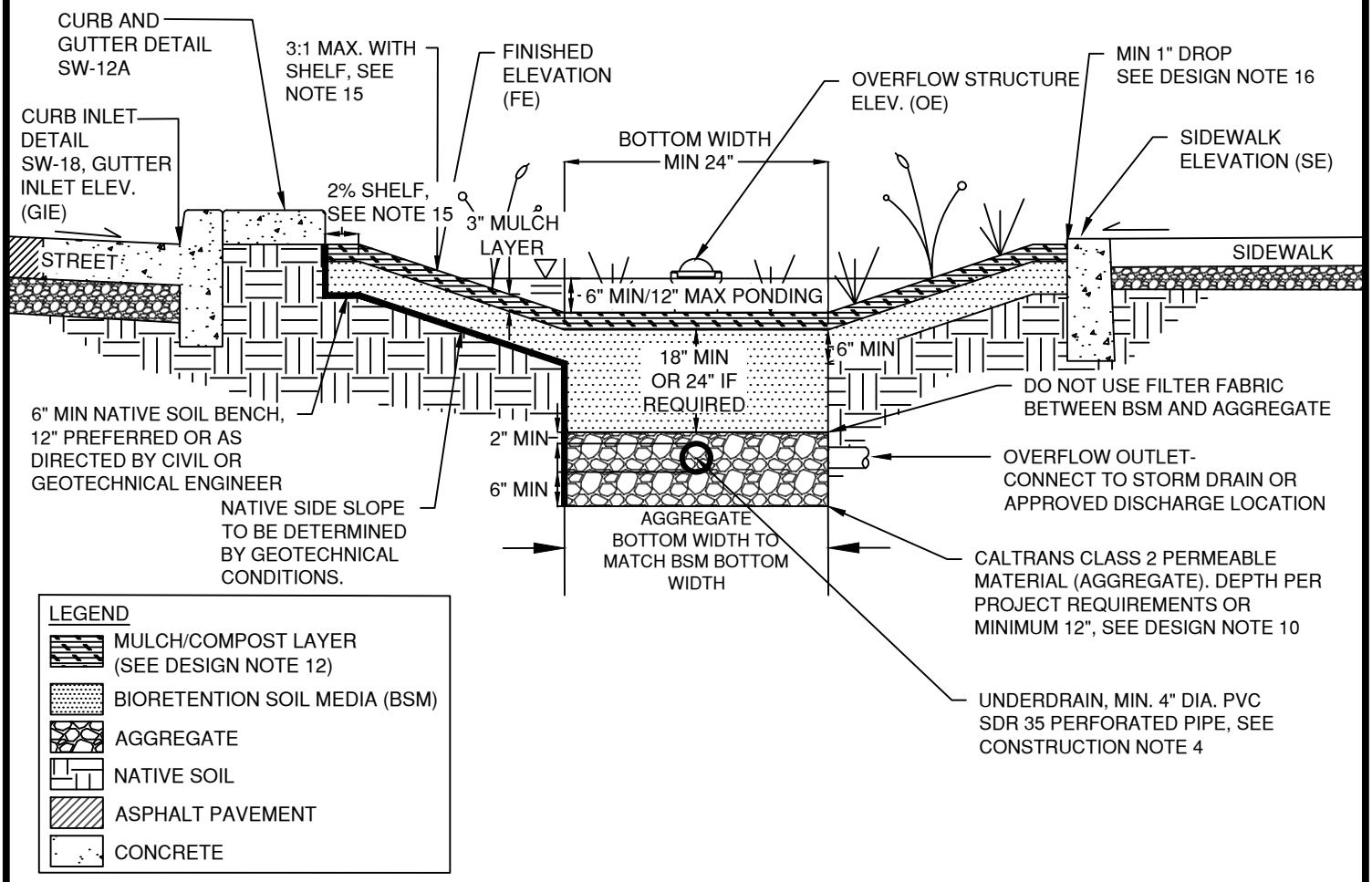
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BB 2.2

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION BASIN
PARCEL SECTION

DWG NO. **BB 2.2**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

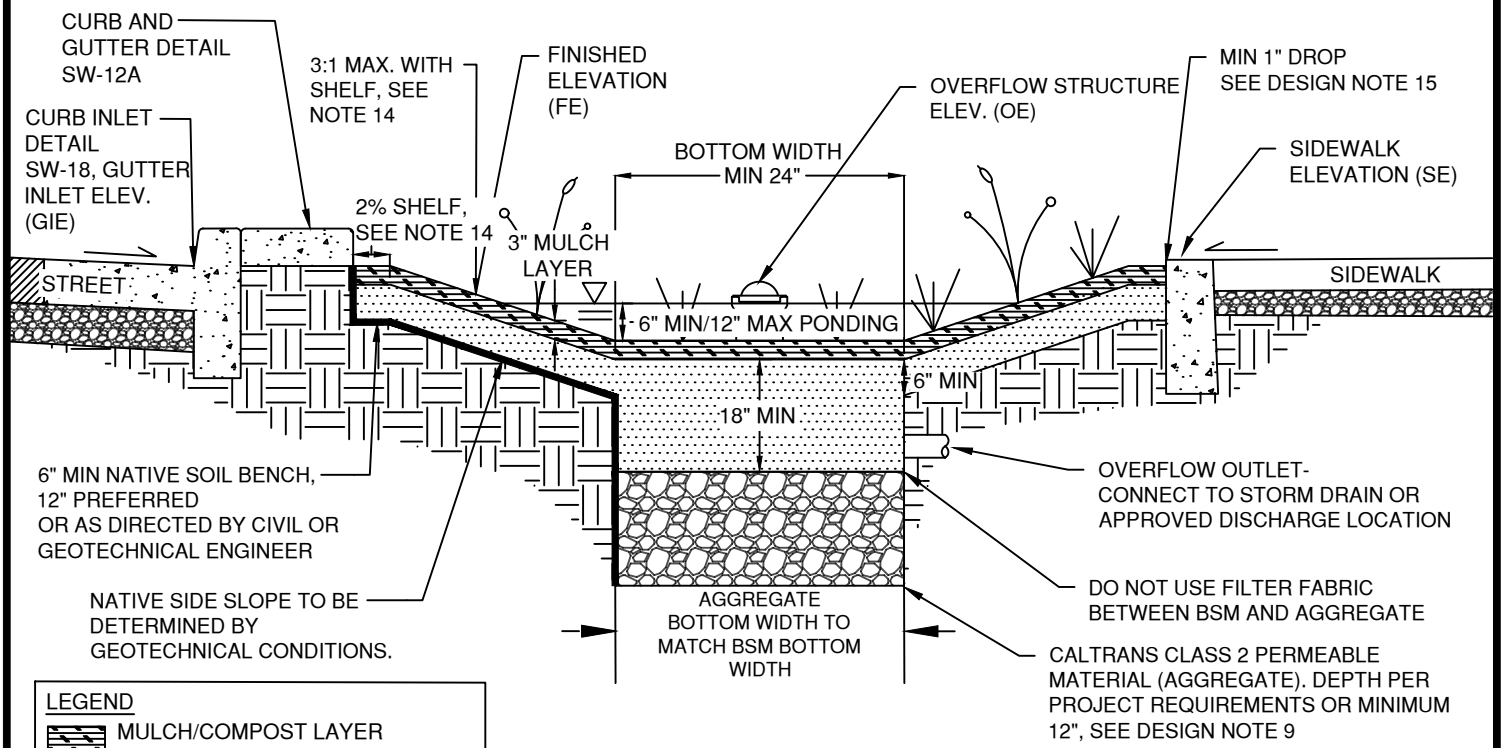


CONSTRUCTION NOTES

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

DESIGN NOTES

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



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

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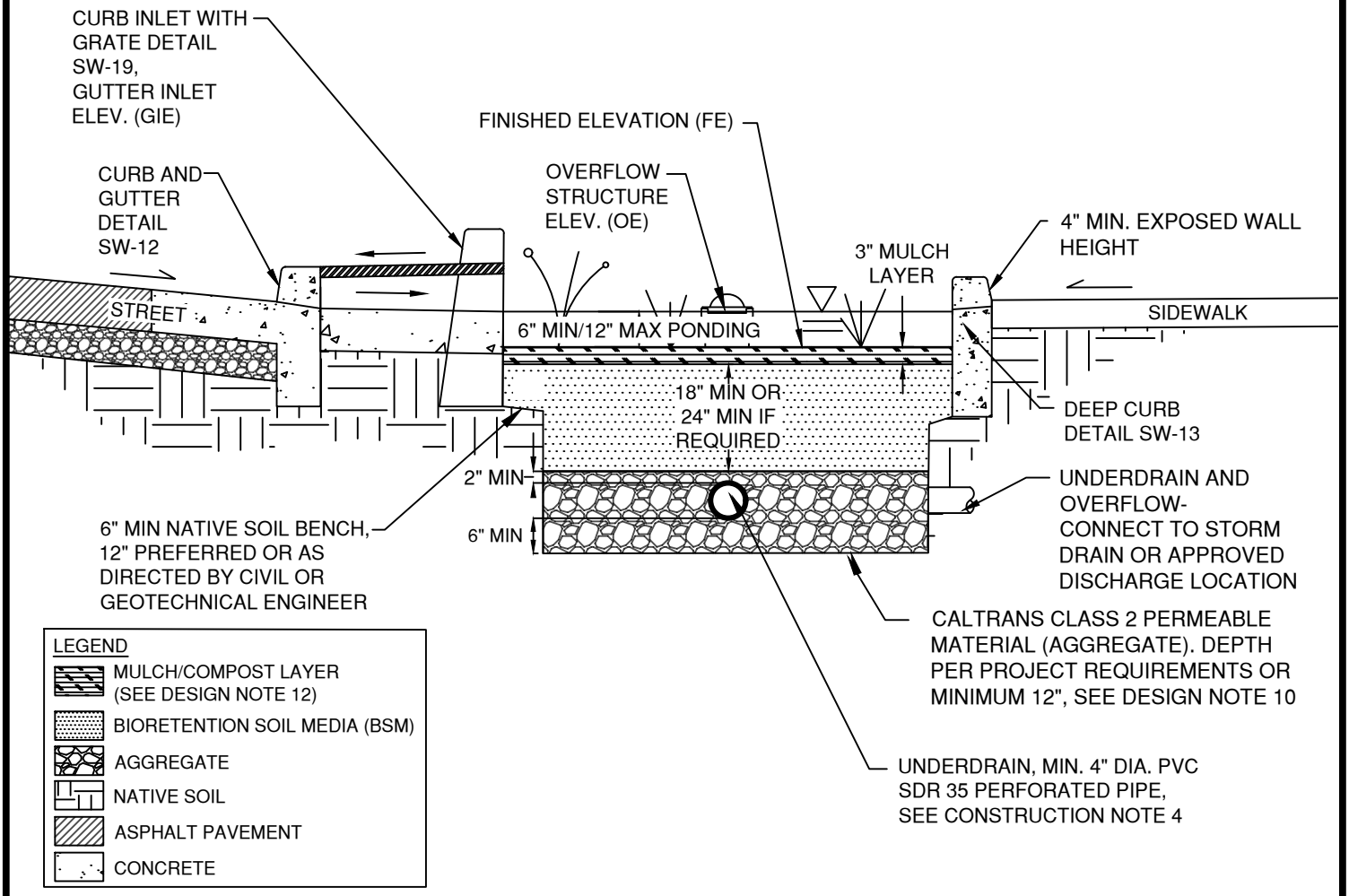
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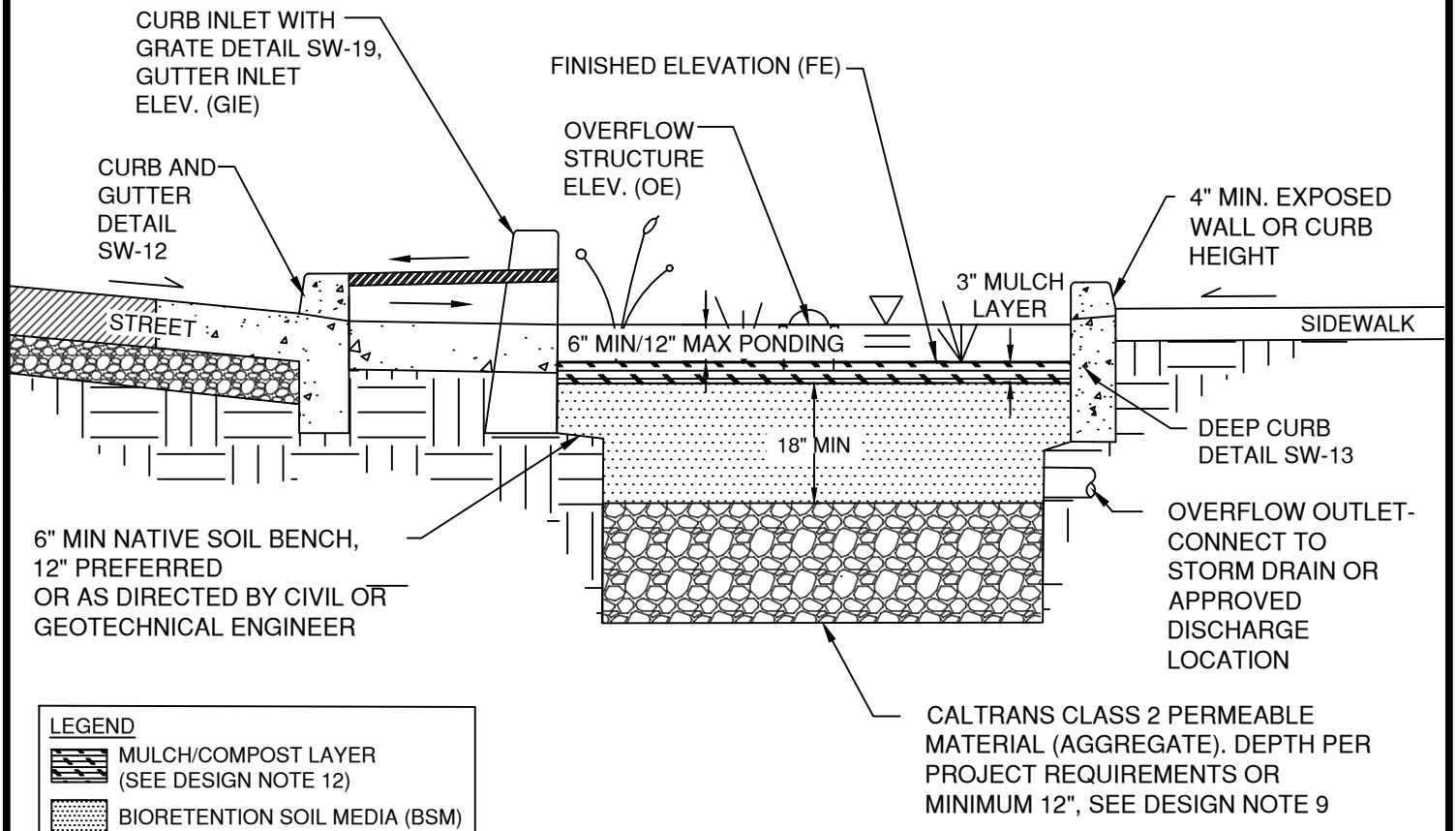


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LEGEND

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

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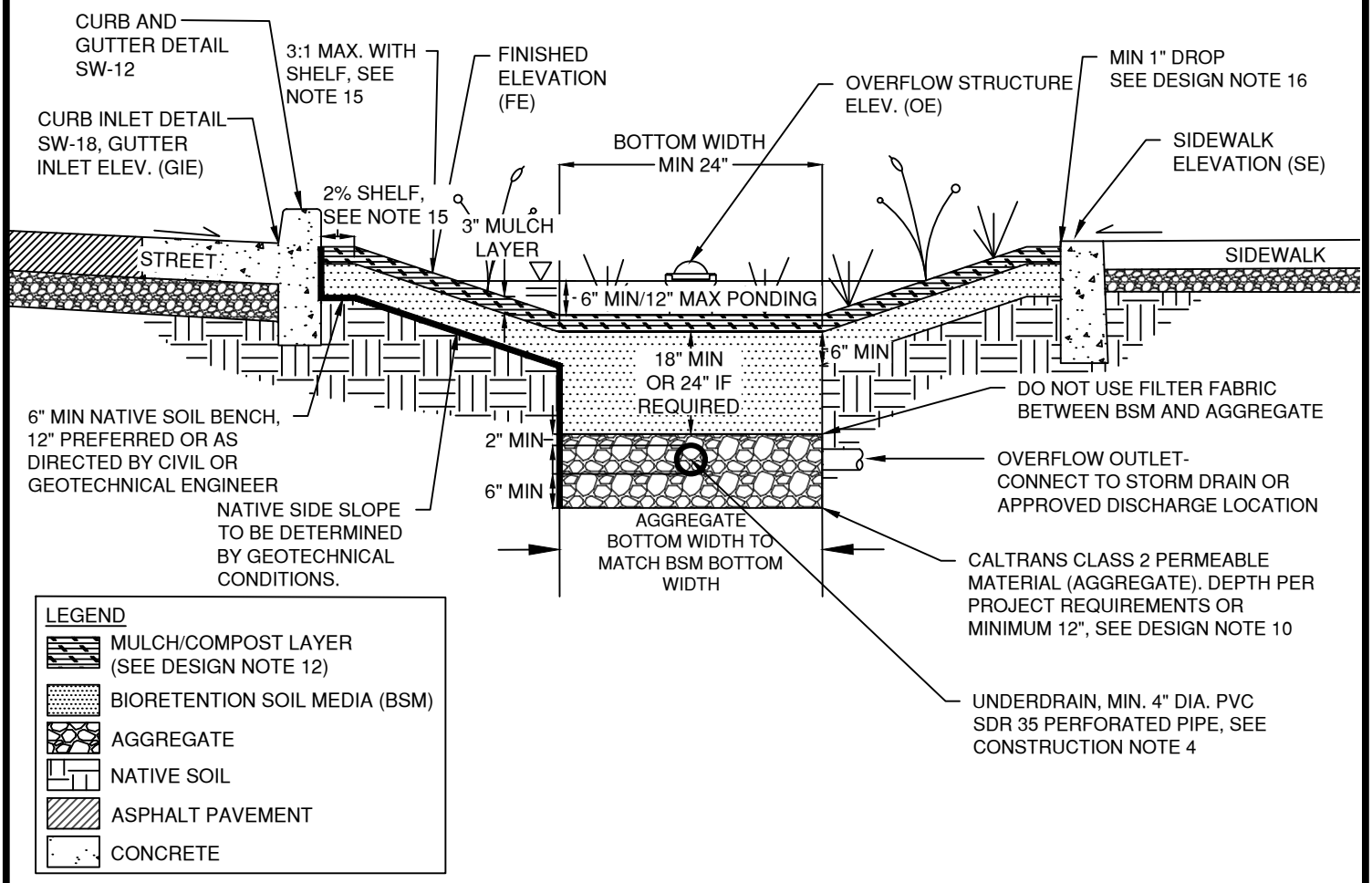
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2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
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4. INSTALL UNDERDRAIN WITH HOLES FACING DOWN. TOP OF UNDERDRAIN 6" BELOW TOP OF AGGREGATE LAYER. UNDERDRAIN SLOPE MAY BE FLAT.
5. PLACE BSM IN 6" LIFTS. COMPACT EACH 6" LIFT OF BSM WITH LANDSCAPE ROLLER OR BY LIGHTLY WETTING. IF WETTING, LET DRY OVERNIGHT BEFORE PLANTING.
6. DO NOT WORK WITHIN BIORETENTION AREA DURING RAIN OR UNDER WET CONDITIONS.
7. KEEP HEAVY MACHINERY OUTSIDE BIORETENTION AREA LIMITS.
8. STORMWATER SHOULD BE DIRECTED AWAY FROM BIORETENTION UNTIL CONSTRUCTION IS COMPLETE AND DRAINAGE AREA VEGETATION IS STABILIZED.

DESIGN NOTES

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

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

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

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

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

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

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

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

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

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

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

12. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

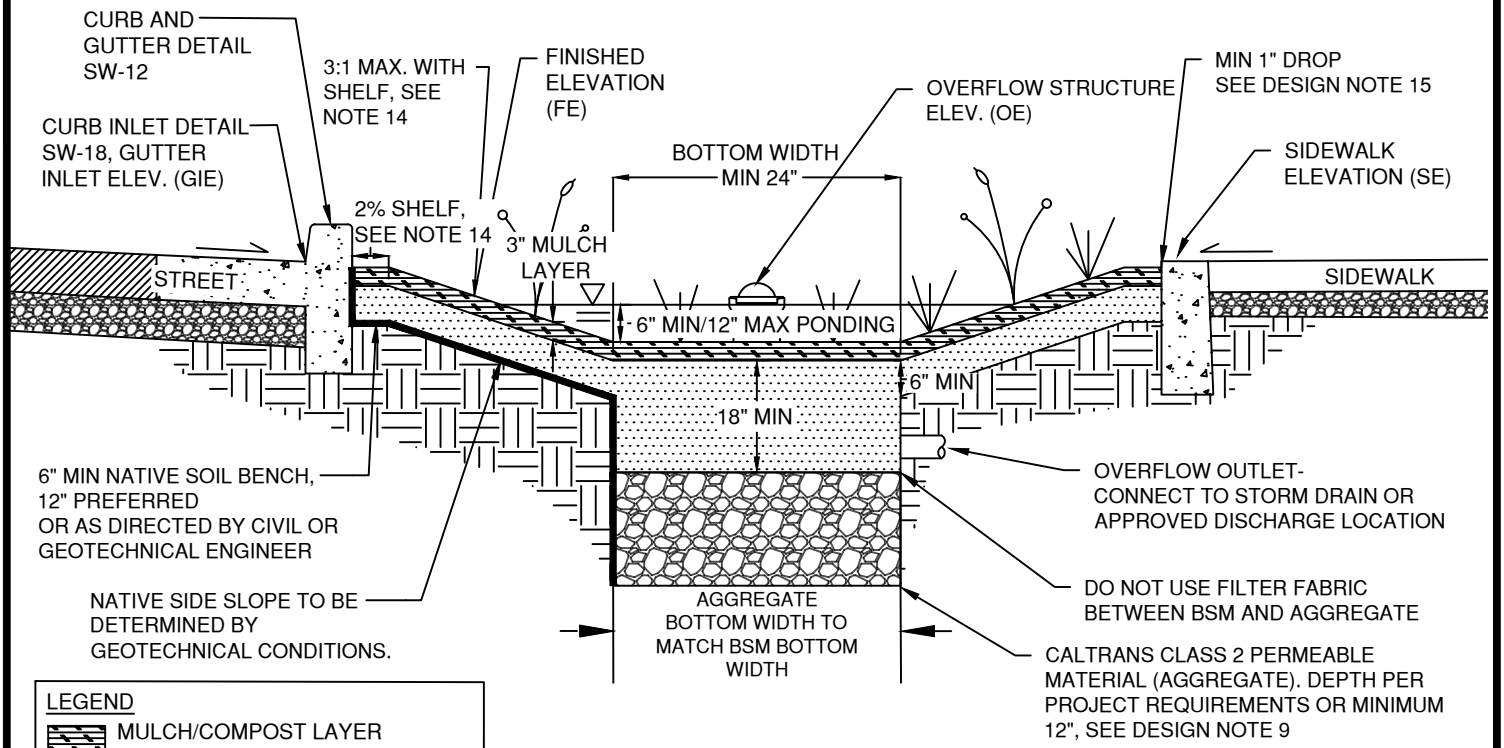
13. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

14. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

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

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

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



CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE, BSM, AND MULCH DEPTHS TO ACHIEVE FINISHED ELEVATIONS ON CIVIL PLANS.
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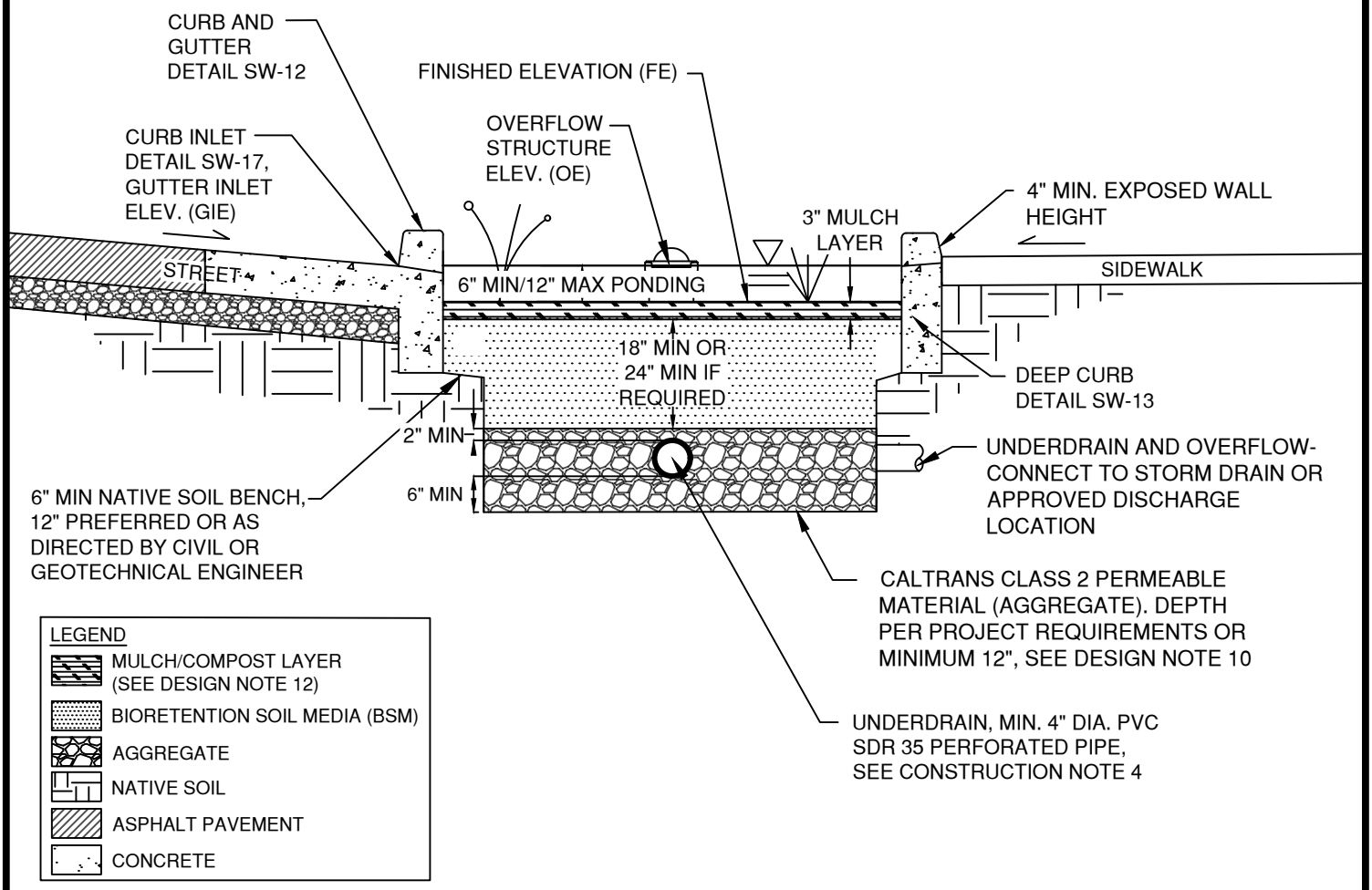
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15. INCLUDE AT LEAST 1" DROP FROM CURB ABOVE MULCH LAYER.

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



LEGEND

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

CONSTRUCTION NOTES

1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
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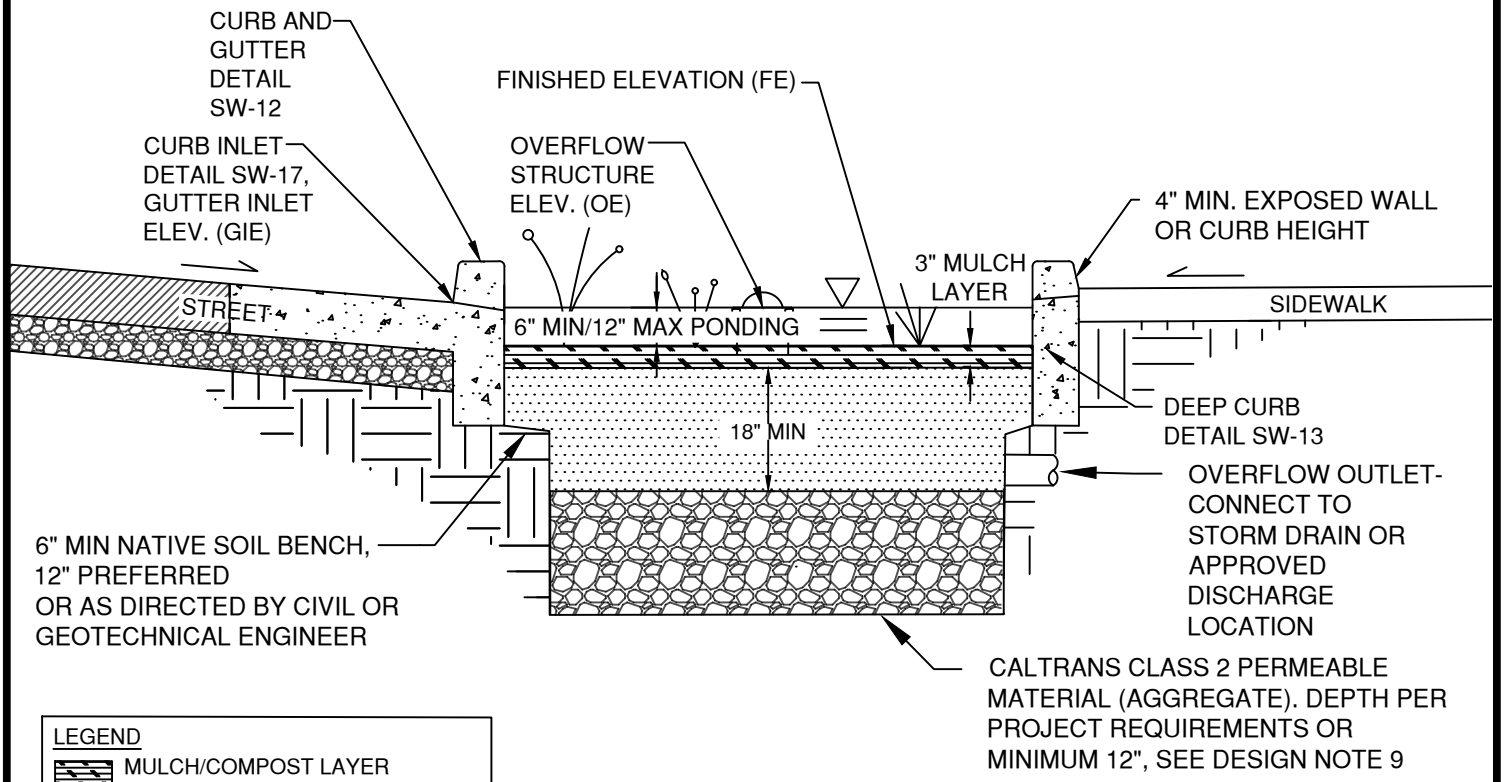
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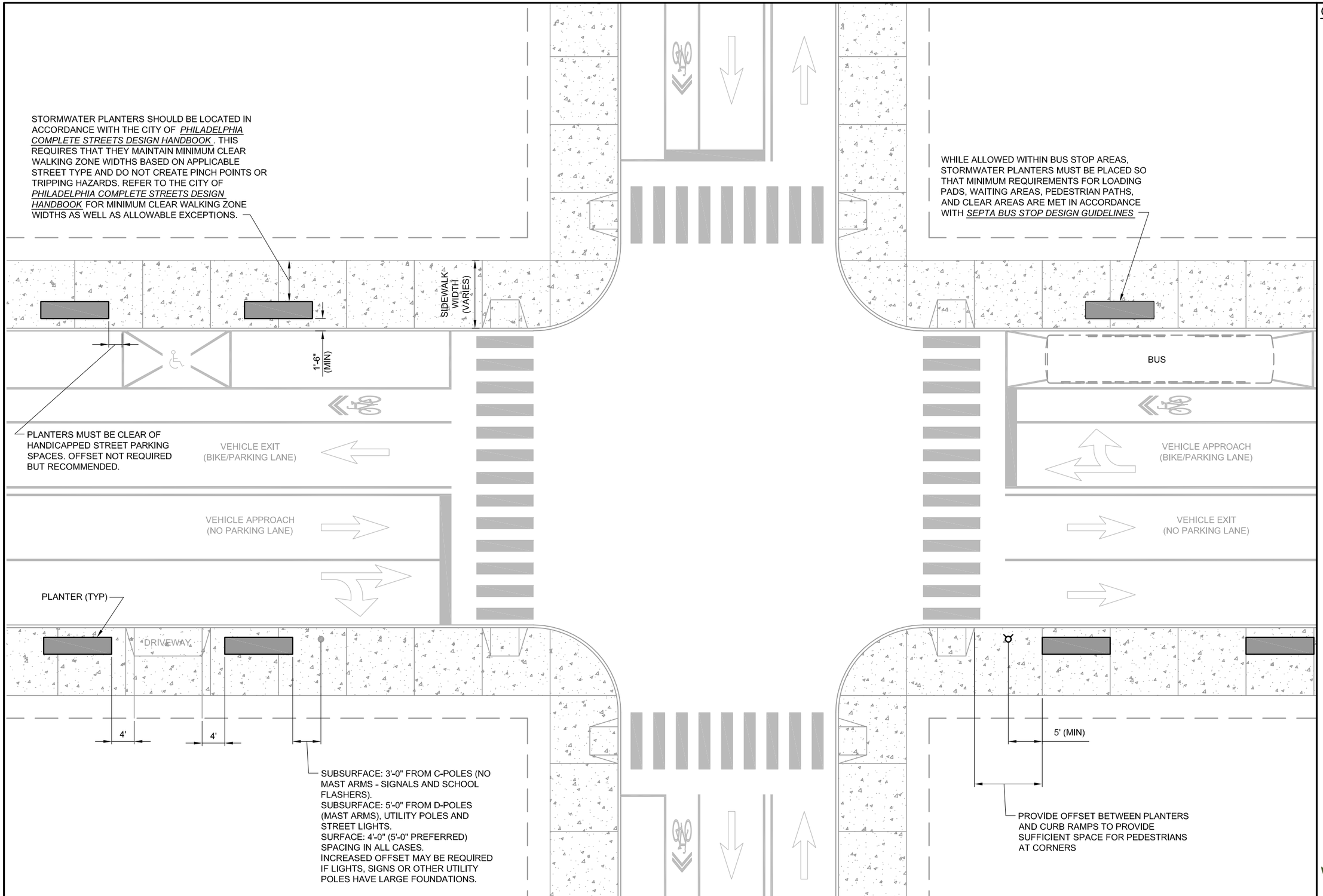
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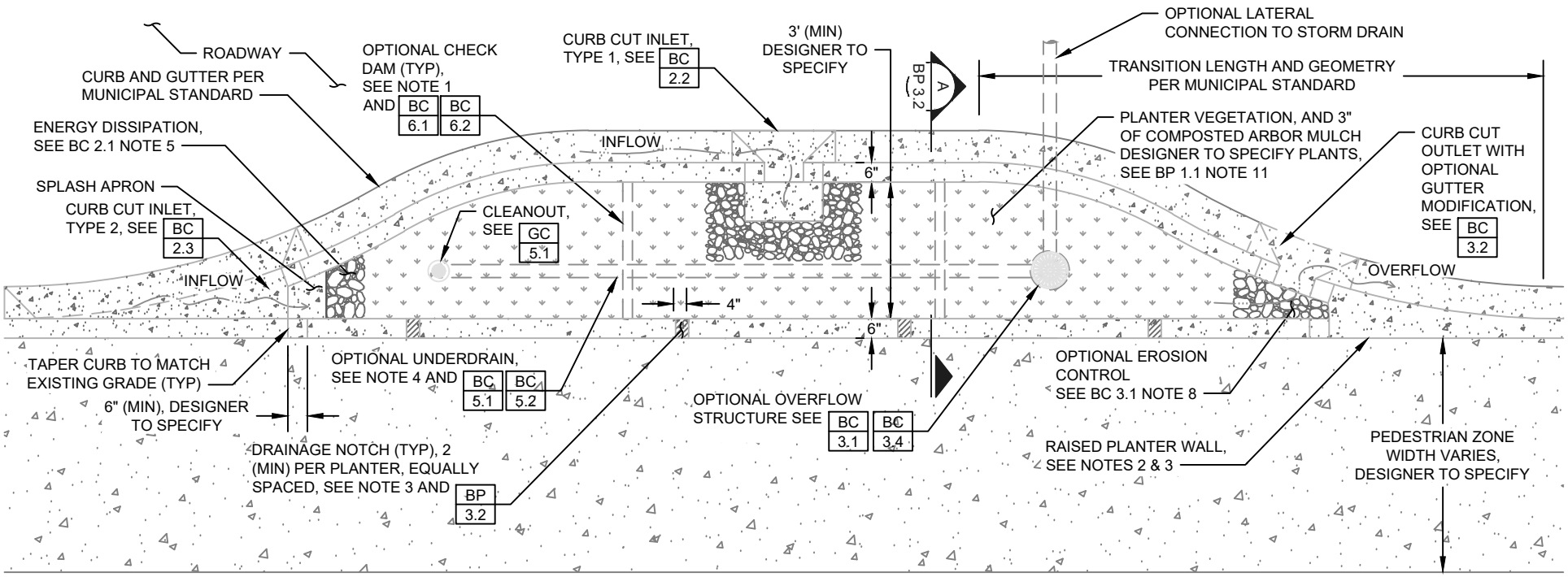


GENERAL NOTES

1. If stormwater planters contain trees, placement of planters will also depend on street tree placement requirements per the Street Tree Planting Diagram in the the city of *Philadelphia Complete Streets Design Handbook.*
2. Reducing the minimum offset from the face of the street curb to the stormwater planter may be appropriate in non-parking lane and non-loading zone conditions but must be reviewed and approved by the City on a case-by-case basis. Reduction of this offset will require additional design considerations regarding the street-side stormwater entrance and area protection design.

Green Streets

STORMWATER CURB EXTENSION (BIORETENTION)



CONSTRUCTION NOTES:

1. CHECK DAMS (IF NEEDED) SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT MUNICIPAL STANDARDS OR SEE SCVURPPP GSI HANDBOOK UTILITY COORDINATION SECTION FOR GUIDANCE. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.

NOTES		W/PARKING		W/O PARKING		BULBOUT					
		PLAN SECTIONS		PLAN SECTIONS		ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 4.1

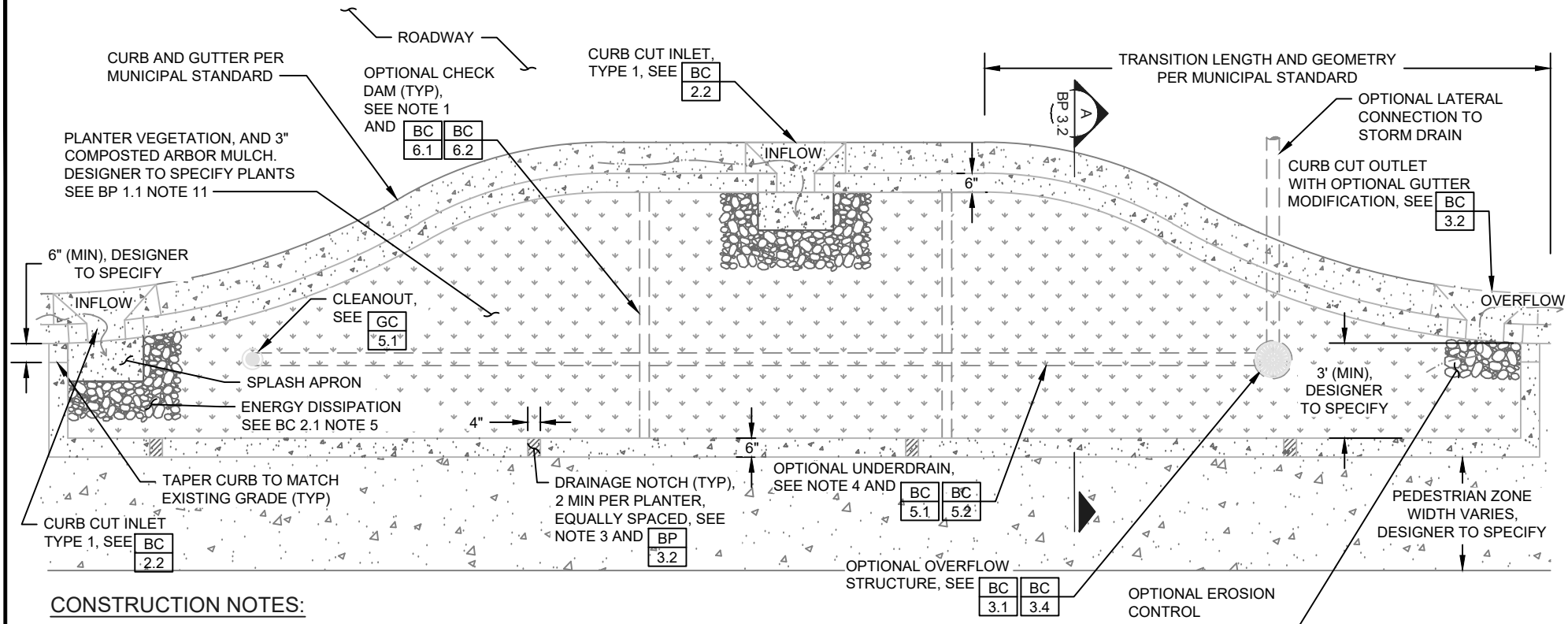
DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION PLANTER

STORMWATER CURB EXTENSION ALT 1-BULBOUT ONLY

DWG NO. **BP 4.1**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



CONSTRUCTION NOTES:

1. CHECK DAMS (IF NEEDED) SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
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BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

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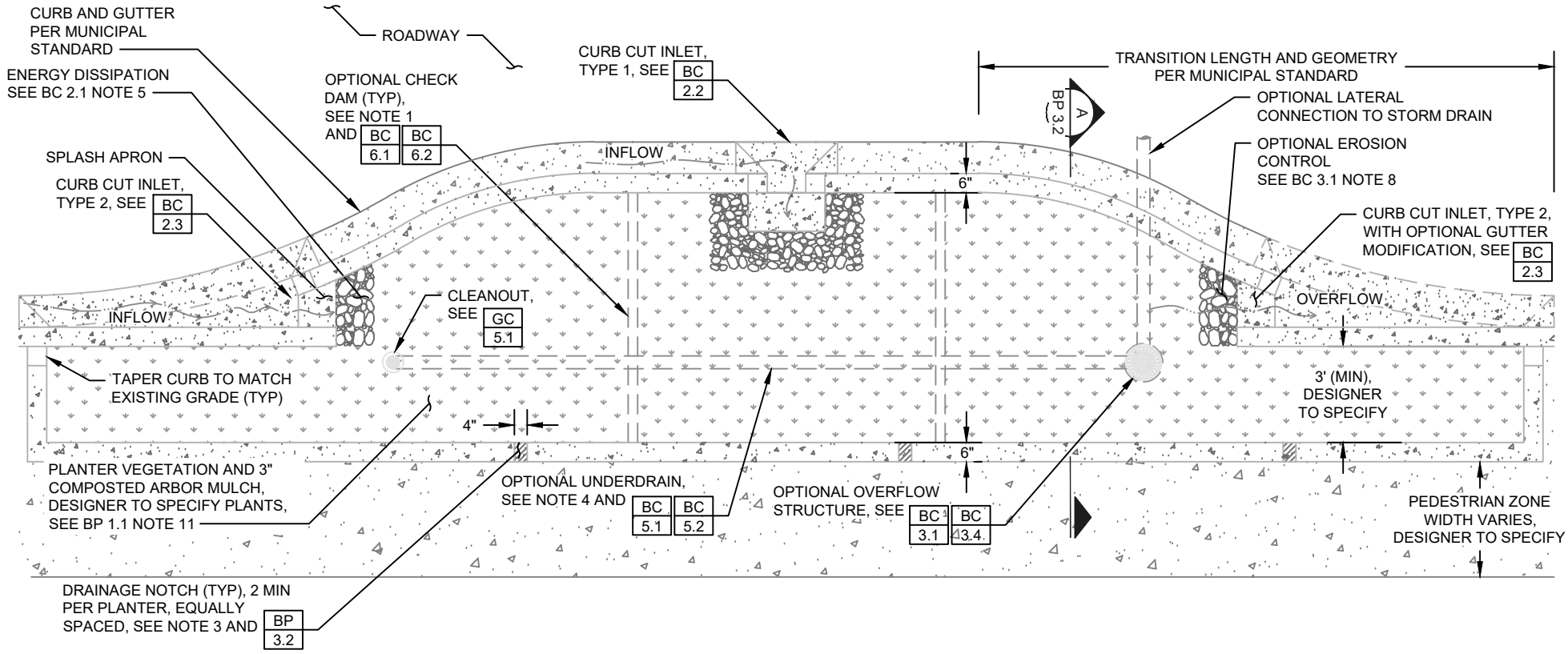
DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION PLANTER

STORMWATER CURB EXTENSION ALT 2-BULBOUT W/ WIDENED PLANTER

DWG NO. **BP 4.2**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



CONSTRUCTION NOTES:

1. CHECK DAMS (IF NEEDED) SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
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BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 4.3

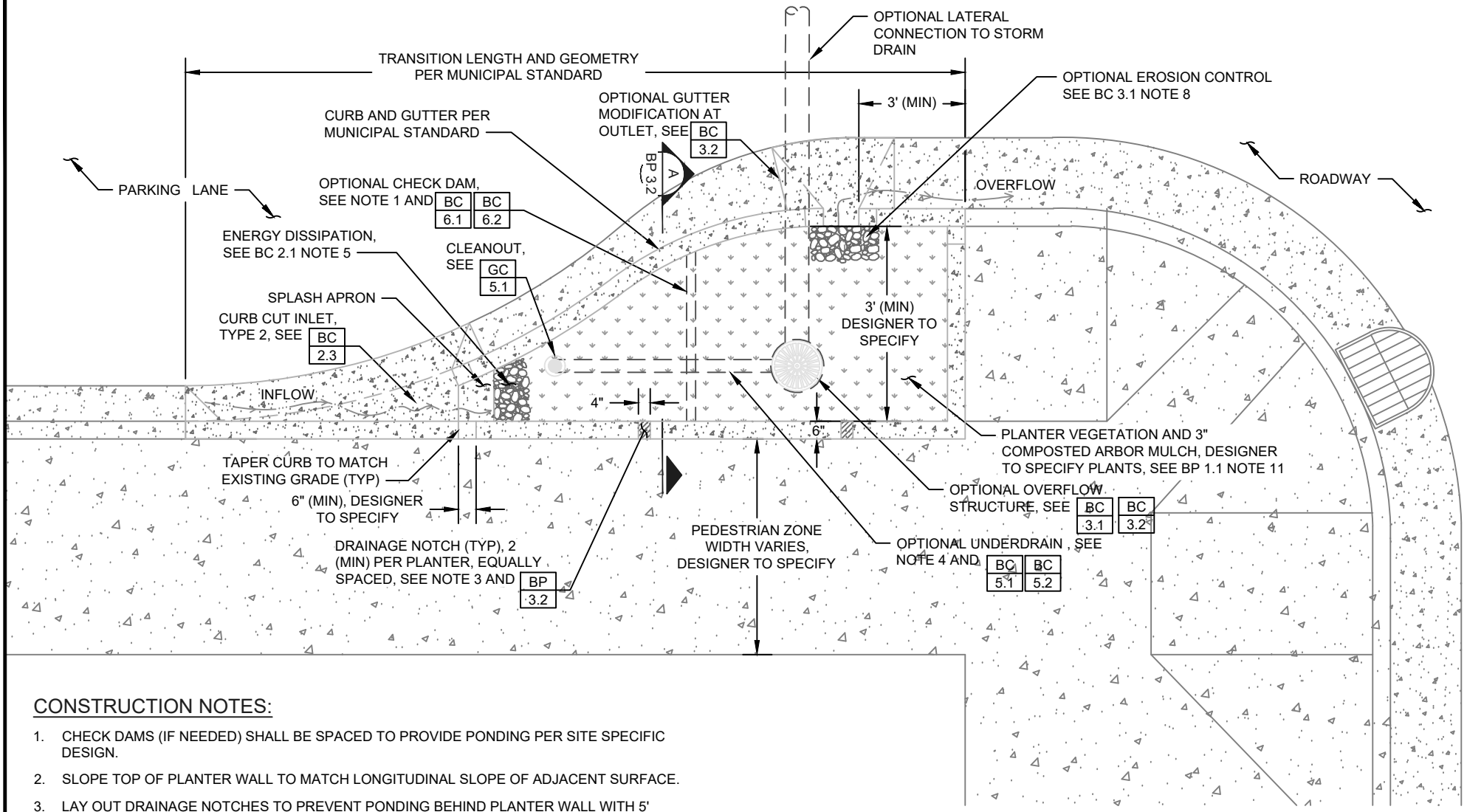
DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION PLANTER

STORMWATER CURB EXTENSION ALT 3 (ALT 2 W/ INLINE CURB CUTS)

DWG NO. **BP 4.3**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



CONSTRUCTION NOTES:

1. CHECK DAMS (IF NEEDED) SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
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						ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 4.4

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

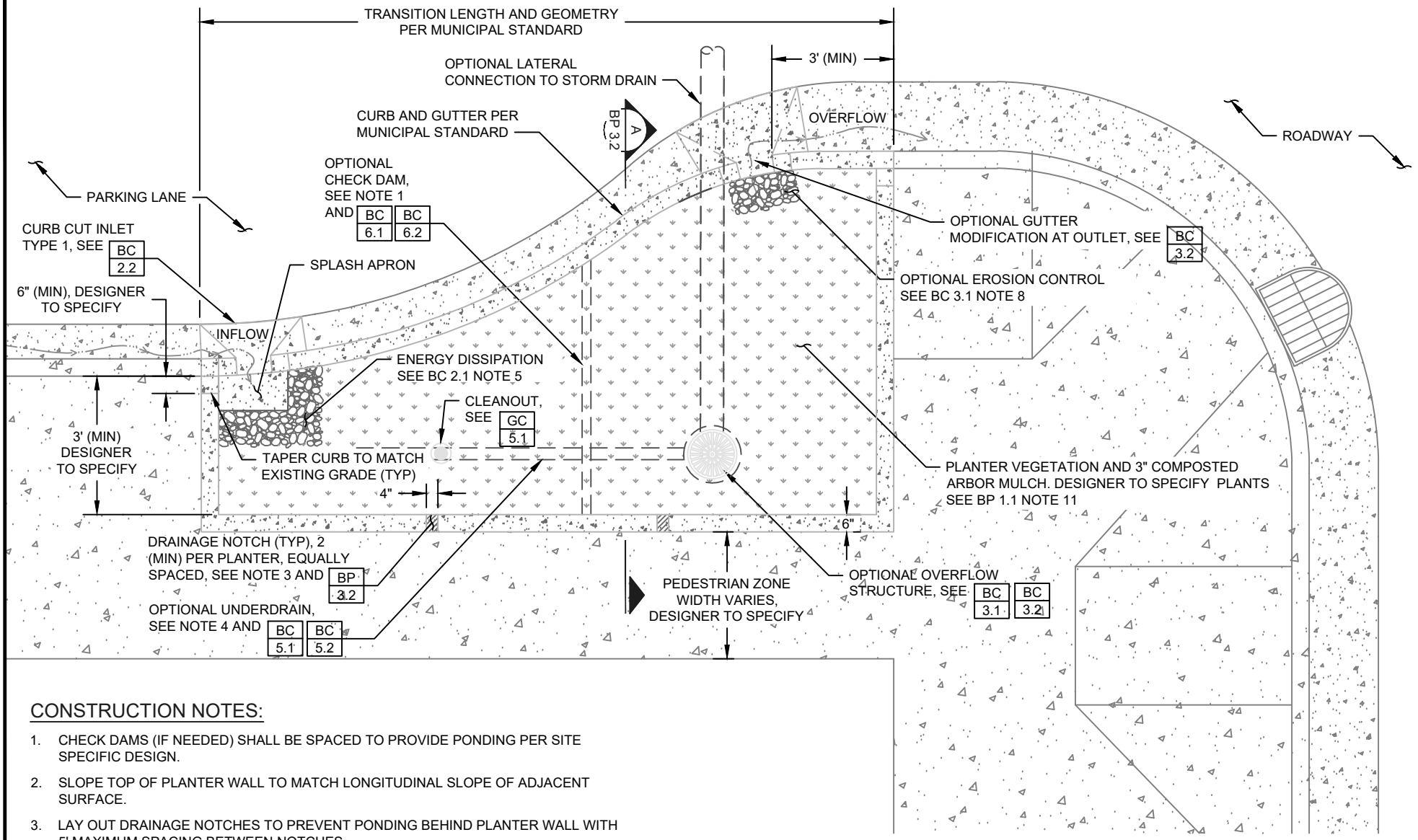
BIORETENTION PLANTER

STORMWATER CURB EXTENSION

ALT 4 - BULBOUT AT INTERSECTION

DWG NO. **BP 4.4**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



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Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 4.5

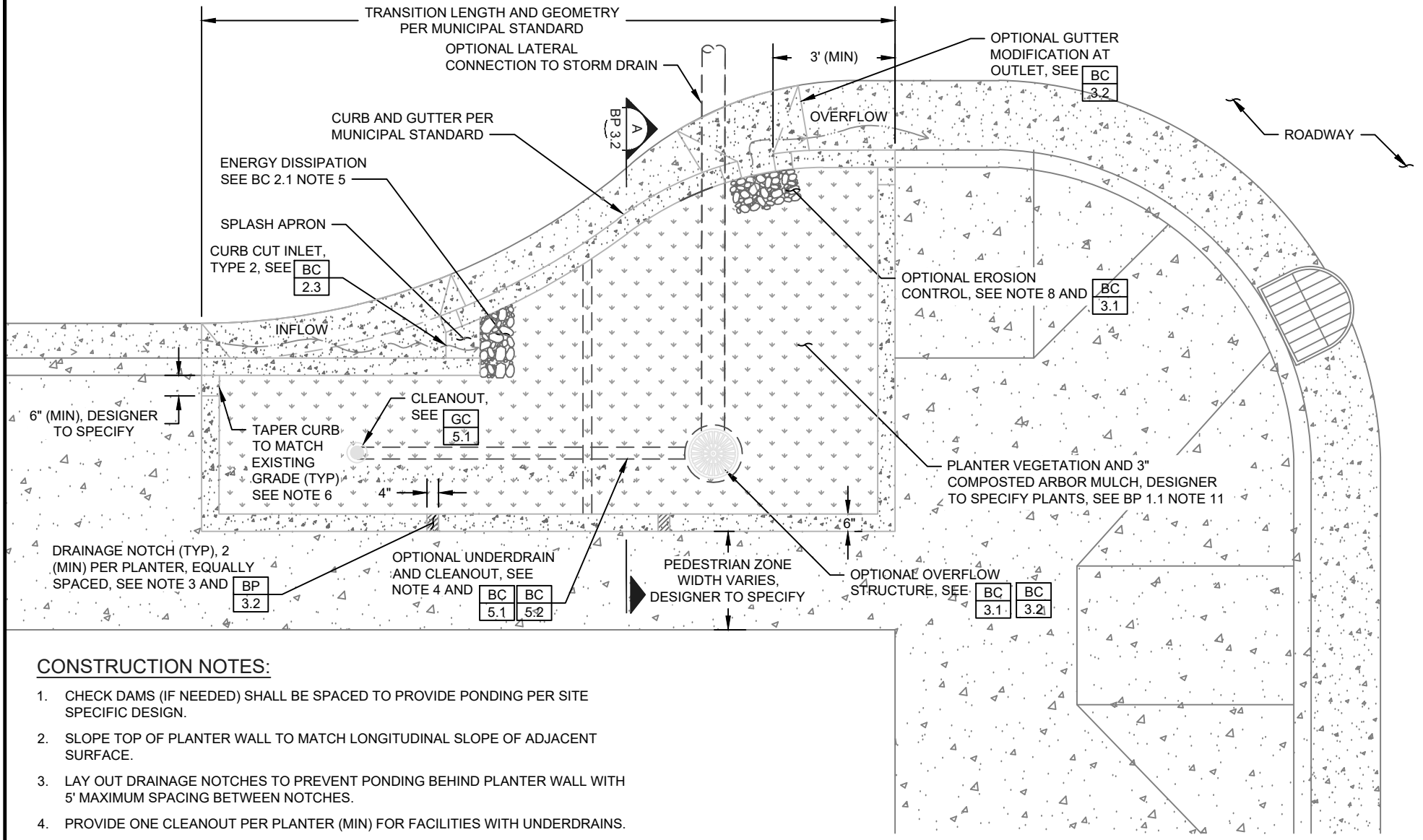
DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION PLANTER

STORMWATER CURB EXTENSION ALT 5 (ALT 2 AT INTERSECTION)

DWG NO. **BP 4.5**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



CONSTRUCTION NOTES:

1. CHECK DAMS (IF NEEDED) SHALL BE SPACED TO PROVIDE PONDING PER SITE SPECIFIC DESIGN.
2. SLOPE TOP OF PLANTER WALL TO MATCH LONGITUDINAL SLOPE OF ADJACENT SURFACE.
3. LAY OUT DRAINAGE NOTCHES TO PREVENT PONDING BEHIND PLANTER WALL WITH 5' MAXIMUM SPACING BETWEEN NOTCHES.
4. PROVIDE ONE CLEANOUT PER PLANTER (MIN) FOR FACILITIES WITH UNDERDRAINS.
5. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT MUNICIPAL STANDARDS OR SEE SCVURPPP GSI HANDBOOK UTILITY COORDINATION SECTION FOR GUIDANCE. COORDINATE WITH ENGINEER IN THE EVENT OF UTILITY CROSSING AND UTILITY CONFLICTS.
6. IF STREET PARKING IS ALLOWED IMMEDIATELY ADJACENT TO THE CURB CUT INLET/OUTLET, THE PLANTER WALL TAPER SHOULD BE LOCATED 18" BEHIND THE FACE OF CURB. COORDINATE WITH MUNICIPALITY.

NOTES		W/PARKING		W/O PARKING		BULBOUT					
		PLAN SECTIONS		PLAN SECTIONS		ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
BP 1.1	BP 1.2	BP 2.1	BP 2.2	BP 3.1	BP 3.2	BP 4.1	BP 4.2	BP 4.3	BP 4.4	BP 4.5	BP 4.6

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION BP 4.6

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION PLANTER

STORMWATER CURB EXTENSION

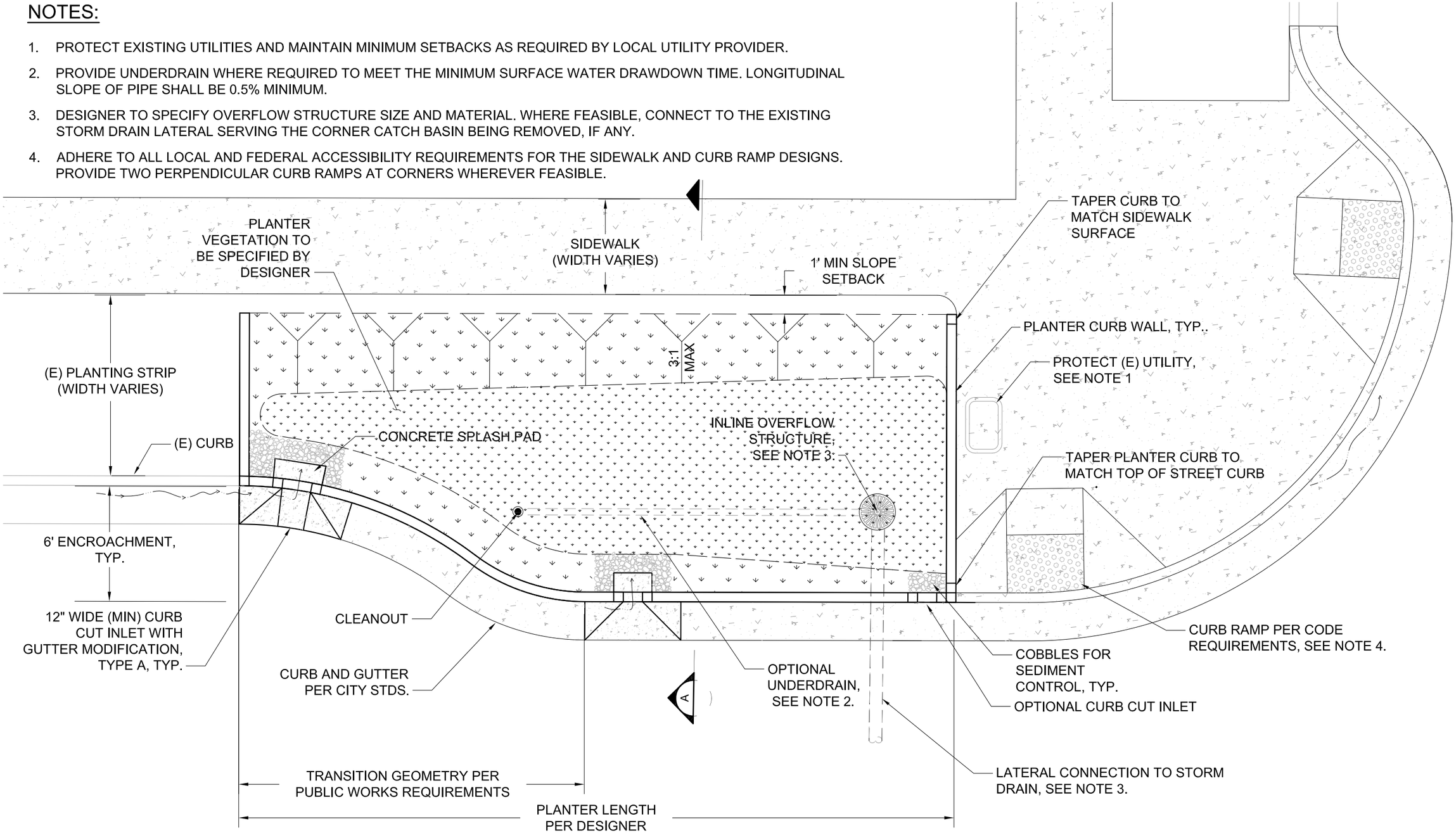
ALT 6 (ALT 4 W/ WIDENED PLANTER)

DWG NO. **BP 4.6**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES:

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



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

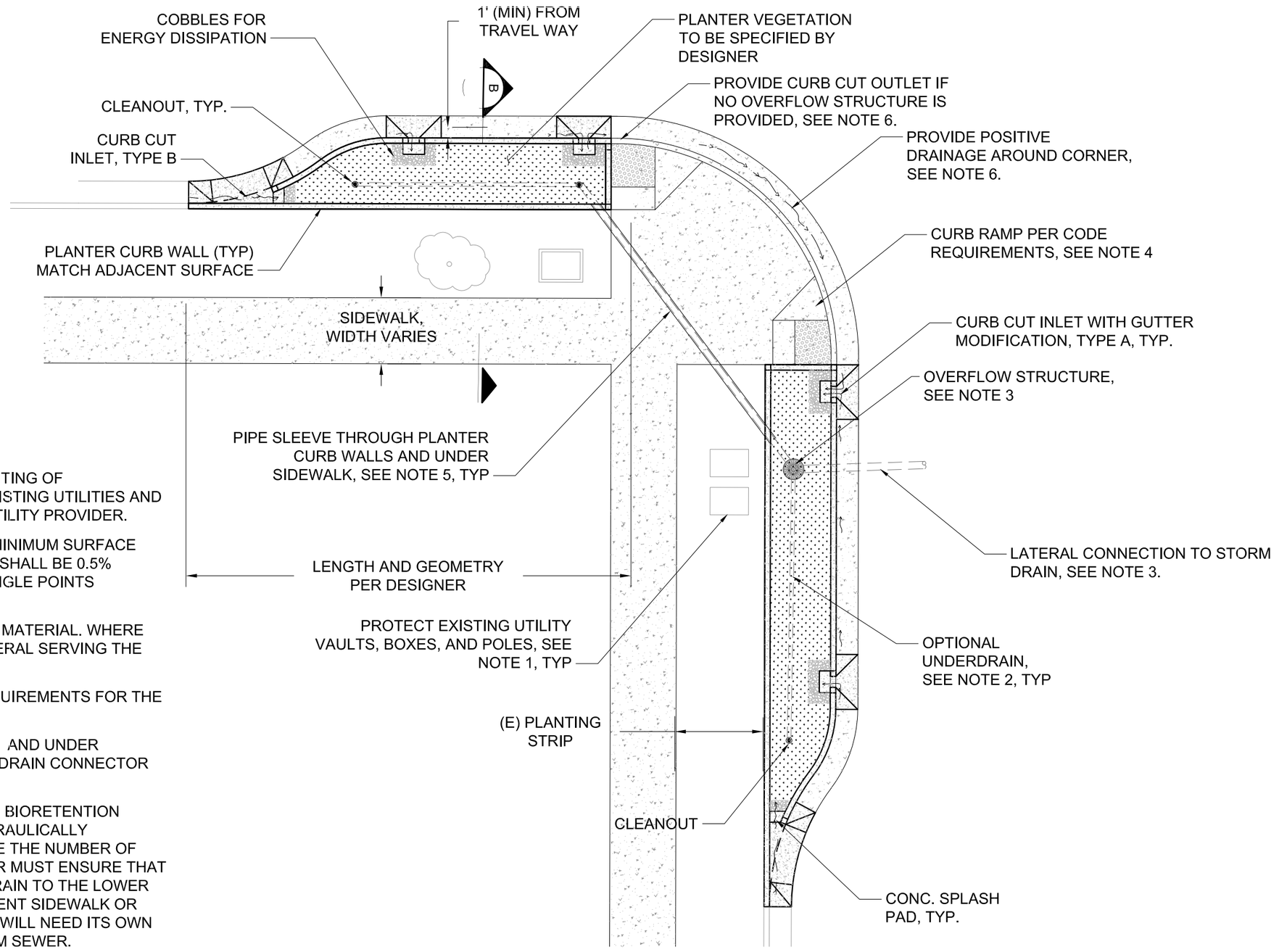
SCALE: 1"=5'

DRAWN BY: BF

CHECKED BY: SD

DATE : APRIL 14, 2017

SHEET NUMBER C-1.1



NOTES:

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

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

SCALE: 1"=10'

DRAWN BY: BF

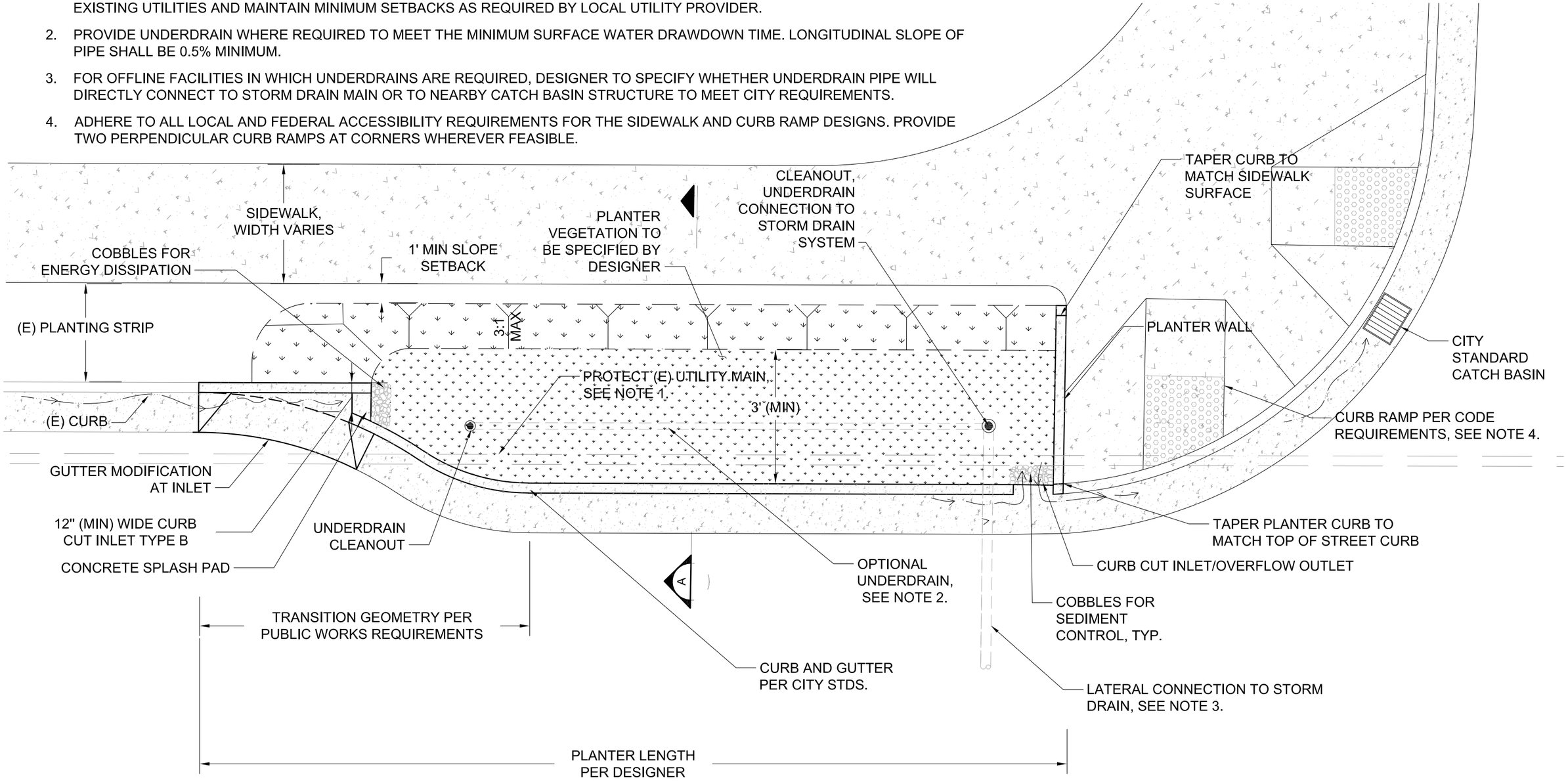
CHECKED BY: SD

DATE : APRIL 14, 2017

SHEET NUMBER C-1.2

NOTES:

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



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

SCALE: 1"=5'

DRAWN BY: BF

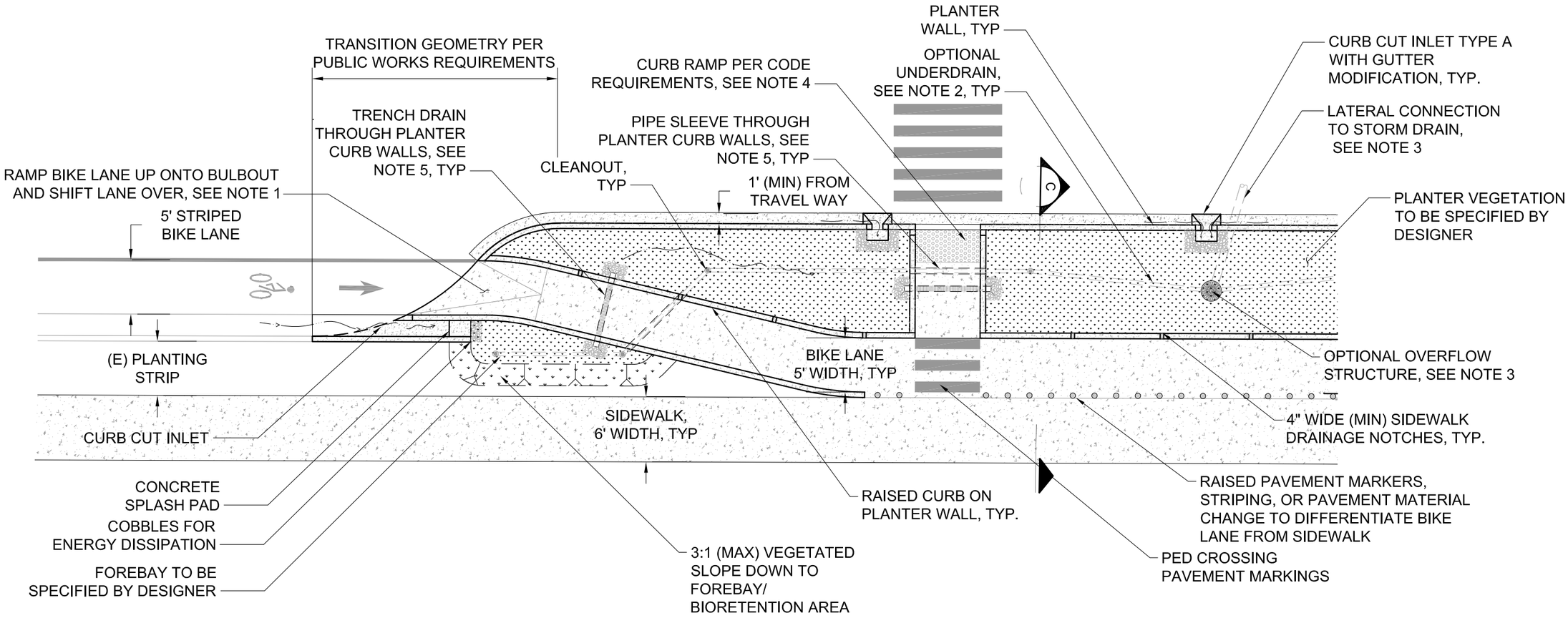
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DATE : APIRL 14, 2017

SHEET NUMBER C-1.3

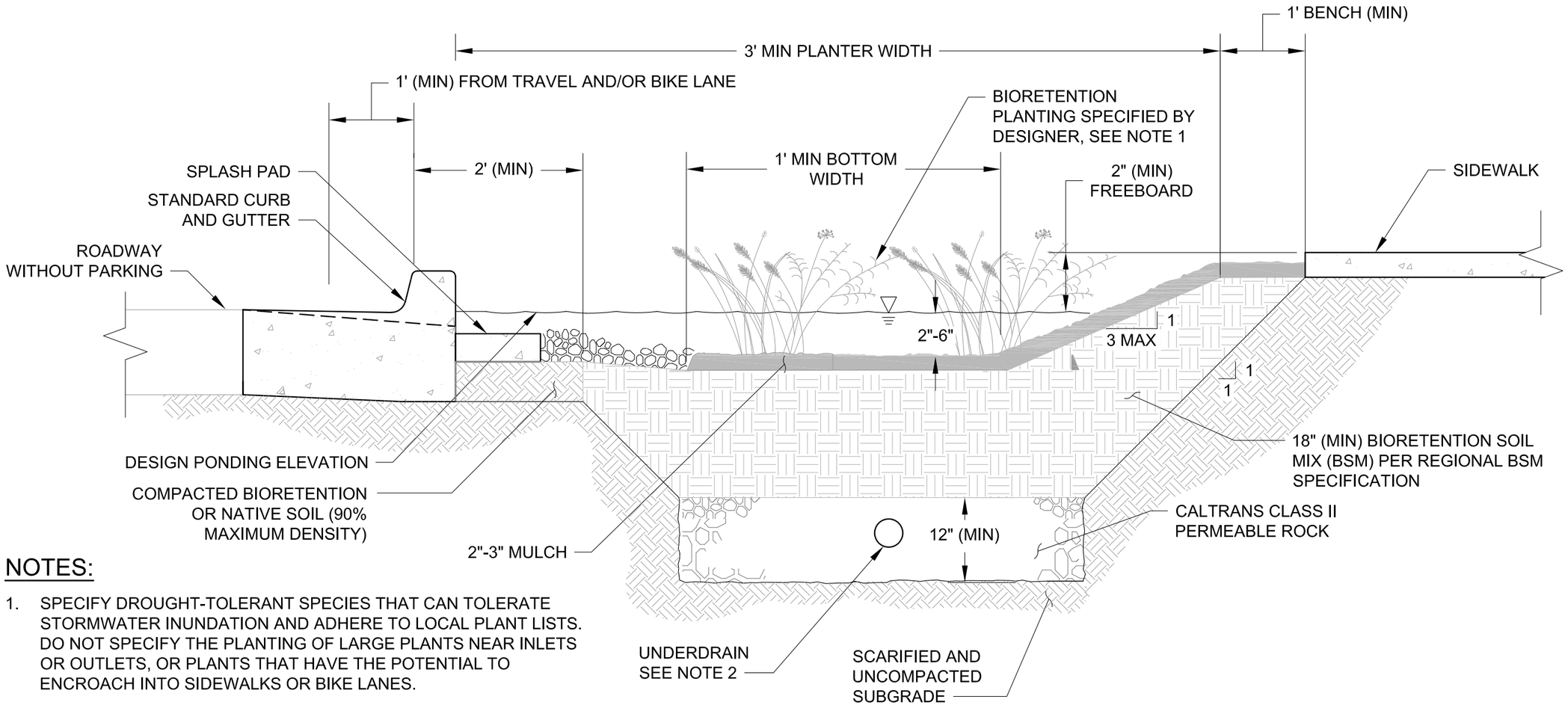
NOTES:

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



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

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



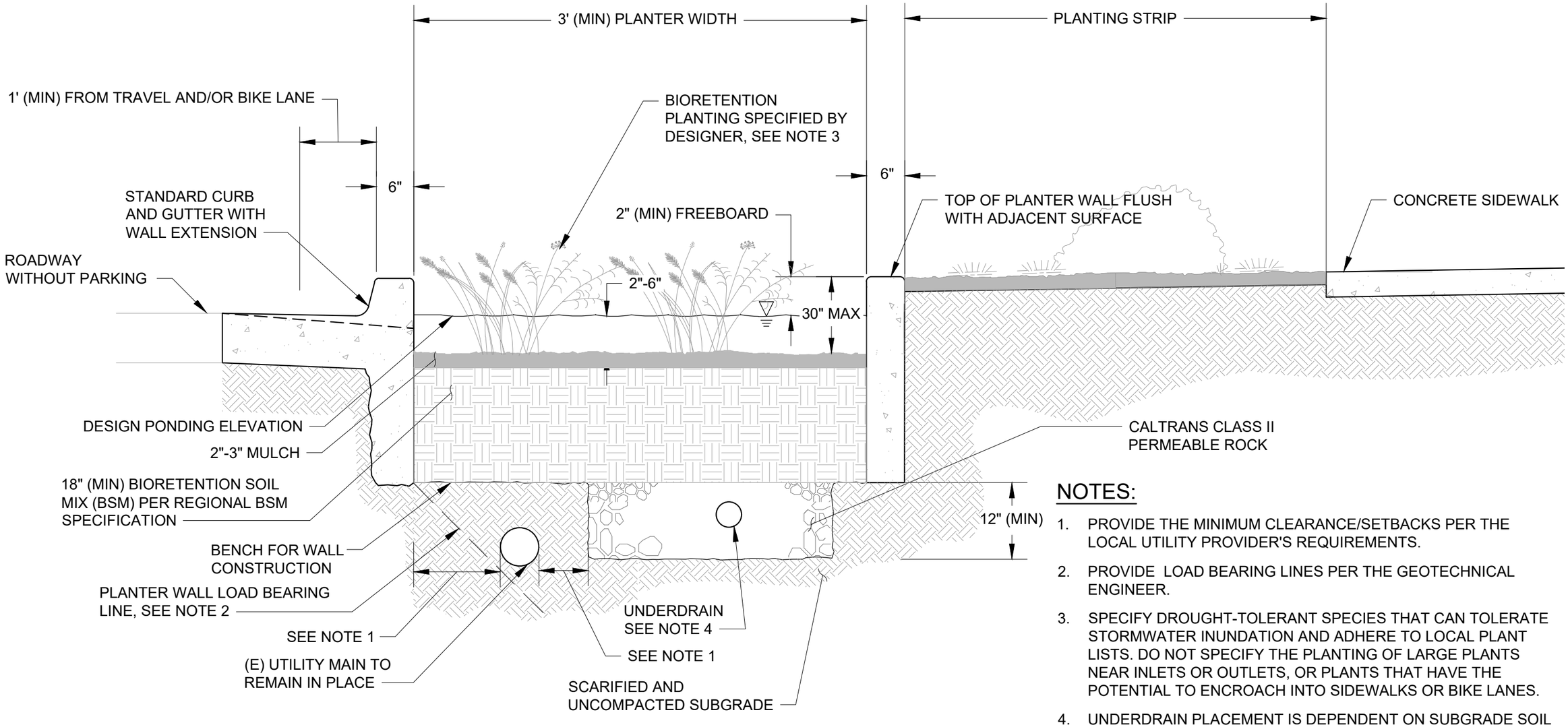
NOTES:

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

BIORETENTION BULBOUT SECTION A

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

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



BIORETENTION BULBOUT SECTION B

NOTES:

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

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

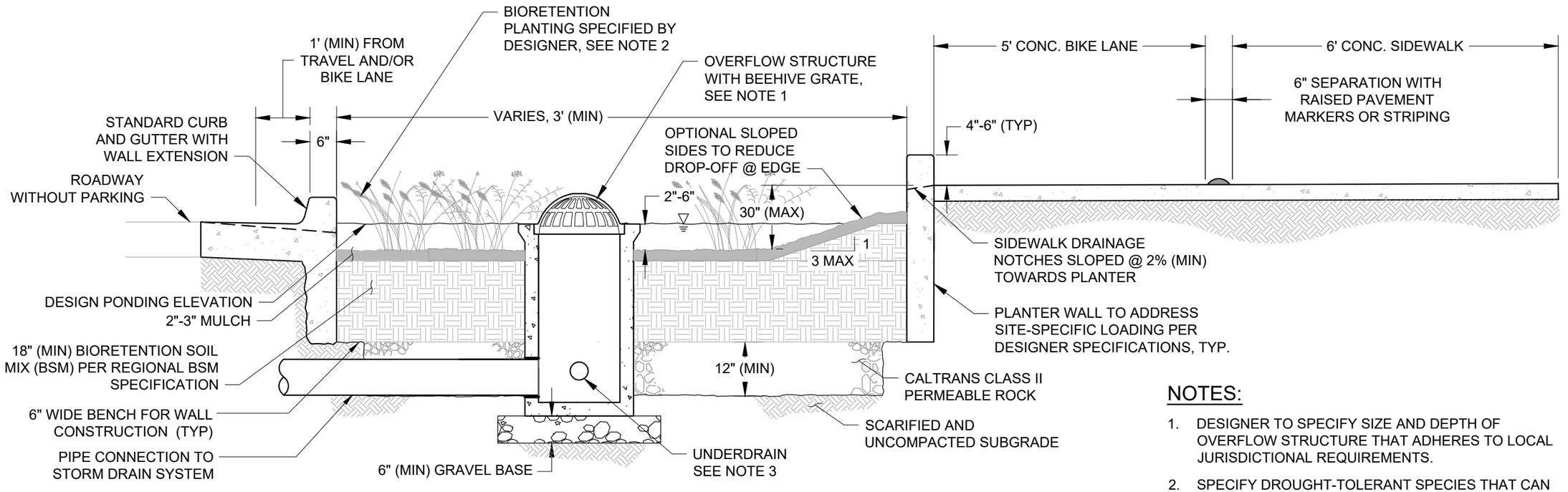
SCALE: 3/4"=1'

DRAWN BY: BF

CHECKED BY: SD

DATE : April 14, 2017

SHEET NUMBER S-B-B



MIDBLOCK BULBOUT SECTION C

NOTES:

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

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

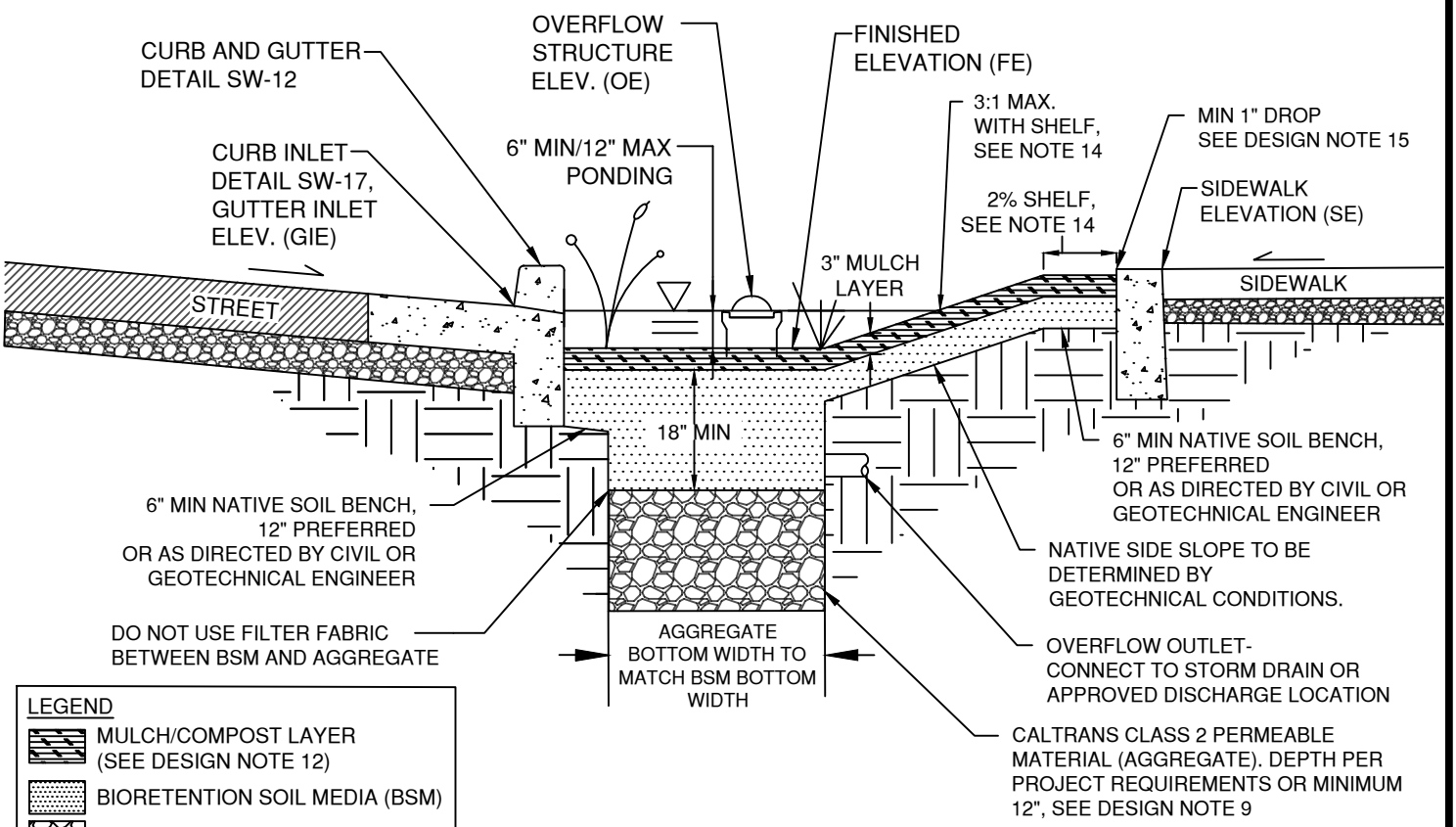
SCALE: 1"=2'

DRAWN BY: BF

CHECKED BY: SD

DATE : April 14, 2017

SHEET NUMBER S-C-C

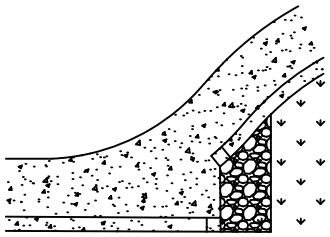


CONSTRUCTION NOTES

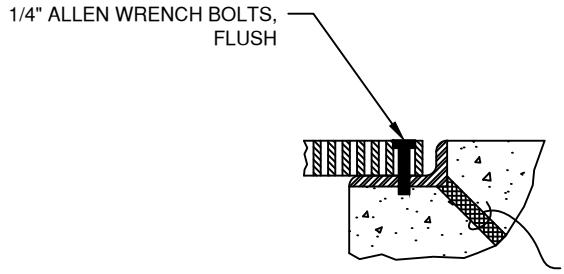
1. MAINTAIN UNDISTURBED NATIVE SOIL BENCH TO SUPPORT ADJACENT SIDEWALK/ROAD. SEQUENCE WORK TO CONSTRUCT CURBS BEFORE EXCAVATING BIORETENTION AREA FOR AGGREGATE AND BSM.
2. SCARIFY SUBGRADE BEFORE INSTALLING BIORETENTION AREA AGGREGATE AND BSM.
3. FACILITY EXCAVATION TO ALLOW FOR SPECIFIED AGGREGATE,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

DESIGN NOTES

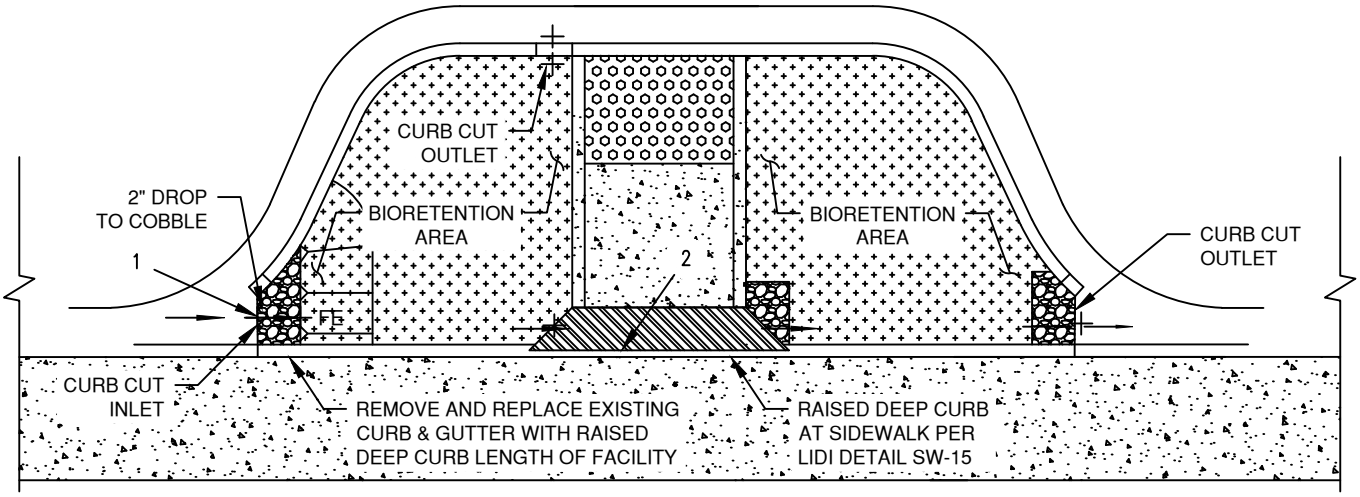
1. BIORETENTION FACILITY DESIGN SHOULD OPTIMIZE THE FLAT BOTTOM DIMENSIONS (I.E., WIDTH, LENGTH) TO MAXIMIZE THE FUNCTIONAL AREA OF THE FACILITY.
2. CAPTURE AND CONVEY OVERFLOW TO STORM DRAIN SYSTEM (DETAIL SW-22, SW-23). ALTERNATIVELY, CONVEY OVERFLOW TO APPROVED DISCHARGE LOCATION THROUGH OTHER OVERLAND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



CURB CUT INLET 1



GRATE & FRAME 2



CONSTRUCTION NOTES:

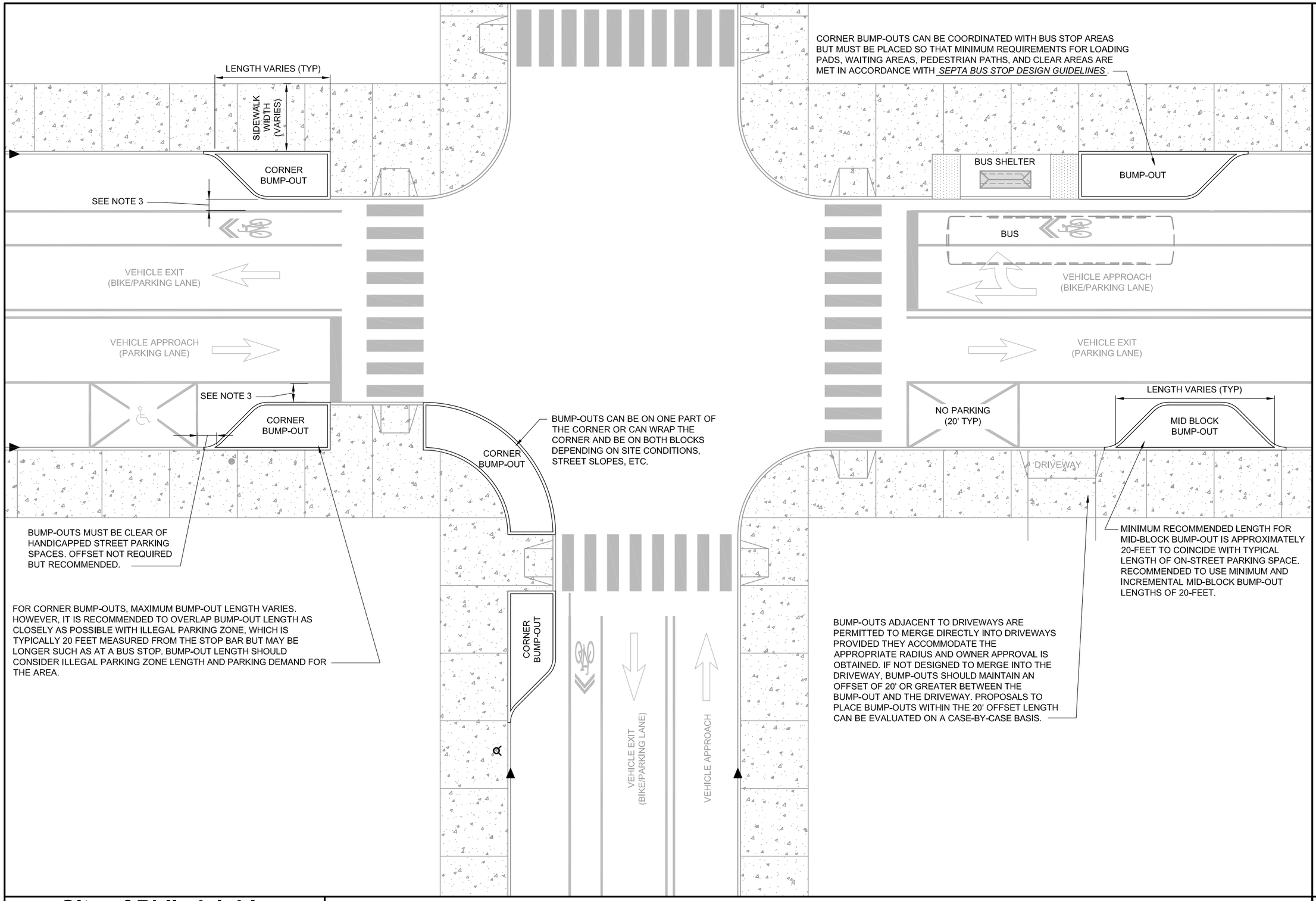
1. INSTALL GRAVEL BAGS AT CURB CUTS TO BLOCK FLOW FROM ENTERING BIORETENTION AREA. CITY TO REMOVE GRAVEL BAGS AT A TIME FOLLOWING CONSTRUCTION COMPLETION.

DESIGN NOTE:

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

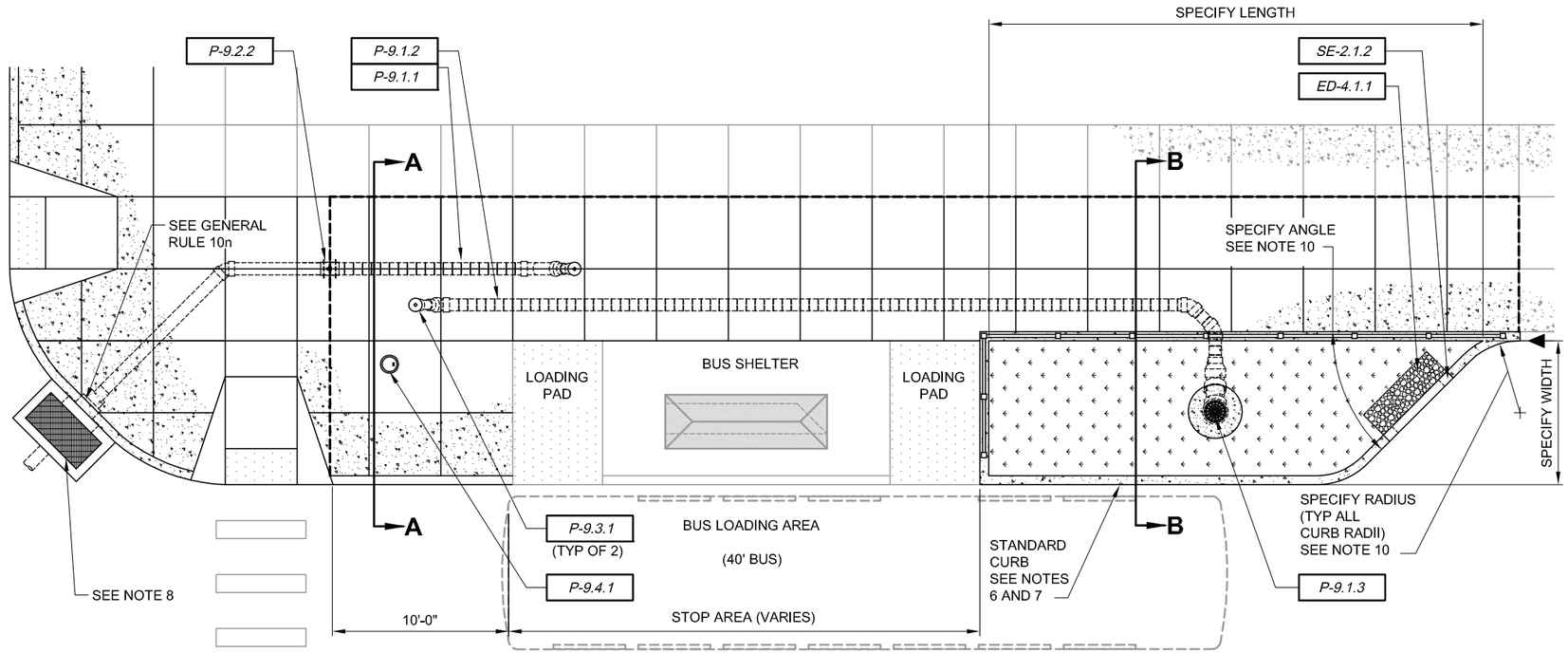
CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY: VERSION: 08/31/2017	STREET BIORETENTION BULB OUT, MID BLOCK CROSSING USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-5.1 SHEET 1 OF 1



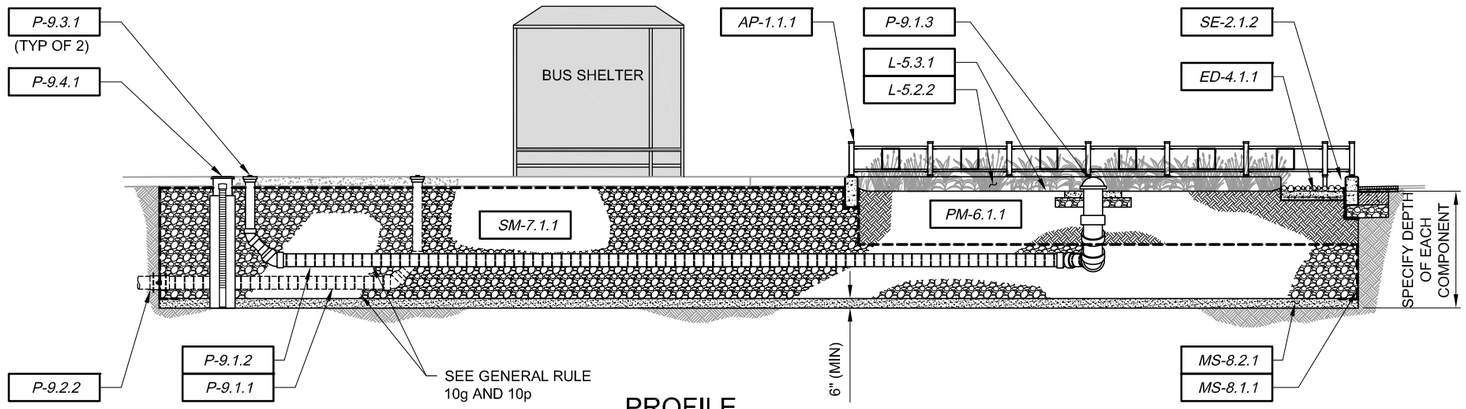
GENERAL NOTES:

1. Corner stormwater bump-outs should only be installed where at least one of the two streets meeting at the corner drain towards the corner.
2. Bump-outs in roadways with no parking lane can be considered on a case-by-case basis.
3. In all cases, bump-outs must maintain a minimum offset of 1' from travel lane. Travel lane includes both vehicle and bike lanes.
4. Bump-outs must never narrow street to less than 20' in order to not limit fire vehicles' access down the street.
5. Designers should determine the approved geometry for bump-outs based on good engineering practice and judgement of the site. This includes the angle of the curb that is cross to the travel lane and all curb radii. A typical bump-out geometry that is often used and approved in Philadelphia includes a curb at a 45 degree angle to the travel lane and 5' curb radii. For corner bump-outs that wrap the corner all curb radii around corners shall follow guidance on curb/corner radii included in the city of *Philadelphia Complete Streets Design Handbook*.
6. Fire hydrants must remain within 18-inches of the curb line unless otherwise approved by the Philadelphia Fire Department.

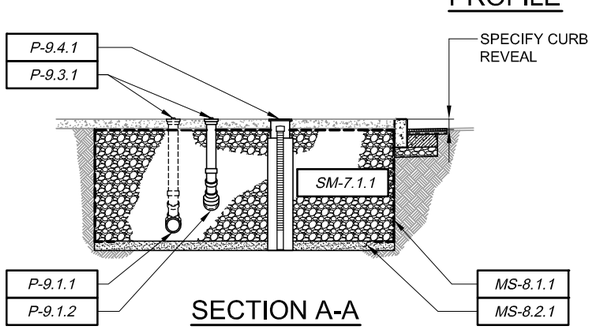
Green Streets



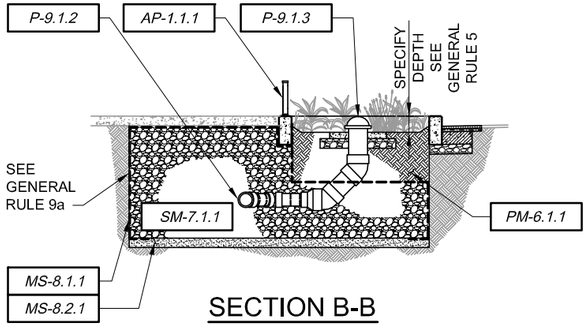
PLAN



PROFILE



SECTION A-A



SECTION B-B

NOTES TO DESIGNER:

1. This design detail should be adapted to the specific engineered design of a respective installation.
2. The lowest planting media surface in stormwater bump-outs should be level along the alignment of the street. A mild slope no greater than 1 percent is acceptable but a level surface is recommended. If surrounding slopes are steep, impermeable barriers such as surface check dams can help maintain a level surface. Note this does not apply to the cross-grading, if used, from the perimeter of the bump-out down to the lowest planting media surface.
3. Designer should consider the height of vegetation both at installation and anticipated maturity. Both heights should be considered in the context of the stormwater bump-out's plan dimensions, depth, and surrounding area protection and vegetation selected accordingly. Note that with the exception of trees, maximum vegetation height at maturity should be no greater than 36-inches above the surrounding sidewalk elevation. Also, plant selection and placement should be done to prevent encroachment of plants outside of the limits of the stormwater bump-out and in consideration of maintaining adequate sight lines based on the placement of the stormwater bump-out.
4. The ponding depth of water in the stormwater bump-outs is correlated to a variety of site specific factors such as surrounding grades, offsets between stormwater entrance elevations and top of planting media, offsets between stormwater entrance and overflow elevations, desired freeboard, the vegetation selected for the stormwater bump-out, and the design depth of the stormwater bump-out. The designer should evaluate site specific conditions such as those mentioned in order to set the design ponding depth in the stormwater bump-out. As a point of reference, ponding depths for PWD's Green Street stormwater bump-outs have typically been between 2-inches to 6-inches.
5. Although not shown, extending the vegetated area into the limits of the sidewalk is permitted. However, any requirements/guidelines for other SMPs located in the sidewalk, such as stormwater planters, would apply.
6. Curbs around stormwater bump-outs on City Streets will follow the same requirements as normal curbs and shall be within a height range of 4" to 8". Designer will select a height within that range based on applicable site conditions and the curb height shall be consistent along the length of the bump-out.
7. Curb height around stormwater bump-outs shall be maximized at corner bump-outs as much as possible and be a consistent height between ADA ramps.
8. When installing corner stormwater bump-outs, gutter flow must be maintained to an existing downstream inlet or a new inlet must be installed along the new curb line as required. Location of new inlet shown can vary and must be evaluated on a case by case basis.
9. Opening size and placement to be determined by designer. Openings along outside edge of bump-out, if used, must include a wheel guard.
10. Designer should determine the appropriate geometry for bump-outs based on good engineering practice and judgment of the site. This includes the angle of curb that is cross to the travel lane and all curb radii. A typical bump-out geometry that is often used and approved in Philadelphia includes a curb at a 45 degree angle to the travel lane. All curb wrapping corners shall follow guidance on curb/corner radii included in the city of *Philadelphia Complete Streets Design Handbook.*
11. Refer to *Septa Bus Stop Design Guidelines* for minimum requirements for loading pads, waiting areas, pedestrian paths, and clear areas.
12. Although not shown here, delineators should be placed along the bump-out curb parallel to the travel lane on snow emergency routes.

APPLICABLE DESIGN COMPONENTS

(AP) Area Protection
- ☑ 1.1.1 Fencing

(ED) Energy Dissipation
- ☑ 4.1.1 Splash Pad

(L) Landscaping
- ☑ 5.2.2 Plants, Grasses, and Shrubs
- ☑ 5.3.1 Mulch

(MS) Media Separation
- ☑ 8.1.1 Geotextile
- ☑ 8.2.1 Sand Filter

(P) Piping
- ☑ 9.1.1 Underdrain
- ☑ 9.1.2 Distribution Pipe
- ☑ 9.1.3 Domed Riser
- ☑ 9.2.2 Anti-seep Collar
- ☑ 9.3.1 Cleanout
- ☑ 9.4.1 Observation Well

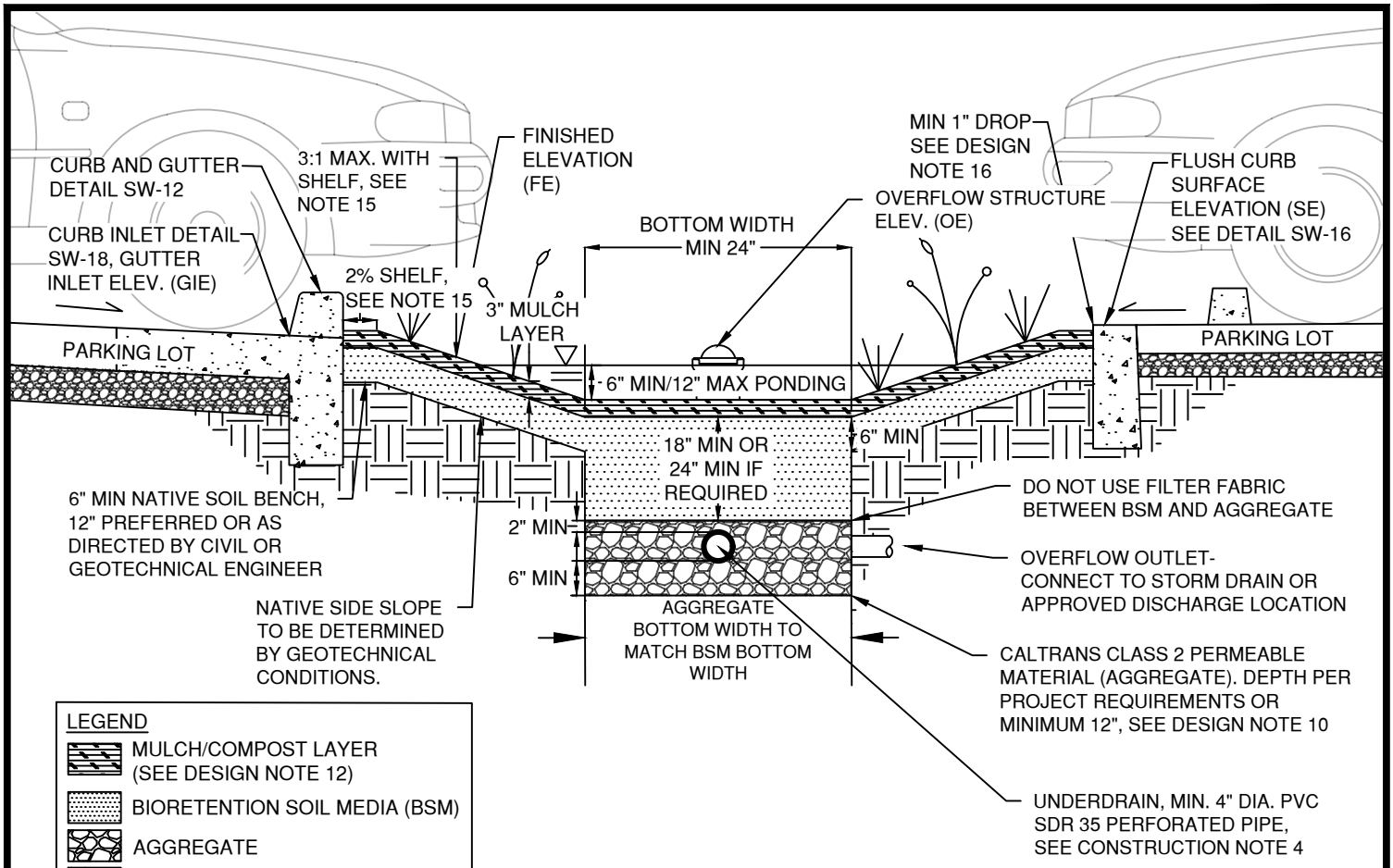
(PM) Planting Media
- ☑ 6.1.1 Engineered Soil

(SE) Stormwater Entrance
- ☑ 2.1.2 Depressed Curb

(SM) Storage Media
- ☑ 7.1.1 Stone

Green Streets

PARKING LOT BIORETENTION



LEGEND

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

CONSTRUCTION NOTES

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

DESIGN NOTES

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

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

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

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

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

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

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

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

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

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

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

12. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

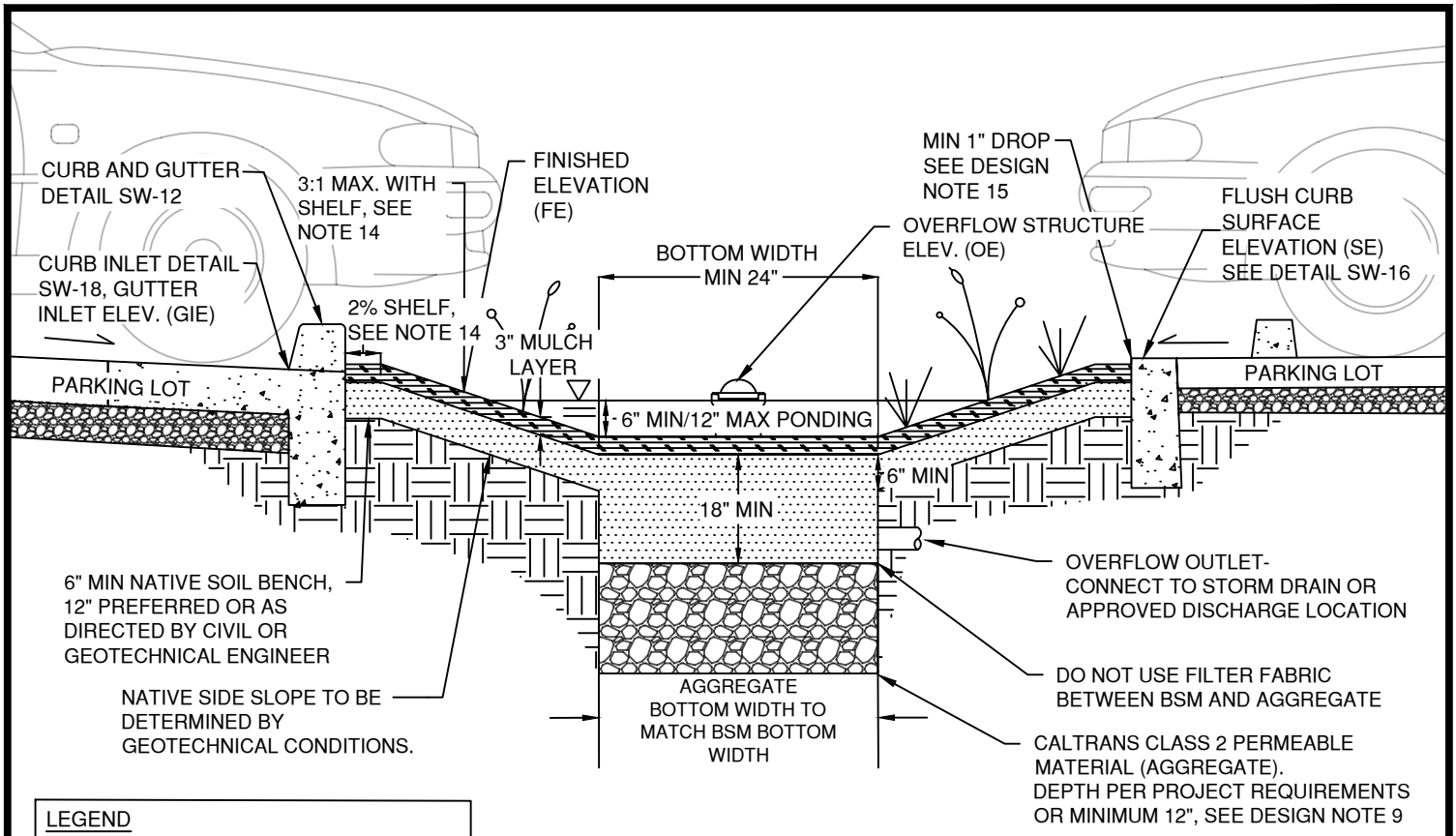
13. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

14. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

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

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

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



LEGEND

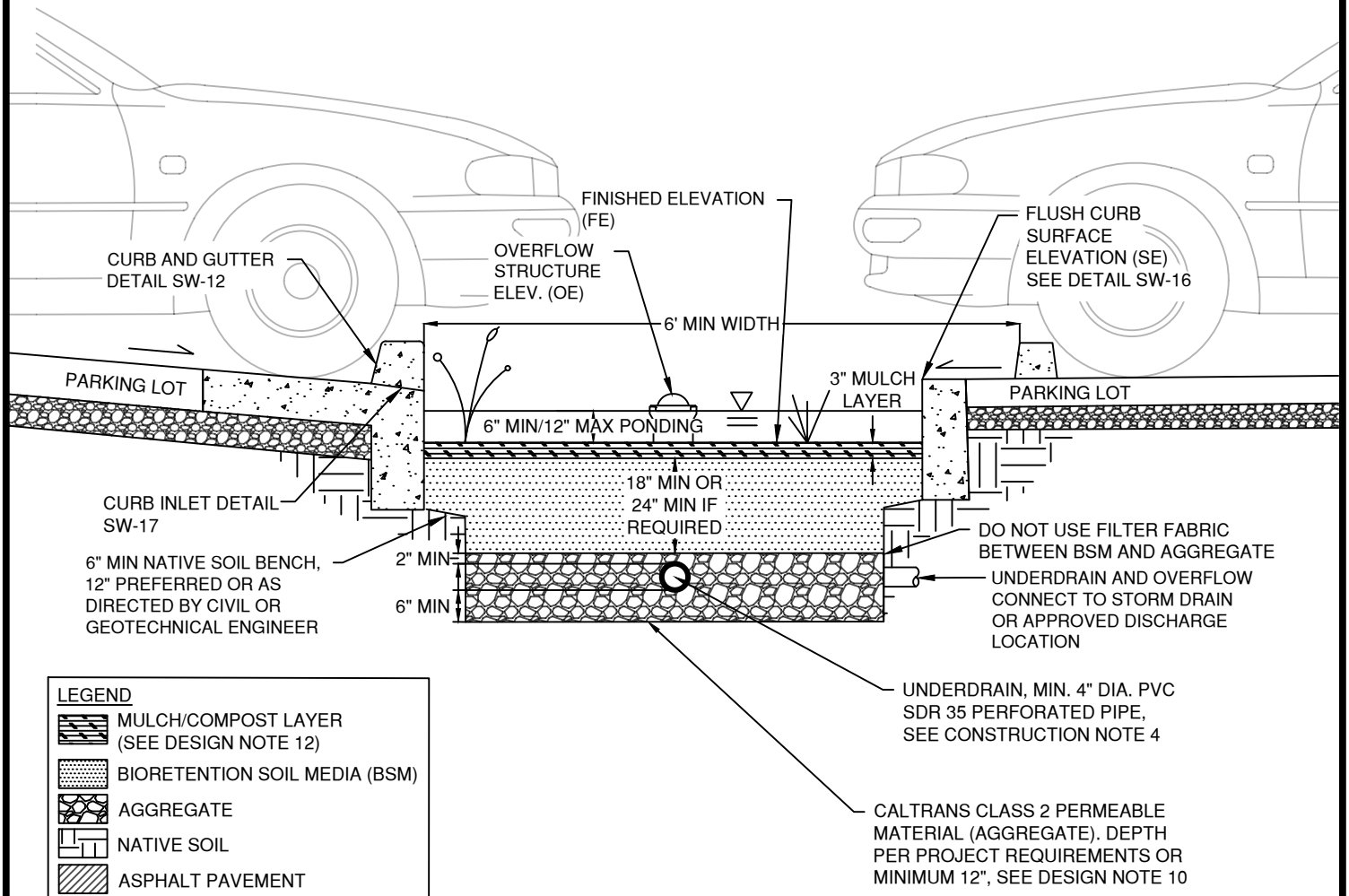
- MULCH/COMPOST LAYER (SEE DESIGN NOTE 12)
- BIORETENTION SOIL MEDIA (BSM)
- AGGREGATE
- NATIVE SOIL
- ASPHALT PAVEMENT
- CONCRETE

CONSTRUCTION NOTES

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

DESIGN NOTES

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

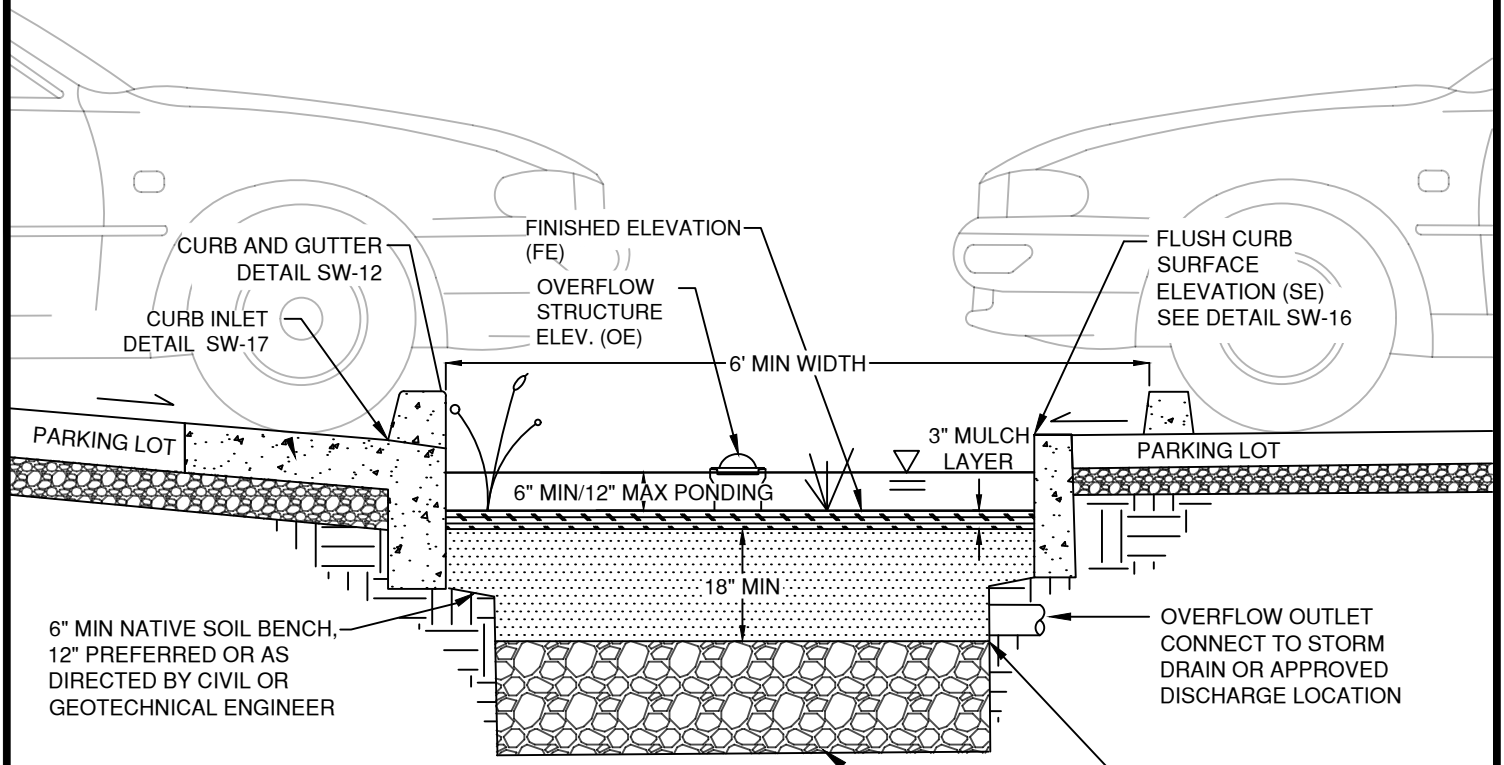


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LEGEND

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

CONSTRUCTION NOTES

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

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

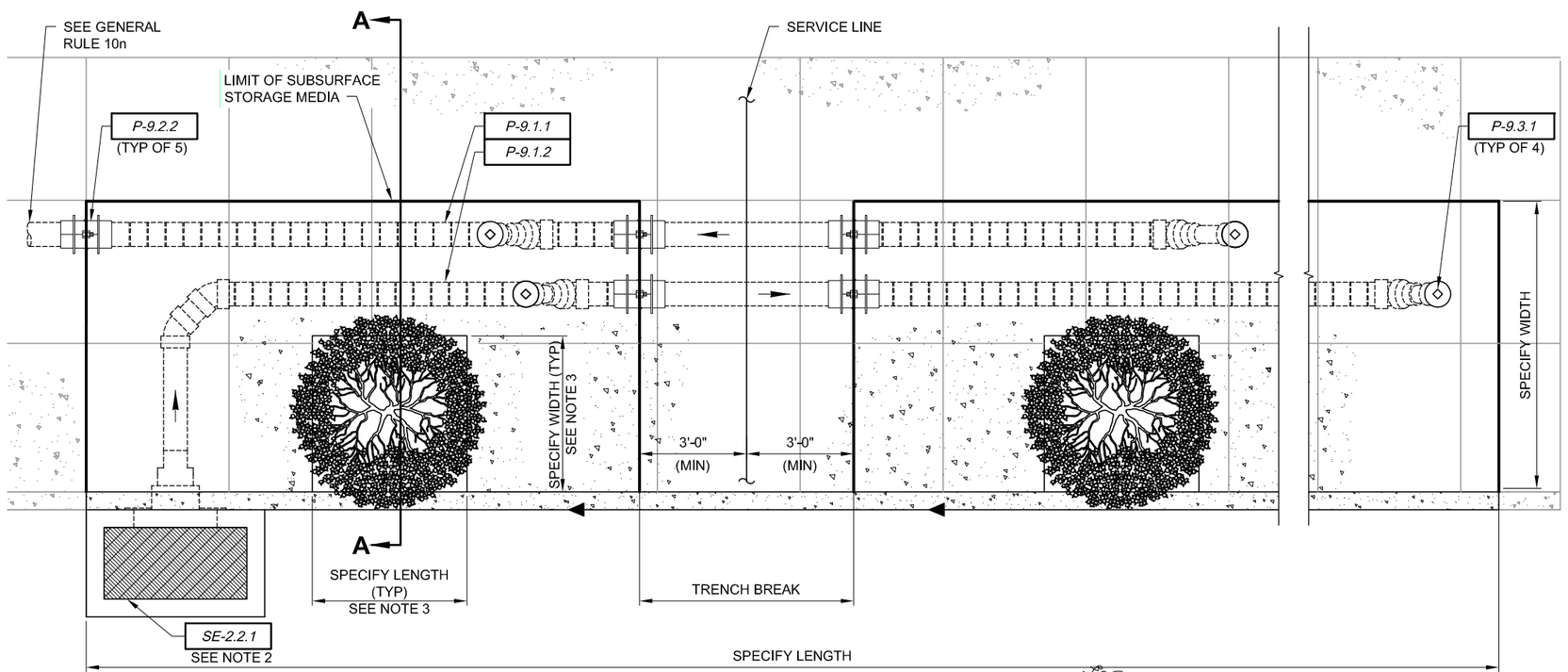
11. PLANT SELECTION PER BIORETENTION TECHNICAL SPECIFICATIONS.

12. MULCH PER BIORETENTION TECHNICAL SPECIFICATIONS.

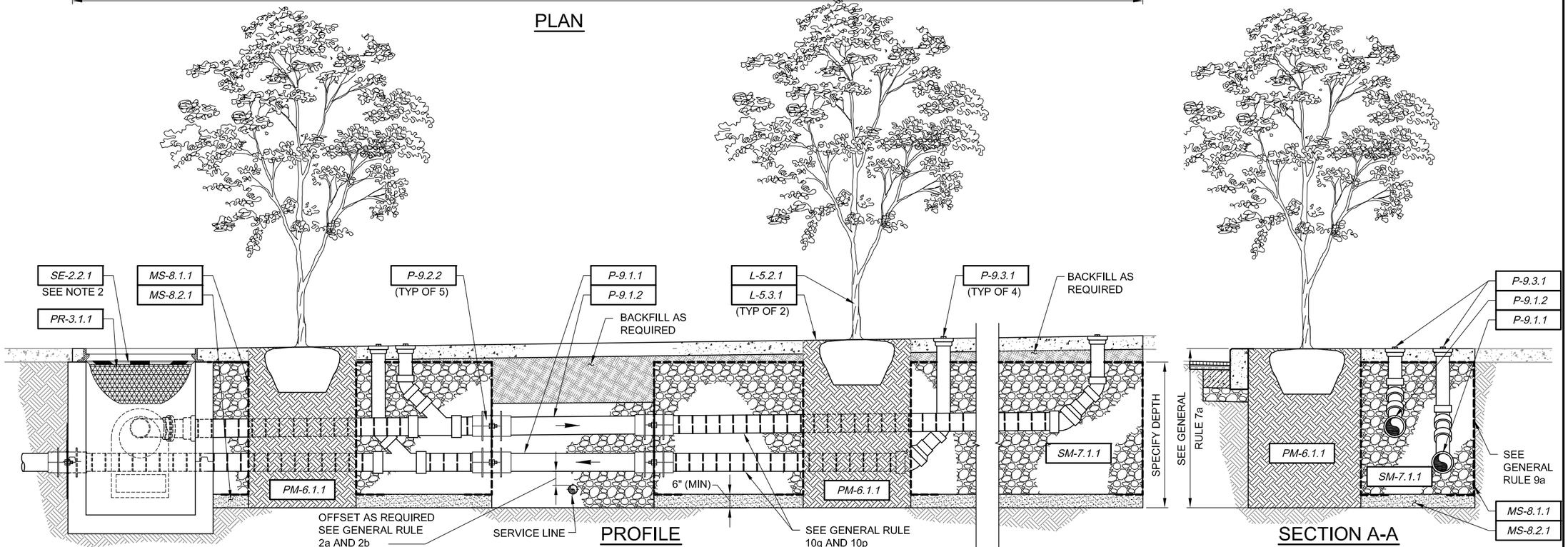
13. LOCATE ENERGY DISSIPATION AS SPECIFIED IN INLET DETAILS.

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

STORMWATER TREE WELL FILTER



PLAN



PROFILE

SECTION A-A

NOTES TO DESIGNER:

1. This design detail should be adapted to your specific engineered design and its respective installation.
2. Green inlets are the most typical inlet used for stormwater tree trenches. While a highway grate type green inlet is depicted and preferred, designers may use a PWD Standard city inlet type as the green inlet if there are utility conflicts or other constraints that preclude installation of a highway grate inlet type.
3. The minimum tree pit dimension is 3-feet by 3-feet. Larger tree pit areas are preferred for the health of the tree and should be used if space is available. Tree pit may also be rectangular in shape.
4. Design should include the number, spacing, and species selection of trees. The city of *Philadelphia Complete Streets Design Handbook* provides a Street Tree Planting Diagram that can be referenced for tree placement. Note that locations and species of all trees are reviewed and approved by PP&R. PP&R can also select tree species, if requested.
5. Although surface is shown as concrete sidewalk, tree trenches can be constructed in conjunction with various surfaces including grass strips, pavers, and other materials. Surface restoration will vary accordingly.

APPLICABLE DESIGN COMPONENTS

(L) Landscaping
- ☑ 5.2.1 Trees
- ☑ 5.3.1 Mulch

(MS) Media Separation
- ☑ 8.1.1 Geotextile
- ☑ 8.2.1 Sand Filter

(P) Piping
- ☑ 9.1.1 Underdrain
- ☑ 9.1.2 Distribution Pipe
- ☑ 9.2.2 Anti-seep Collar
- ☑ 9.3.1 Cleanout

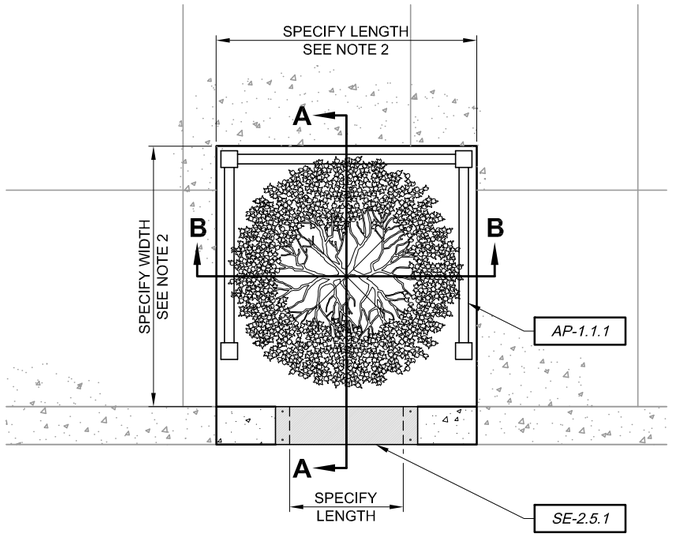
(PM) Planting Media
- ☑ 6.1.1 Engineered Soil

(PR) Pretreatment
- ☑ 3.1.1 Filter Insert

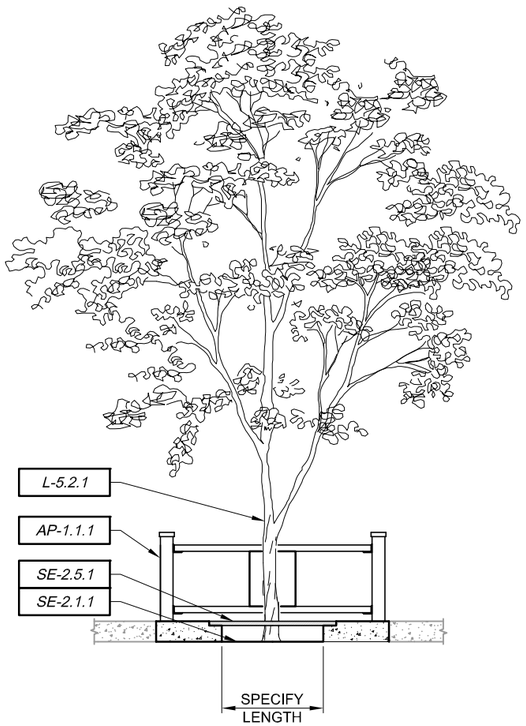
(SE) Stormwater Entrance
- ☑ 2.2.1 Green Inlet

(SM) Storage Media
- ☑ 7.1.1 Stone

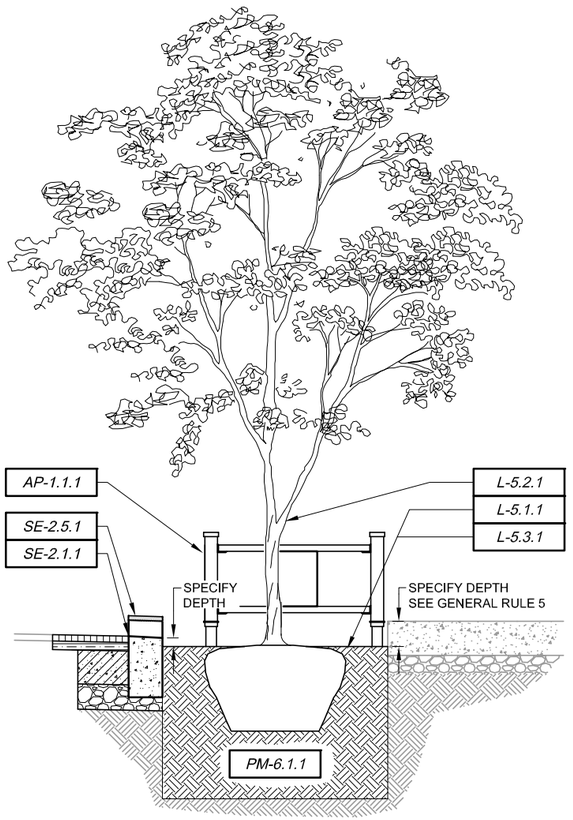
Green Streets



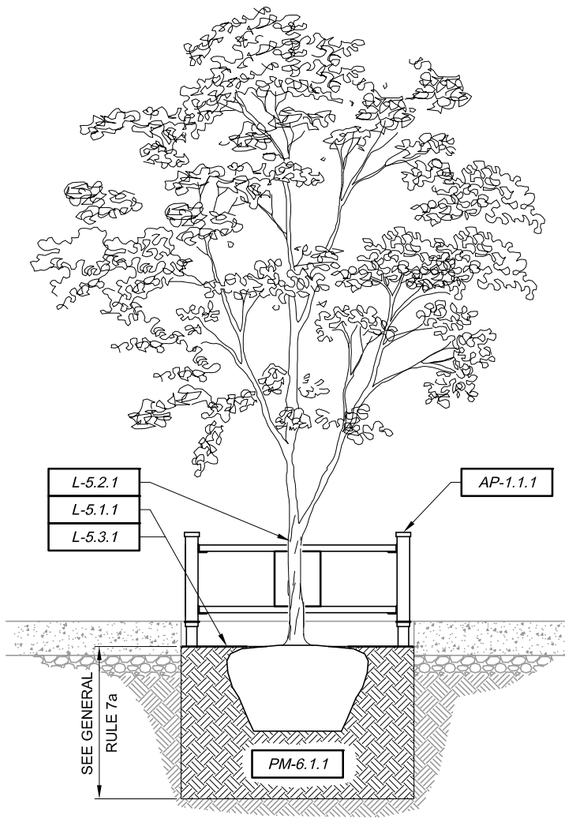
PLAN



FRONT ELEVATION



SECTION A-A



SECTION B-B

NOTES TO DESIGNER

1. This design detail should be adapted to your specific engineered design and its respective installation.
2. The minimum tree pit dimension for tree pits is 3-feet by 3-feet. Larger tree pit areas are preferred for the health of the tree and should be used if space is available. Also, tree pit may also be rectangular in shape.
3. Design should include location and species selection of tree. Note, however, that locations and species of all trees are reviewed and approved by PP&R. PP&R can also select tree species, if requested.
4. Although surface is shown as concrete sidewalk, stormwater trees can be constructed adjacent to various surfaces including grass strips, pavers, and other materials..
5. Designer must ensure the planting media surface is set at an elevation to prevent exposure of the sidewalk's aggregate subbase. If depth of the planting media surface will cause this material to be exposed, designer should design a system to prevent this material from sloughing into the tree pit.
6. The ponding depth of water in the stormwater tree is correlated to a variety of site specific factors such as surrounding grades, offsets between stormwater tree entrance elevations and top of planting media, offsets between stormwater tree entrance and overflow elevations, desired freeboard, and the design depth of the stormwater tree. The designer should evaluate site specific conditions such as those mentioned in order to set the design ponding depth in the stormwater tree. As a point of reference, ponding depths for PWD's Green Street stormwater trees have typically been between 2-inches and 6-inches.

APPLICABLE DESIGN COMPONENTS

(AP) Area Protection
- ☑ 1.1.1 Fencing

(L) Landscaping
- ☑ 5.1.1 Erosion Control Blanket
- ☑ 5.2.1 Trees
- ☑ 5.3.1 Mulch

(PM) Planting Media
- ☑ 6.1.1 Engineered Soil

(SE) Stormwater Entrance
- ☑ 2.1.1 Curb Cut
- ☑ 2.5.1 Wheel Guard

Green Streets

L

5.2.1 Trees

Description

Trees are used both within and outside of vegetated stormwater management practices (SMP) and are an important element of green streets. They create shade, make SMPs more attractive and visible, help to reduce heat island effects, improve air quality, help maintain and improve soil permeability, and provide evapotranspiration of the stormwater being managed.

Specifications

- Native species are preferred.

Additional Considerations/Options

Selected tree species for street applications must be able to withstand a wide range of conditions. Consider stressors such as wind, exposure, salt tolerance, insects, drought and inundation tolerance, and disease as well as micro-climates and sunlight conditions.

Applicability

Typically used in stormwater tree trenches and stormwater trees but may be used in stormwater planters and stormwater bump-outs or outside of SMPs altogether.

Submittal Requirements

Submit location and species of all trees to Philadelphia Parks and Recreation (PP&R) for review and approval.

References

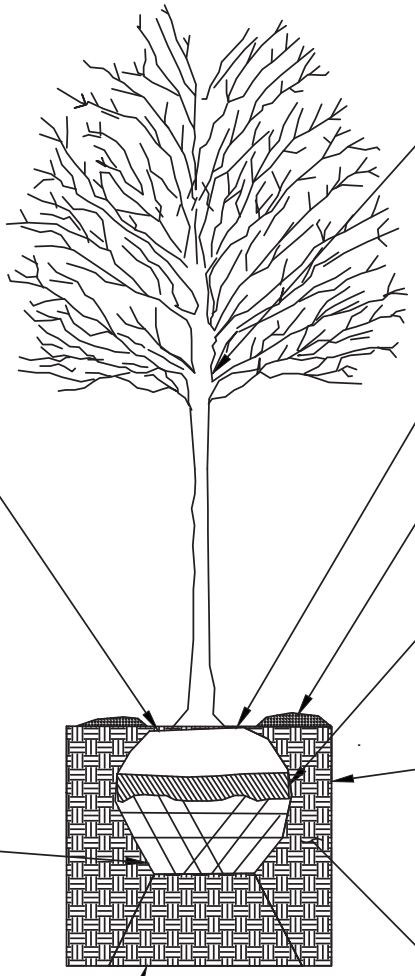
- PWD Green Stormwater Infrastructure Design Requirements and Guidelines Packet, GSI Recommended Plant List (dated March 26, 2013)

Attachments

- Tree Pit detail
- GSI Recommended Plant List (Trees Only)

L

NOTES:
1. THE TRUNK OF THE TREE SHALL NOT BE USED AS A LEVER IN POSITIONING OR MOVING THE TREE. CONTRACTOR SHALL LEAVE NURSERY/CONTRACTOR SEAL IN PLACE.



DO NOT HEAVILY PRUNE THE TREE AT PLANTING. PRUNE ONLY CO-DOMINANT LEADERS, BROKEN, DEAD OR DAMAGED BRANCHES. PRUNE WITH A CLEAN CUT PER ANSI A300 & ISA (2008) STANDARDS. DO NOT CUT TREE'S CENTRAL LEADER.

KEEP MULCH 6" AWAY FROM TRUNK FLARE

2" DOUBLE SHREDDED HARDWOOD MULCH DRESSING AROUND ALL SIDES TO THE EDGE OF THE SIDEWALK OPENING.

CONTRACTOR SHALL EXPOSE THE TREE ROOT FLARE PRIOR TO PLANTING TO ENSURE THAT THE BASE OF THE TRUNK FLARE IS LEVEL WITH FINISHED GRADE AND THE TREE IS PLUMB IN ALL DIRECTIONS. TREES WITH ROOT FLARES SET BELOW GRADE WILL BE REJECTED.

CUT AND REMOVE 2/3 OF WIRE BASKET OR BURLAP; REMOVE TREE WRAP OR CARDBOARD TUBING FROM ALL TREE TRUNKS. DO NOT LEAVE MATERIALS IN THE TREE PIT.

PLACE GEOTEXTILE ON SIDES OF TREE PIT WHEN IN CONTACT WITH AN SMP'S STORAGE MEDIA, IF APPLICABLE.

PLACE ROOT BALL ON FIRMLY PACKED SOIL PEDESTAL TO PREVENT SETTLING AND PROVIDE TREE STABILITY

PLANTING MEDIA BACKFILL IN 6" LIFTS, FIRMLY TAMPING EACH LIFT TO PREVENT SETTLEMENT.

SCARIFY SOIL HORIZON WHERE PLANTING SOIL MEETS UNDISTURBED SOIL TO DEPTH OF ROOT BALL

Green Streets

2014

TREE PIT

Figure 1: Bioretention Schematic

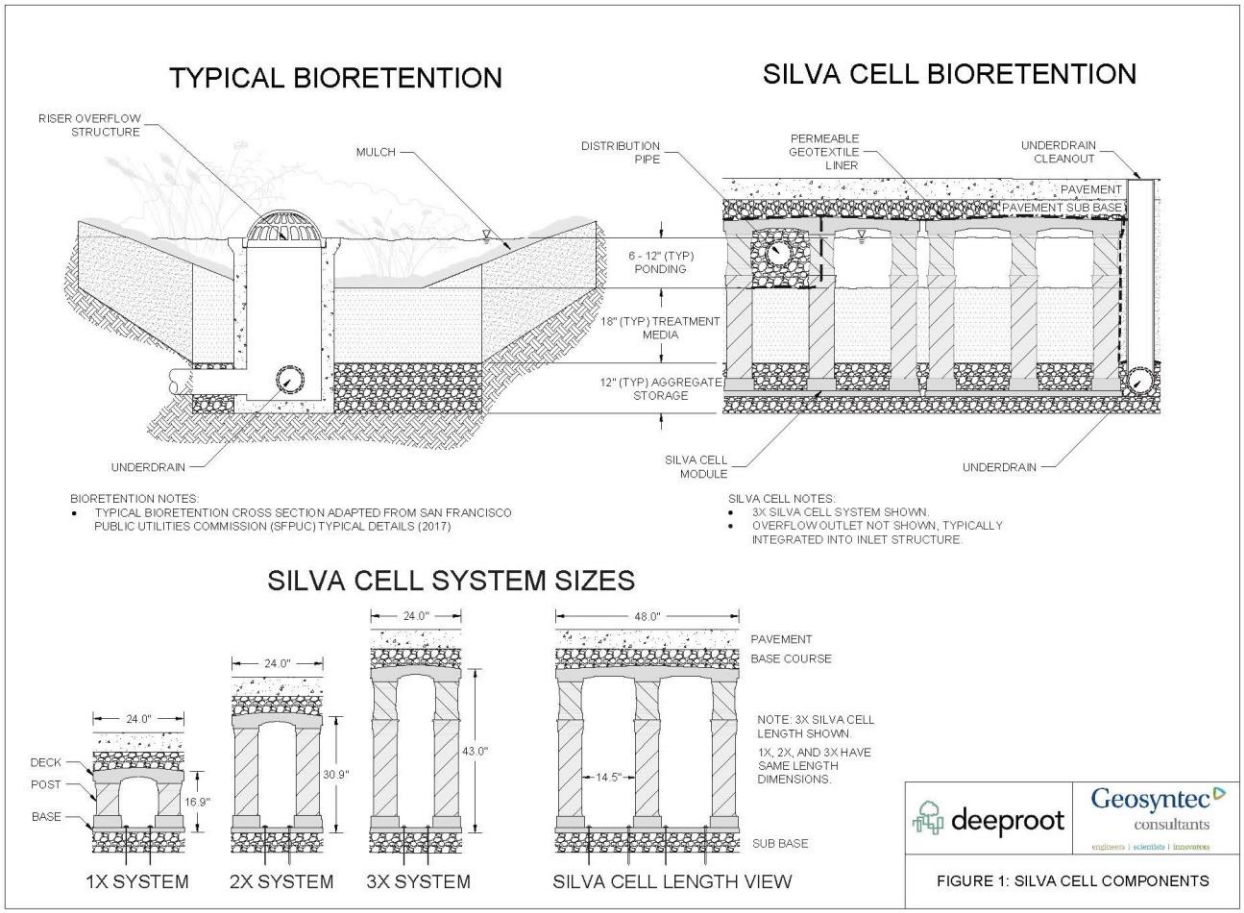


Figure 2: Simple Schematic Drawing of System Overview

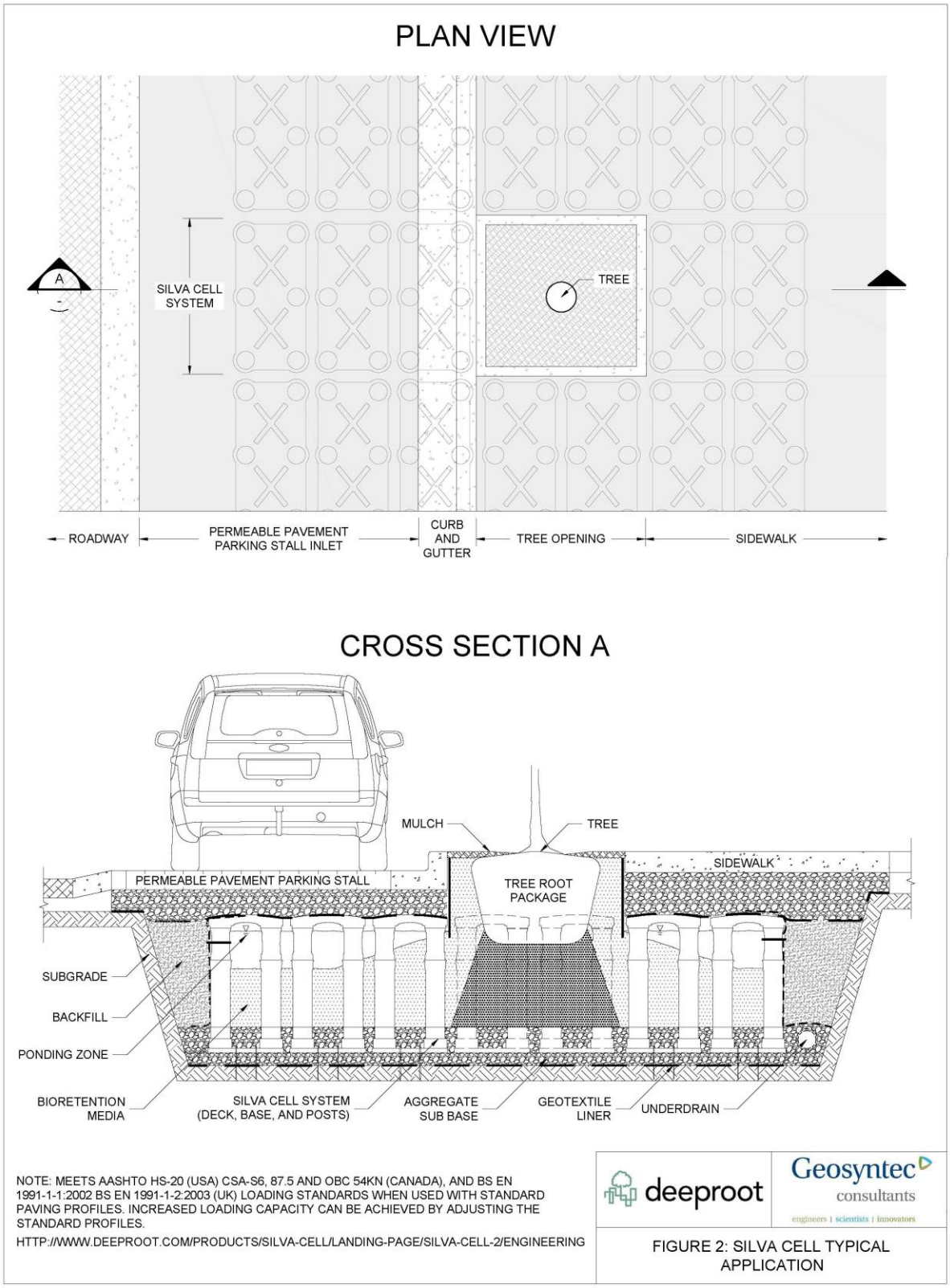


Figure 3: Silva Cell Hydraulic Components

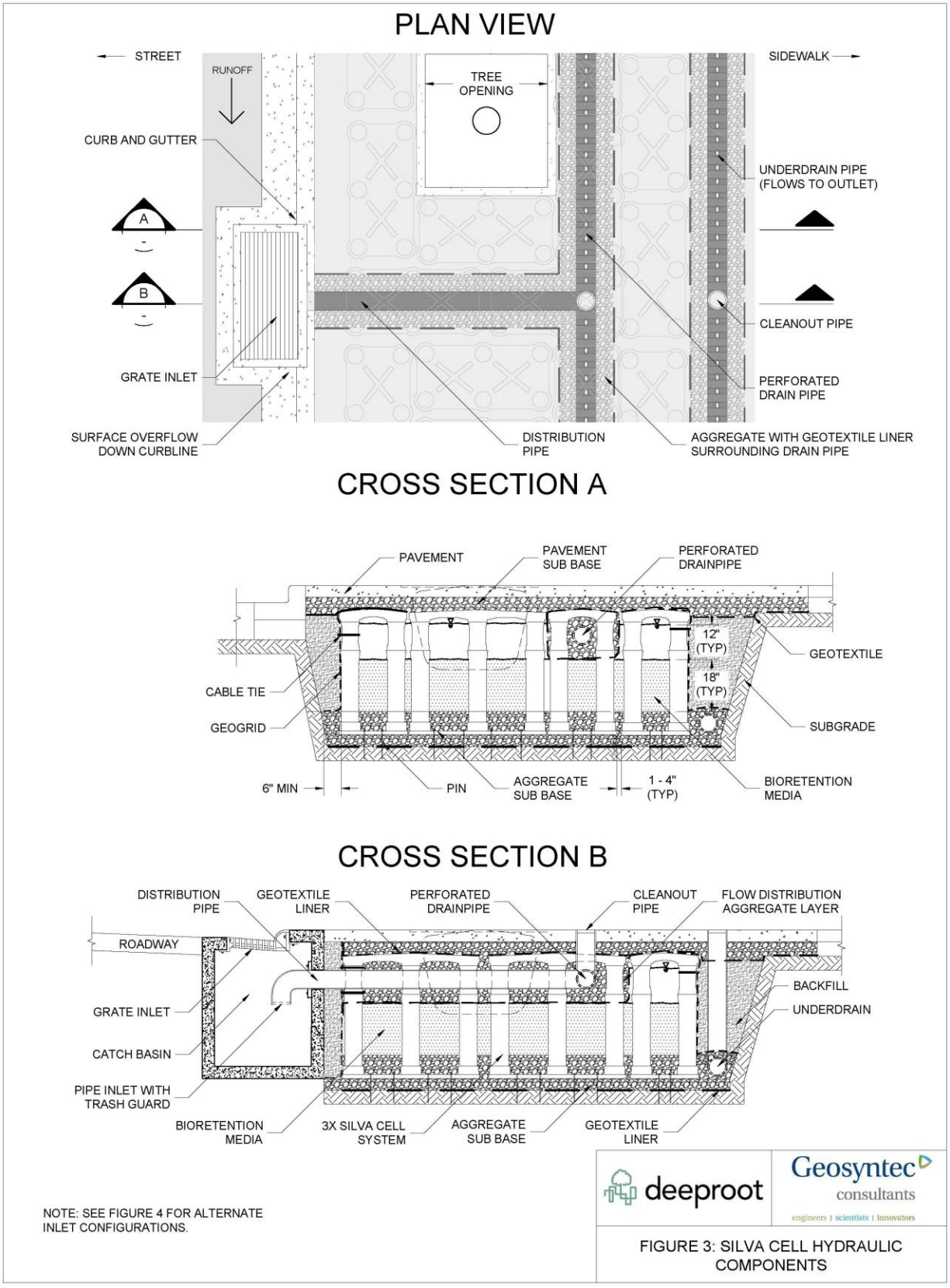
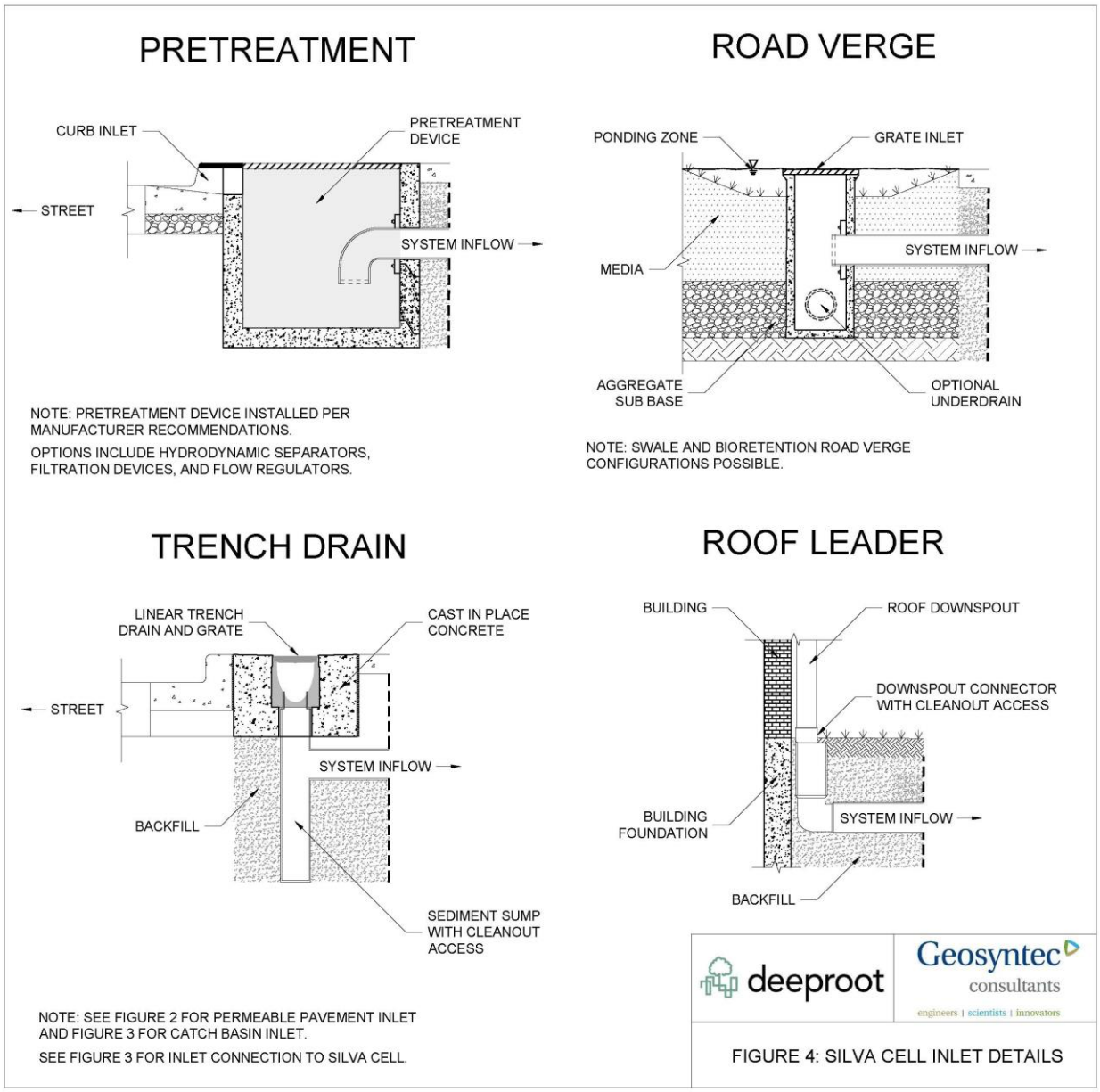


Figure 4: Silva Cell Inlet Configuration Options



BIORETENTION COMPONENTS

PURPOSE:

EDGE TREATMENTS ARE USED TO DEFINE THE BOUNDARIES OF A BIORETENTION FACILITY AND ARE INTENDED PRIMARILY TO STABILIZE THE EDGE OF ADJACENT PAVEMENT AND MINIMIZE LATERAL MOVEMENT OF WATER, AS APPLICABLE. IN CASES WHERE ADEQUATE SPACE IS AVAILABLE, THE FACILITY SIDESLOPE CAN BE LAID BACK SUCH THAT THE SURROUNDING NATIVE SOIL IS STABLE AND CAN FUNCTION AS THE FACILITY EDGE TREATMENT. HOWEVER, WHEN SPACE IS LIMITED, EDGE TREATMENTS SUCH AS VERTICAL WALLS MAY BE USED TO MAINTAIN THE STRUCTURAL INTEGRITY OF THE SURROUNDING SURFACES. THESE EDGE TREATMENTS RETAIN STORMWATER WITHIN THE FACILITY (AND OUT OF THE SURROUNDING PAVEMENT SECTIONS, AS APPLICABLE) UNTIL WATER INFILTRATES, IS COLLECTED BY THE UNDERDRAIN, OR OVERFLOWS VIA THE DESIGNATED OUTLETS.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. MINIMUM EDGE TREATMENT EMBEDMENT DEPTHS ARE SPECIFIED TO PREVENT LATERAL SEEPAGE UNDER THE EDGE TREATMENT AND INTO ADJACENT PAVEMENT SECTIONS, AS APPLICABLE.
3. DESIGNER MAY ELIMINATE CONSTRUCTION BENCH TO INCREASE EFFECTIVE FACILITY AREA (I.E. INFILTRATION AND STORAGE FOOTPRINT) PROVIDED PLANTER WALL EXTENDS TO BOTTOM OF AGGREGATE STORAGE.
4. DESIGNER MAY SPECIFY ALTERNATIVE MATERIAL TYPE FOR EDGE TREATMENTS PROVIDED MATERIAL MEETS STRUCTURAL REQUIREMENTS FOR LOADING CONDITIONS, SERVES AS A WATER BARRIER BETWEEN THE FACILITY AND ADJACENT PAVEMENT SECTIONS (AS APPLICABLE), AND COMPLIES WITH MUNICIPAL STANDARD ACCESSIBILITY REQUIREMENTS.
5. FOOTING OR LATERAL BRACING SHALL BE PROVIDED FOR ALL PLANTER WALLS UNLESS THE DESIGNER DEMONSTRATES THAT THE PROPOSED WALL DESIGN MEETS LOADING REQUIREMENTS AND STRUCTURAL INTEGRITY.
6. FOOTINGS AND LATERAL BRACING SHALL BE DESIGNED TO WITHSTAND ANTICIPATED LOADING ASSUMING NO REACTIVE FORCES FROM THE UNCOMPACTED BIOTREATMENT SOIL WITHIN THE FACILITY.
7. LATERAL BRACING SHALL MEET HYDROLOGIC AND HYDRAULIC DESIGN REQUIREMENTS FOR CHECK DAMS WHEN USED AS CHECK DAMS. SEE **BC 6.1**.
8. PLANTER WALLS EXTENDING MORE THAN 36 INCHES BELOW ADJACENT LOAD-BEARING SURFACE, OR WHEN LOCATED ADJACENT TO PAVERS, MUST HAVE FOOTING OR LATERAL BRACING. SEE **BC 1.5**
9. ALL WALLS (I.E., SHORT AND EXTENDED) SHALL BE DESIGNED FOR APPROPRIATE SITE-SPECIFIC LOAD CASES. COORDINATE WITH ENGINEER AS NEEDED.
10. PLANTER WALLS THAT RETAIN SOIL SHALL BE DESIGNED TO RESIST SLIDING, OVERTURNING, AND APPROPRIATE SITE-SPECIFIC LOAD CASES. COORDINATE WITH ENGINEER AS NEEDED.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ EDGE TREATMENT TYPE AND MATERIAL
- ☐ EDGE TREATMENT WIDTH AND HEIGHT
- ☐ EMBEDMENT DEPTH INTO SUBGRADE SOILS
- ☐ LATERAL BRACING/FOOTING REQUIREMENTS
- ☐ PIPE MATERIAL AND DIAMETER FOR ALL WALL PENETRATIONS
- ☐ WATER TIGHT CONNECTOR TYPE FOR ALL WALL PENETRATIONS (E.G., GROUTED, COMPRESSION, BOOT) SEE **GC 2.9** AND **GC 2.10**.
- ☐ ELEVATIONS - INLET, OUTLET, OVERFLOW STRUCTURE (RIM & INVERT), CLEANOUT (RIM & INVERT)
- ☐ ELEVATIONS - TOP OF SLOPE AND TOE OF SLOPE

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

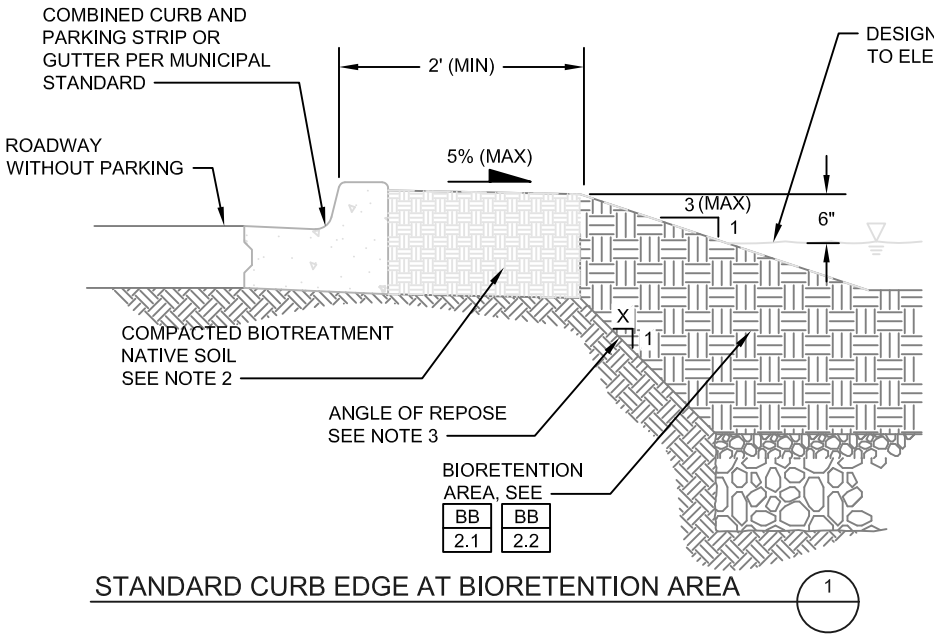
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 1.1

DATE: OCTOBER 2024
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BIORETENTION COMPONENTS
EDGE TREATMENTS
DESIGNER NOTES

DWG NO. **BC 1.1**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



STANDARD CURB EDGE AT BIORETENTION AREA (1)

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. COMPACT BIOTREATMENT OR NATIVE SOIL TO 90% OF MAXIMUM DENSITY PER STANDARD PROCTOR TEST (ASTM D698). TRANSITION TO STANDARD BIOTREATMENT SOIL SECTION UPSLOPE OF DESIGN PONDING ELEVATION.
3. ANGLE OF REPOSE VARIES PER GEOTECHNICAL ENGINEERS RECOMMENDATIONS.

EDGE TREATMENTS								INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 1.2

DATE: SEPTEMBER 2019
VERSION: 1.0
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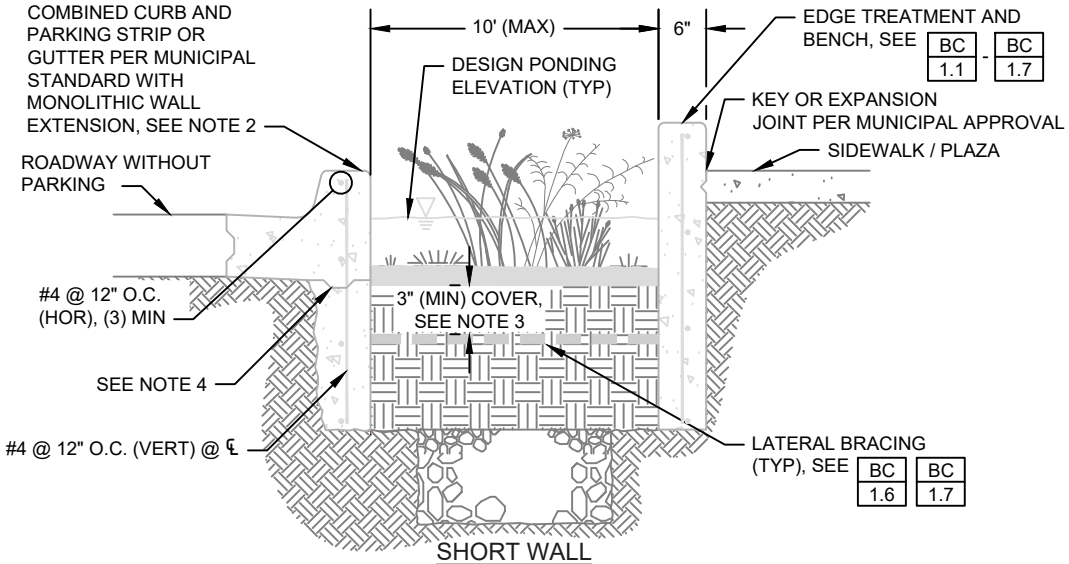
BIORETENTION COMPONENTS

EDGE TREATMENTS

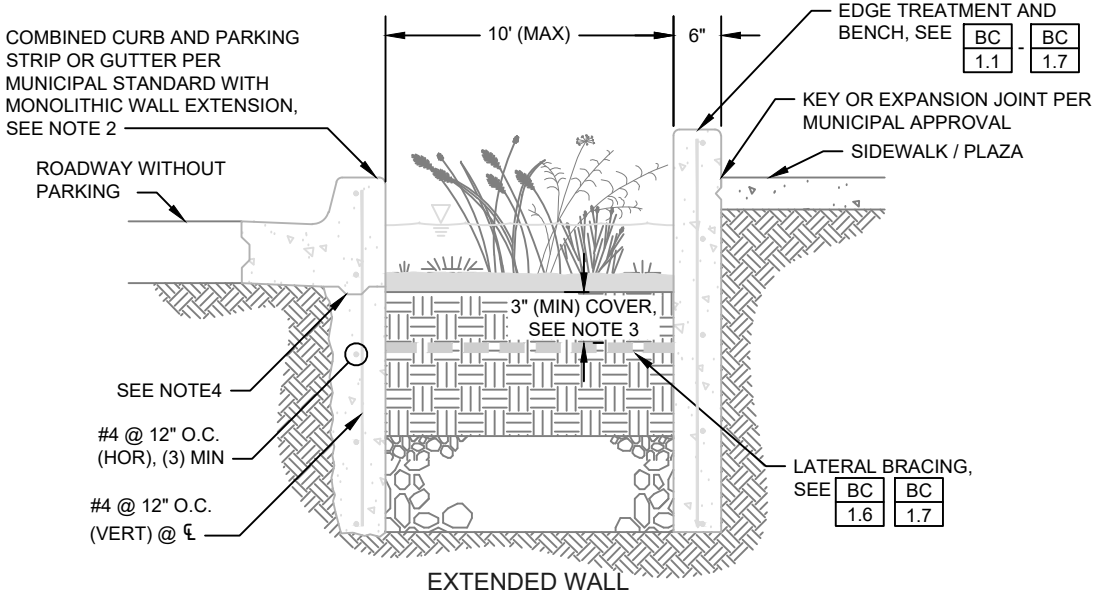
VEHICULAR APPLICATIONS (1 OF 2)

DWG NO. BC 1.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

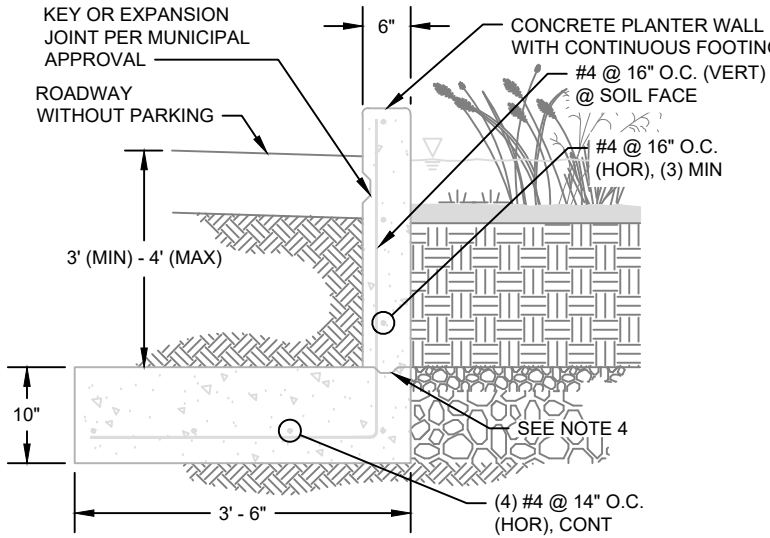


SHORT WALL



EXTENDED WALL

PLANTER WALL WITH LATERAL BRACING 1



PLANTER WALL WITH CONTINUOUS FOOTING 2

CONSTRUCTION NOTES:

1. ALL MATERIAL, REINFORCEMENT AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. ALL PLANTER WALLS SHALL EXTEND TO BOTTOM OF BIOTREATMENT SOIL OR DEEPER.
3. CONTRACTOR TO PROVIDE 3 INCH MINIMUM COVER OVER ALL LATERAL BRACING FOR PLANT ESTABLISHMENT.
4. ALL CONSTRUCTION COLD JOINTS SHALL INCORPORATE EPOXY, DOWEL/TIE BAR, KEYWAY, OR WATER STOP.

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 1.3

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

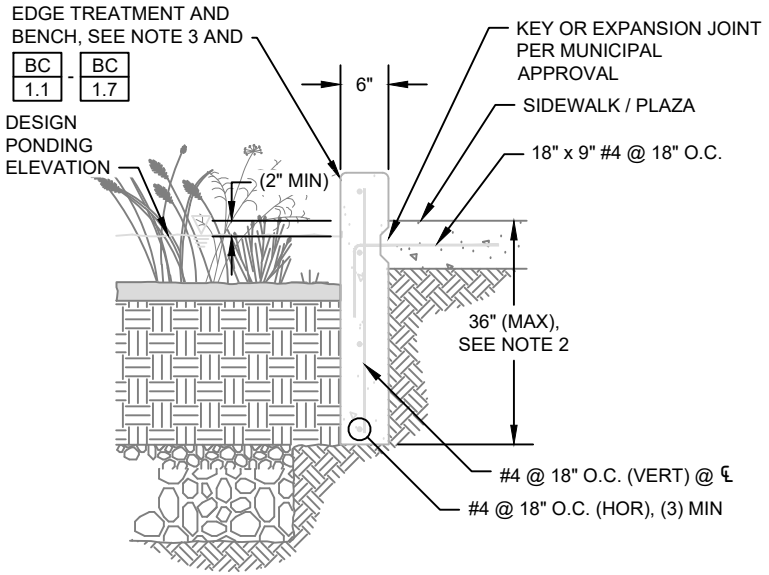
BIORETENTION COMPONENTS

EDGE TREATMENTS

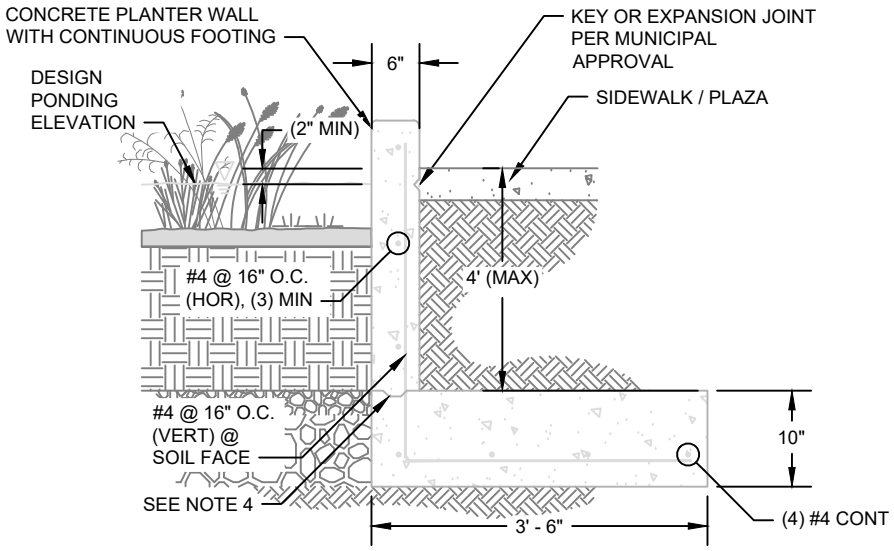
VEHICULAR APPLICATIONS (2 OF 2)

DWG NO. BC 1.3

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



PLANTER WALL - PARCEL ONLY 1



PLANTER WALL WITH CONTINUOUS FOOTING 2

CONSTRUCTION NOTES:

1. ALL MATERIAL, REINFORCEMENT, AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. PLANTER WALLS EXTENDING MORE THAN 36 INCHES BELOW ADJACENT LOAD-BEARING SURFACE, OR WHEN LOCATED ADJACENT TO PAVERS, MUST HAVE FOOTING OR LATERAL BRACING. COORDINATE WITH ENGINEER.
3. ALL PLANTER WALLS SHALL EXTEND TO BOTTOM OF BIOTREATMENT SOIL OR DEEPER.
4. ALL CONSTRUCTION COLD JOINTS SHALL INCORPORATE EPOXY, DOWEL/TIE BAR, KEYWAY, OR WATER STOP.

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

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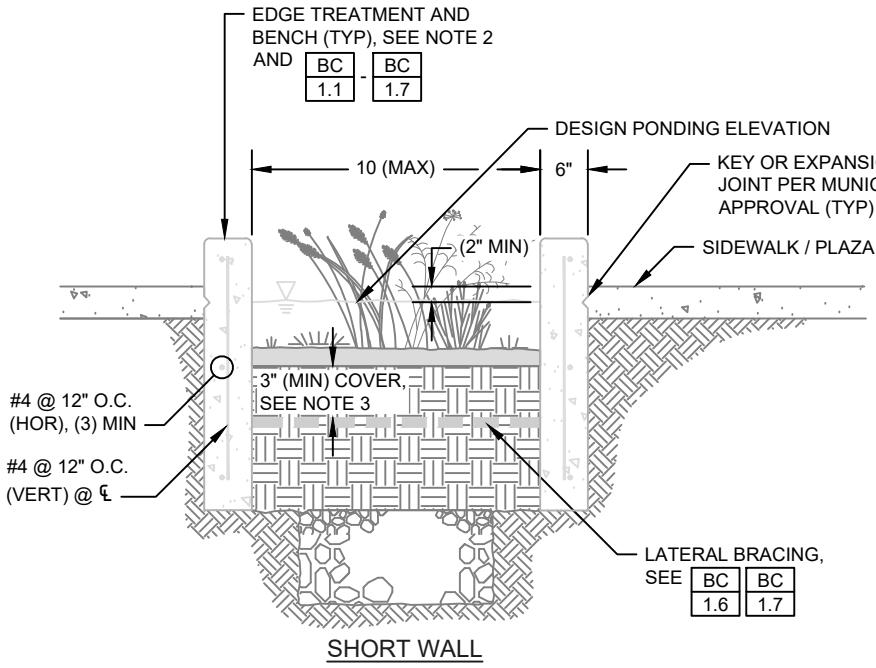
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BIORETENTION COMPONENTS

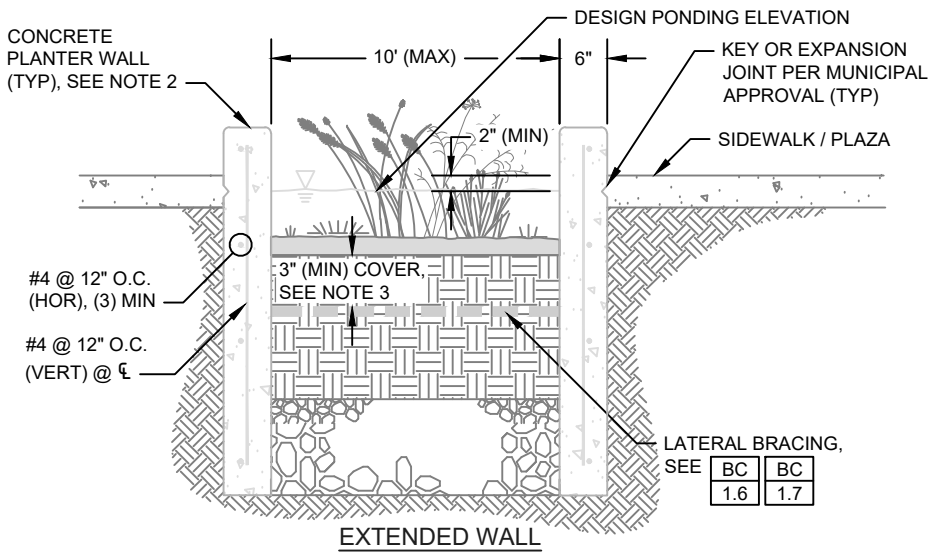
EDGE TREATMENTS
PEDESTRIAN APPLICATIONS (1 OF 2)

DWG NO. BC 1.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



PLANTER WALL WITH LATERAL BRACING -SHORT 1



PLANTER WALL WITH LATERAL BRACING - EXTENDED 2

CONSTRUCTION NOTES:

1. ALL MATERIAL, REINFORCEMENT, AND WORKMANSHIP FOR EDGE TREATMENTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. ALL PLANTER WALLS SHALL EXTEND TO BOTTOM OF BIOTREATMENT SOIL OR DEEPER.
3. CONTRACTOR TO PROVIDE 3 INCH MINIMUM COVER OVER ALL LATERAL BRACING FOR PLANT ESTABLISHMENT.
4. ALL CONSTRUCTION COLD JOINTS SHALL INCORPORATE EPOXY, DOWEL/TIE BAR, KEYWAY, AND WATER STOP.

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

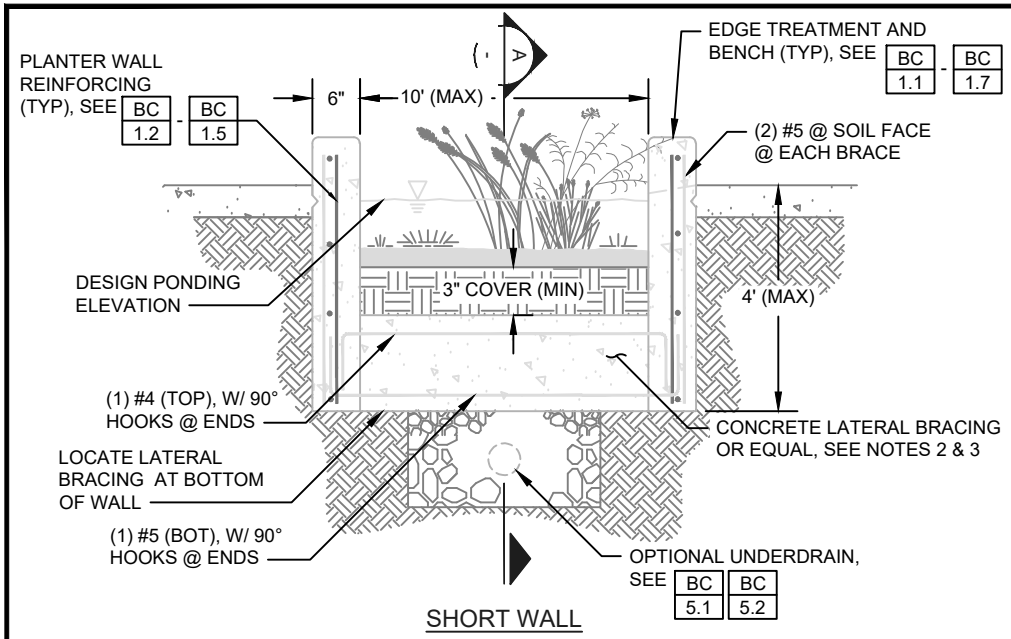
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VERSION: 2.0
REVISED:

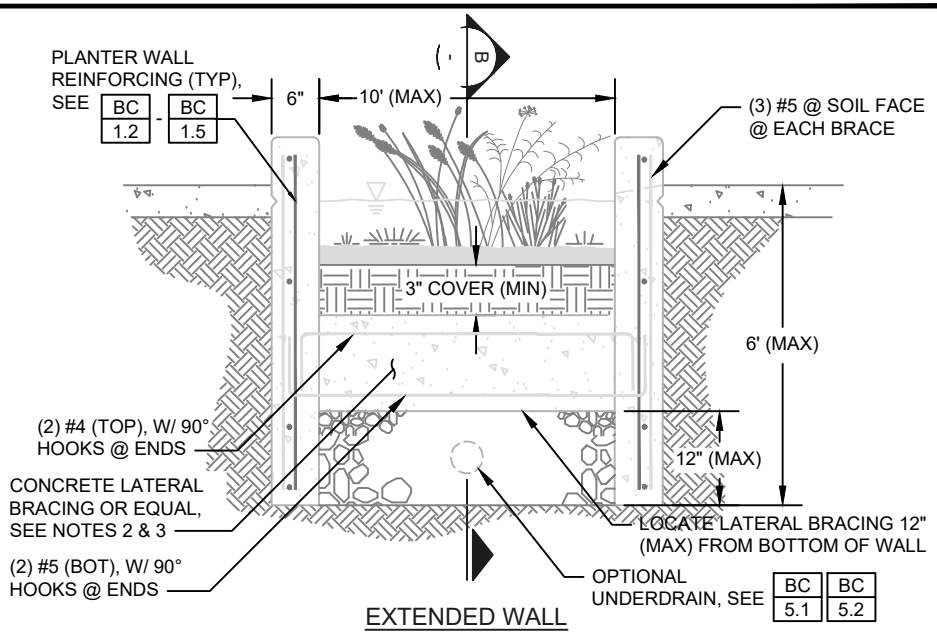
BIORETENTION COMPONENTS
EDGE TREATMENTS
PEDESTRIAN APPLICATIONS (2 OF 2)

DWG NO. BC 1.5

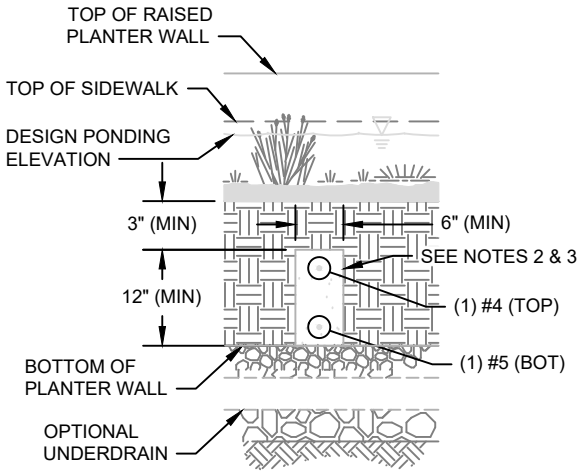
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SHORT WALL



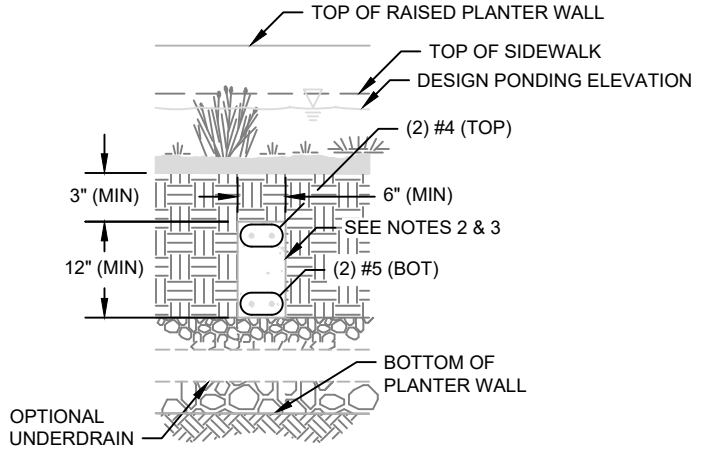
EXTENDED WALL



SECTION A

CONSTRUCTION NOTES:

1. ALL MATERIAL, REINFORCEMENT, AND WORKMANSHIP FOR LATERAL BRACING SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. CONCRETE LATERAL BRACING SHALL BE CONTINUOUS (NO JOINTS).
3. LATERAL BRACING SHALL BE PROVIDED EVERY 6 FEET (MAX) FOR WALLS UP TO 4 FEET IN HEIGHT AND EVERY 4 FEET (MAX) FOR WALLS BETWEEN 4 AND 6 FEET IN HEIGHT.



SECTION B

CONCRETE BRACING WALL - SHORT 1

CONCRETE BRACING WALL - EXTENDED 2

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 1.6

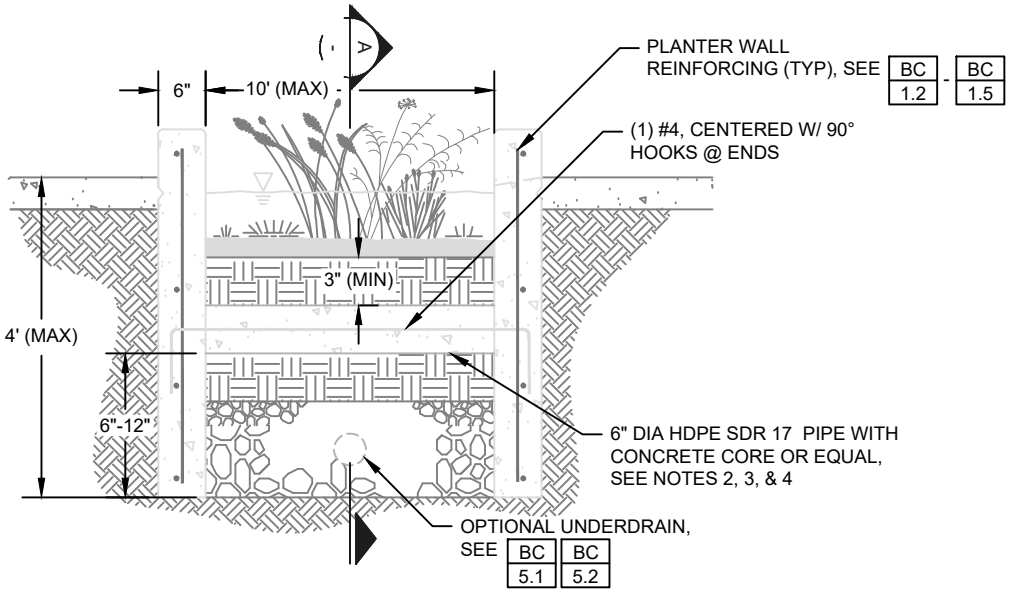
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VERSION: 2.0
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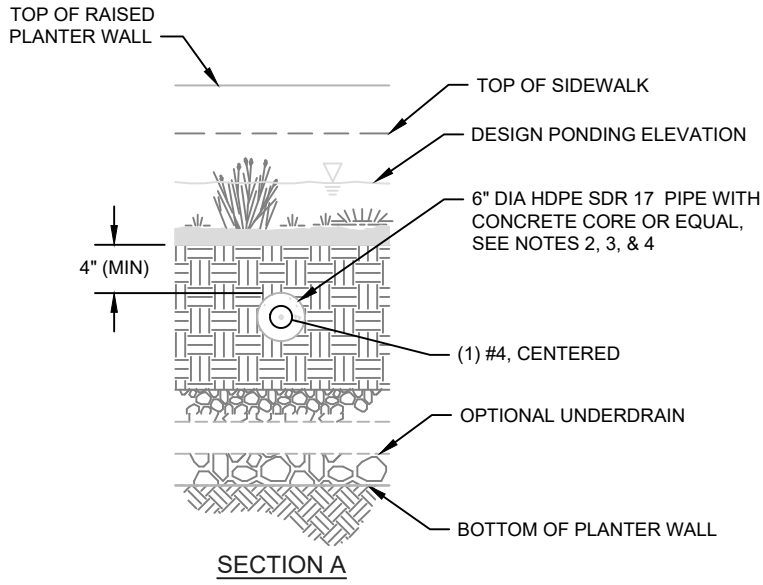
BIORETENTION COMPONENTS

EDGE TREATMENTS
LATERAL BRACING (1 OF 2)

DWG NO. BC 1.6

NOT FOR CONSTRUCTION - REFER TO USER GUIDE





SECTION A

CONCRETE STRUT 1

CONSTRUCTION NOTES:

1. ALL MATERIAL, REINFORCEMENT, AND WORKMANSHIP FOR LATERAL BRACING STRUCTURES SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. LATERAL BRACING SHALL BE PROVIDED EVERY 6 FEET (MAX) FOR WALLS UP TO 4 FEET IN HEIGHT.
3. OTHER MATERIALS MAY BE USED IN LIEU OF HDPE PROVIDED MATERIAL IS NON CORROSIVE, NON-LEACHING, AND SCHEDULE 40.
4. PROVIDE 3 INCH CONTINUOUS SLOT ACROSS TOP OF PIPE TO PLACE REINFORCEMENT AND ENSURE STRUT IS FREE OF VOIDS.

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 1.7

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION COMPONENTS

EDGE TREATMENTS
LATERAL BRACING (2 OF 2)

DWG NO. BC 1.7

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

PURPOSE:

CURB CUTS AND TRENCH DRAINS SERVE AS INLETS TO CONVEY STORMWATER RUNOFF TO A BIORETENTION FACILITY. CURB CUTS ARE TYPICALLY USED IN PLANTER APPLICATIONS WHEN THE FACILITY IS IMMEDIATELY ADJACENT TO THE ROADWAY (I.E. NO STEP OUT ZONE), PROVIDING AN OPENING TO INTERCEPT AND CONVEY STORMWATER FROM THE GUTTER TO THE PLANTER. TRENCH DRAIN SYSTEMS ARE MOST COMMONLY USED TO CONVEY STORMWATER FROM A GUTTER THROUGH THE STEP OUT ZONE TO A BIORETENTION PLANTER; PROVIDING A CONTINUOUS SURFACE FOR PEDESTRIAN ACCESS WHILE MINIMIZING ELEVATION LOSSES AT THE FACILITY INFLOW LOCATIONS. CURB CUT AND TRENCH DRAIN INLETS INCLUDE MODIFICATIONS TO THE GUTTER TO HELP DIRECT FLOW INTO THE FACILITY.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST ENSURE THAT CURB CUTS AND TRENCH DRAIN INLETS ARE ADQUATELY SIZED, SPACED, AND SLOPED TO SATISFY MUNICIPAL HYDRAULIC REQUIREMENTS.
3. TRENCH DRAIN GRATES AND ASSEMBLIES MUST COMPLY WITH MUNICIPAL STANDARD
4. DESIGNER MAY SPECIFY CURB CUT INLET/OUTLET MODIFICATION WITH METAL PLATE TOP WHEN ADJACENT TO VEHICLE PARKING AND LOADING AREAS WITH APPROVAL FROM MUNICIPALITY.
5. ENERGY DISSIPATION AT INLET STRUCTURES SPECIFIED BY DESIGNER. RECOMMENDED METHOD IS TO USE A CONCRETE SPLASH APRON SUPPLEMENTED WITH ROCK MULCH OR STREAMBED COBBLE EMBEDDED IN CONCRETE, OR EQUIVALENT.
6. AFTER CONSTRUCTION BLOCK GUTTER OPENINGS TO KEEP STORM FLOWS FROM ENTERING FACILITY UNTIL VEGETATION IS ESTABLISHED.
7. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ CURB CUT DIMENSIONS
- ☐ FRAME AND GRATE TYPE/MATERIAL AND DIMENSIONS
- ☐ TRENCH DRAIN DIMENSIONS
- ☐ CONTROL ELEVATIONS FOR OPENINGS AT GUTTER AND PLANTER WALL
- ☐ ENERGY DISSIPATION

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

EDGE TREATMENTS								INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

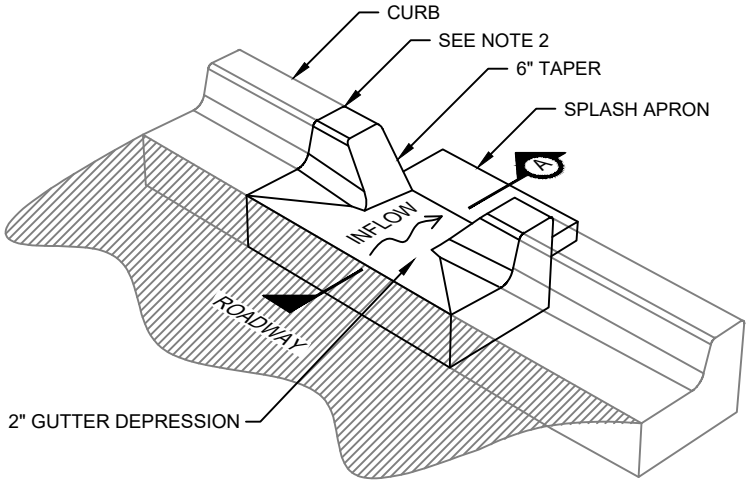
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 2.1

DATE: OCTOBER 2024
VERSION: 2.0
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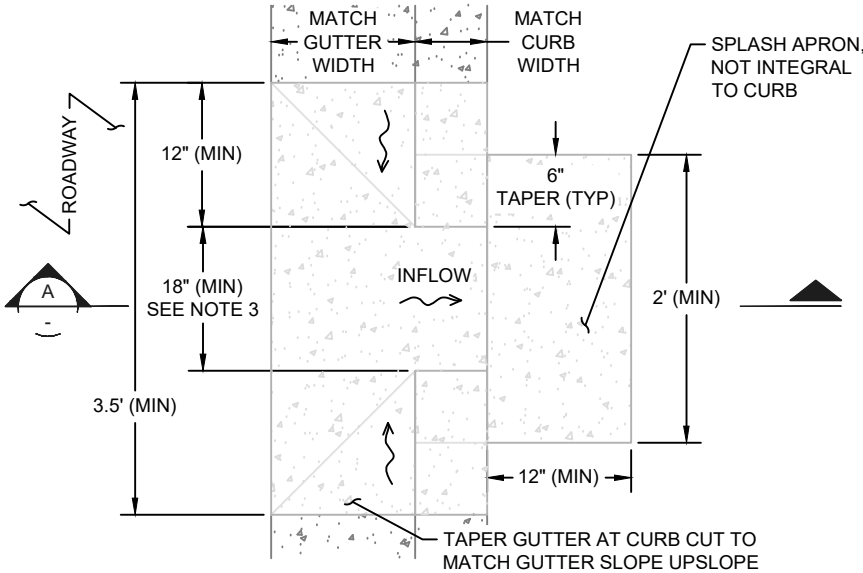
BIORETENTION COMPONENTS

INLETS
DESIGNER NOTES

DWG NO.
BC 2.1



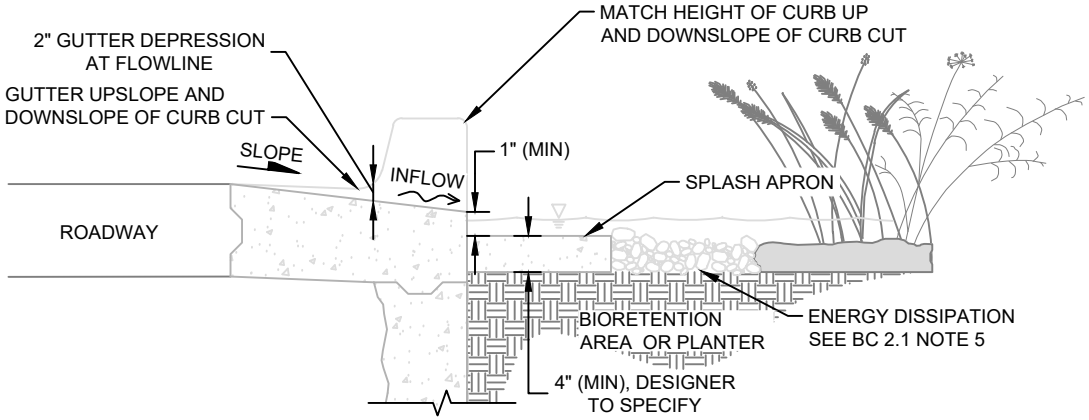
ISOMETRIC



PLAN

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CURB CUTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
3. INLET CURB CUT WIDTH MAY BE INCREASED ON STEEPER GUTTER SLOPES. DESIGNER TO SPECIFY.
4. CHAMFERED OR FILLET EDGES AT CURB CUTS MAY BE REQUIRED - CHECK WITH MUNICIPALITY.



SECTION A

INLET - CURB CUT TYPE 1 (1)

EDGE TREATMENTS								INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

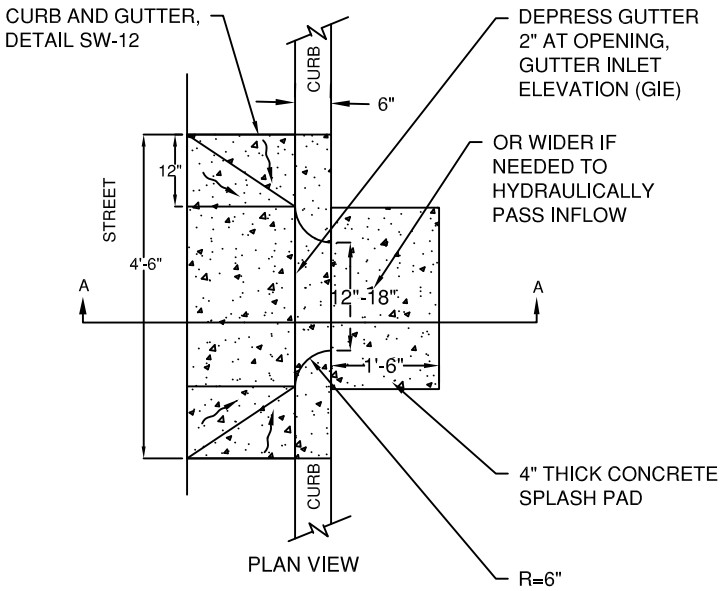
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DATE: OCTOBER 2024
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REVISED:

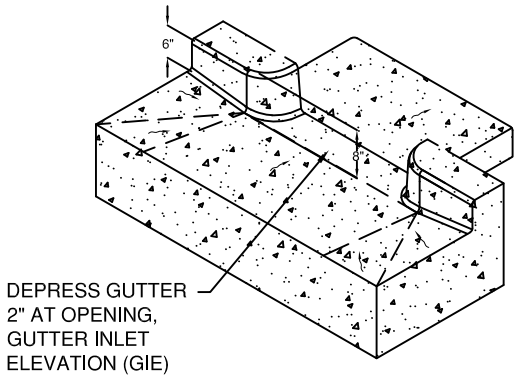
BIORETENTION COMPONENTS
INLETS
CURB CUT WITH GUTTER MODIFICATION

DWG NO. BC 2.2

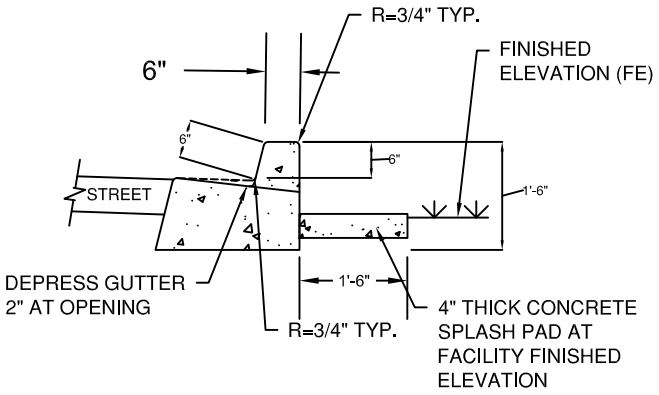
NOT FOR CONSTRUCTION - REFER TO USER GUIDE



PLAN VIEW



PERSPECTIVE VIEW



SECTION A-A

BIORETENTION DESIGN NOTES

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

CONSTRUCTION NOTES

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

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

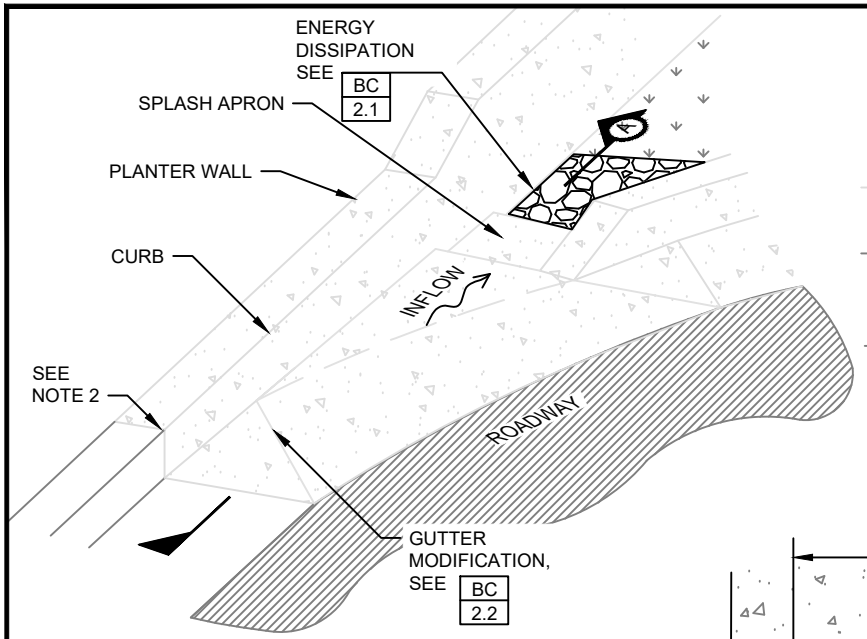
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DATE: SEPTEMBER 2019
VERSION: 1.0
REVISED:

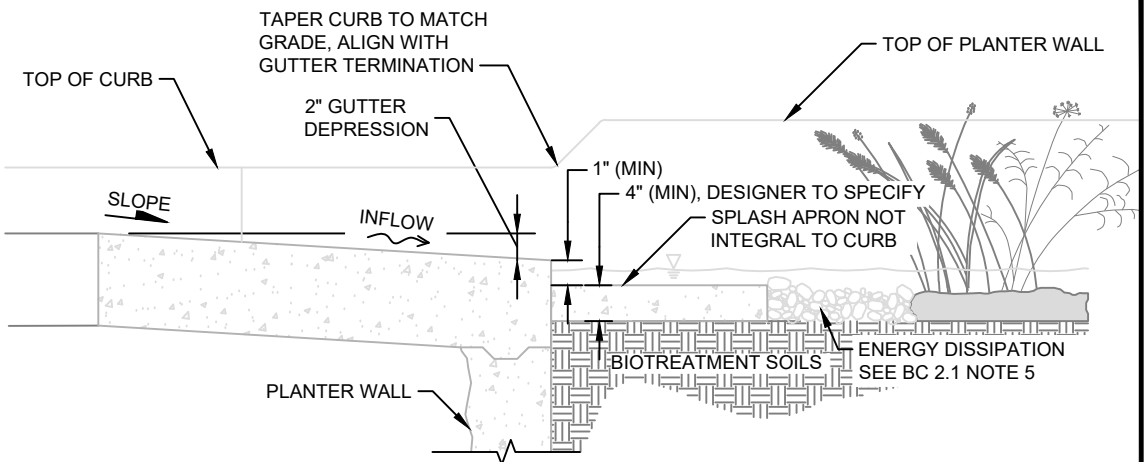
CURB CUT INLET FOR PLANTERS

DESIGNER NOTES

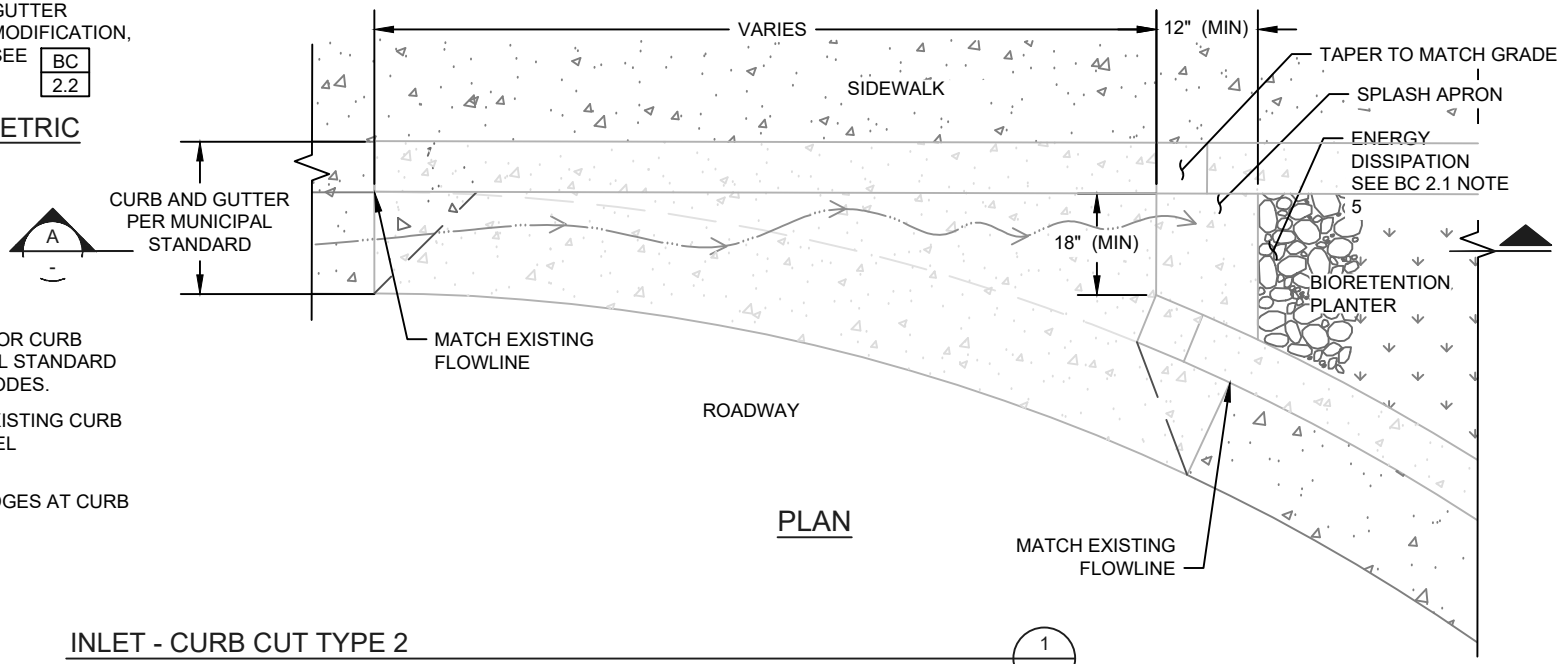
DWG NO.
BC
2.2.1



ISOMETRIC



SECTION A



PLAN

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CURB CUTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
3. OPTIONAL CHAMFERED OR FILLET EDGES AT CURB CUTS MAY BE USED.

INLET - CURB CUT TYPE 2 (1)

EDGE TREATMENTS								INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	**BC 2.3**	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 2.3

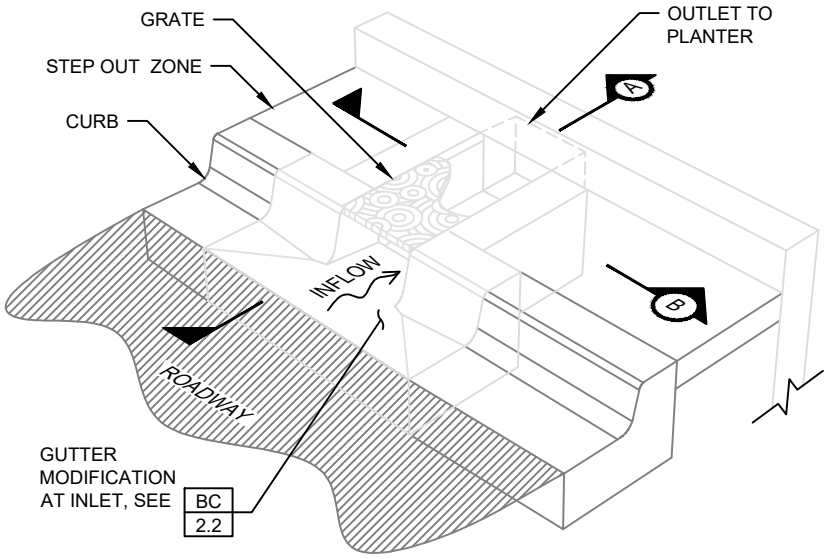
DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION COMPONENTS

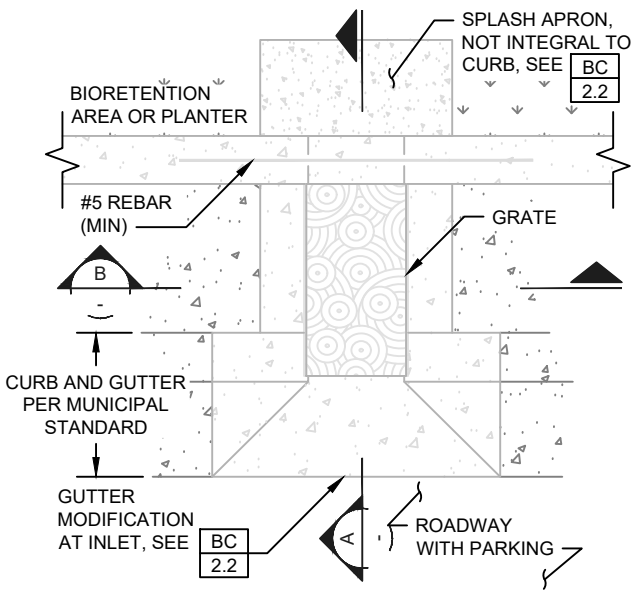
INLETS

CURB CUT AT BULB OUT

DWG NO. **BC 2.3**



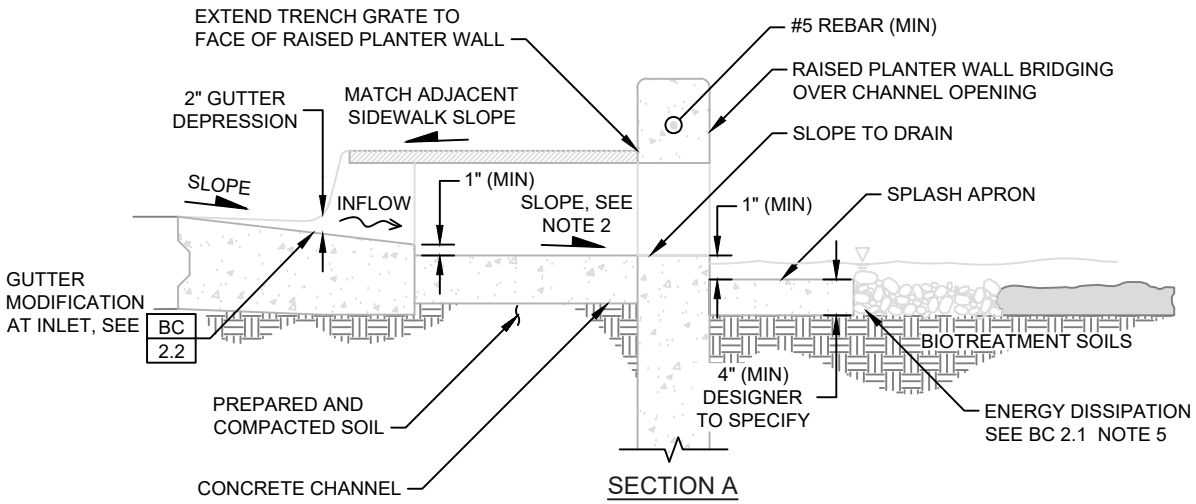
ISOMETRIC



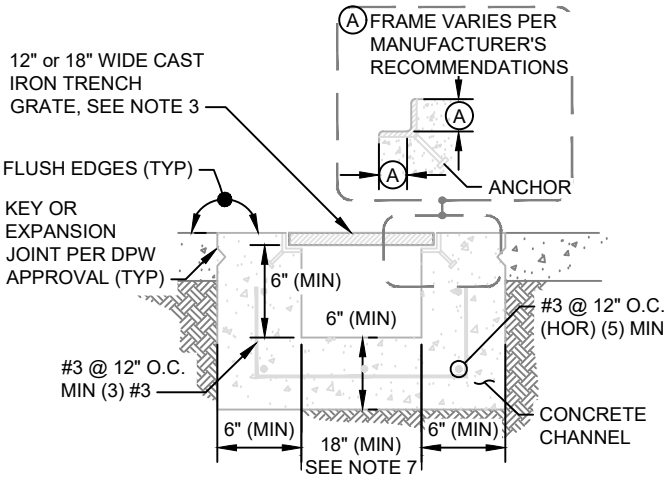
PLAN

CONSTRUCTION NOTES:

1. ALL MATERIAL, REINFORCEMENT, AND WORKMANSHIP FOR TRENCH DRAIN ASSEMBLY SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. SLOPE TO PROVIDE AT LEAST 1 INCH DROP OVER LENGTH OF CHANNEL OR A MINIMUM OF 2 PERCENT, WHICHEVER IS LARGER.
3. ALL TRENCH GRATES SHALL BE REMOVABLE, RATED PER THE ANTICIPATED LOADING, AND BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM, FLUSH OR RECESSED IN GRATE.
4. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
5. NOT USED
6. APPLY EPOXY BONDING AGENT AT ALL TRENCH DRAIN CONSTRUCTION COLD JOINTS.
7. INLET CURB CUT AND CONCRETE CHANNEL WIDTH SHALL BE INCREASED ON STEEPER GUTTER SLOPES. DESIGNER TO SPECIFY.



SECTION A



SECTION B

INLET - TRENCH DRAIN 1

8. AFTER CONSTRUCTION BLOCK GUTTER OPENINGS TO KEEP STORM FLOWS FROM ENTERING FACILITY UNTIL VEGETATION IS ESTABLISHED.

EDGE TREATMENTS							INLETS				OUTLETS			UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS		NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 2.4

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION COMPONENTS

INLETS

CURB CUT WITH TRENCH DRAINS

DWG NO. BC 2.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

PURPOSE:

BIORETENTION OUTLET STRUCTURES CONVEY SURFACE AND/OR SUBSURFACE OUTFLOWS FROM A BIORETENTION FACILITY TO AN APPROVED DISCHARGE LOCATION.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST SIZE CURB CUT, GRATE, AND OTHER OVERFLOW STRUCTURE FEATURES TO SATISFY MUNICIPAL HYDRAULIC REQUIREMENTS. THE SIZING AND DESIGN OF ALL OVERFLOW STRUCTURES MUST ALSO CONSIDER MAINTENANCE ACCESS, COMPATIBLE GRATE SIZES, LOCATION, AND GENERAL AESTHETICS.
3. AN OUTLET STRUCTURE OR CLEANOUT(S) THAT ALLOWS MAINTENANCE ACCESS TO ALL PIPES IS REQUIRED FOR FACILITIES WITH UNDERDRAINS.
4. IF SITE CONSTRAINTS NECESSITATE STORM DRAIN PIPE IN AN AREA SUBJECT TO VEHICULAR TRAFFIC OR OTHER LOADING, APPROPRIATE COVER DEPTH AND PIPE MATERIAL MUST BE SPECIFIED.
5. OUTLET PIPES MUST BE EQUIPPED WITH CLEANOUTS, SEE CLEANOUT DETAILS (**GC 5.2**).
6. DESIGNER SHALL EVALUATE BUOYANCY OF STRUCTURES FOR SITE SPECIFIC APPLICATION AND SPECIFY THICKENED OR EXTENDED BASE / ANTI-FLOTATION COLLAR, AS NECESSARY.
7. DESIGNER MAY SPECIFY CURB CUT INLET/OUTLET WITH METAL PLAT TOP WHEN ADJACENT TO VEHICLE PARKING AND LOADING AREAS WITH MUNICIPAL APPROVAL.
8. OPTIONAL EROSION CONTROL AT OUTLET STRUCTURES SPECIFIED BY DESIGNER. EXAMPLES INCLUDE ROCK MULCH, STREAMBED COBBLE OR EQUIVALENT. MINIMUM DIAMETER OF ROCK MULCH OR STREAMBED COBBLE SHALL BE LARGER THAN MAXIMUM GRATE OPENING WHEN USED AT OVERFLOW STRUCTURE.
9. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ OUTLET STRUCTURE TYPE/MATERIAL, DIAMETER, AND DEPTH
- ☐ ATRIUM GRATE MANUFATURER, MODEL NO., AND SIZE
- ☐ FRAME AND GRATE TYPE, MODEL NO., AND SIZE
- ☐ CONTROL ELEVATIONS FOR OUTLET STRUCTURE RIMS
- ☐ MATERIAL AND DIAMETER FOR ALL PIPES
- ☐ WATER TIGHT CONNECTOR TYPE FOR ALL WALL PENETRATIONS (E.G., GROUTED, COMPRESSION, BOOT), SEE GC 2.9 AND GC 2.10
- ☐ CURB CUT WITH OR WITHOUT METAL PLATE TOP MODIFICATION

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 3.1

DATE: OCTOBER 2024
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REVISED:

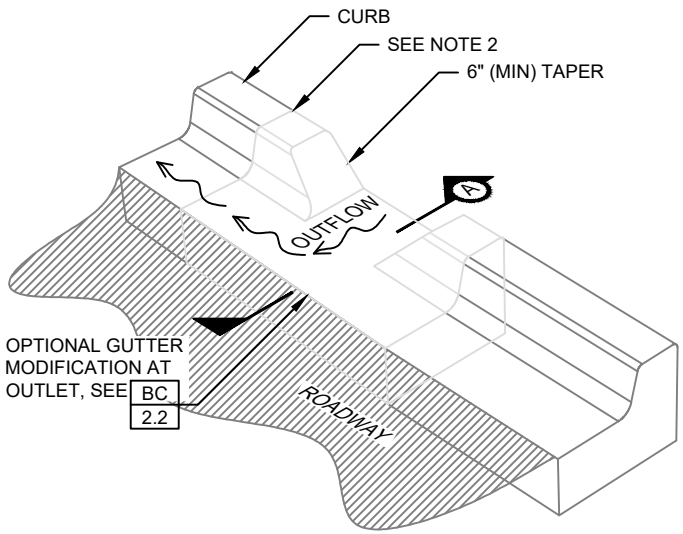
BIORETENTION COMPONENTS

OUTLETS

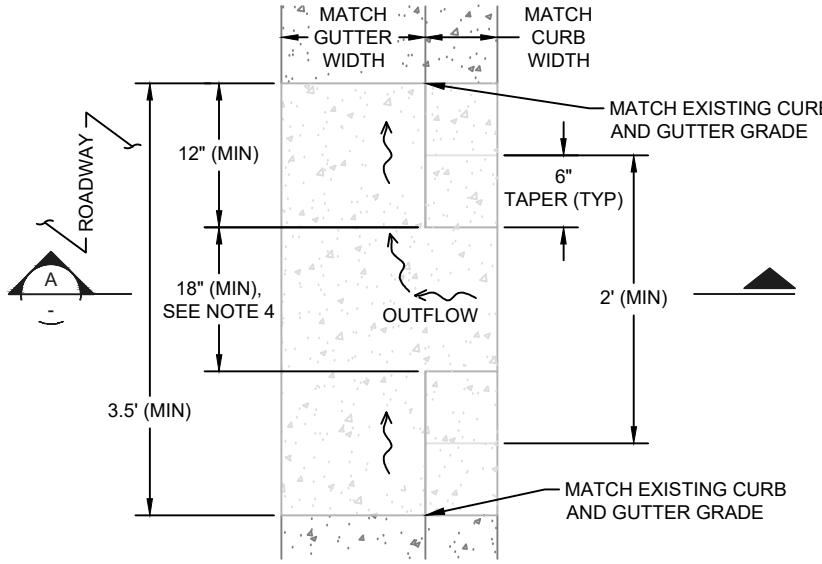
DESIGNER NOTES

DWG NO. BC 3.1

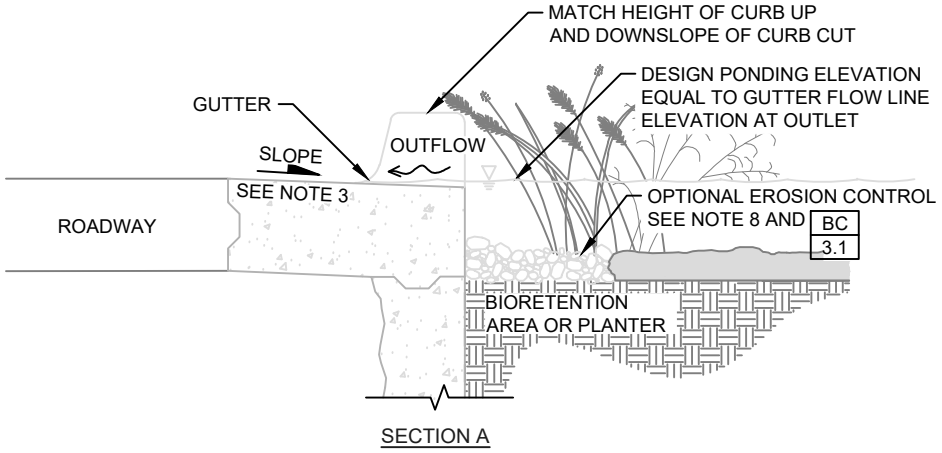
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ISOMETRIC



PLAN



SECTION A

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CURB CUTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
3. MATCH GUTTER SLOPE UP AND DOWNSLOPE OF CURB CUT SLOPE SIMILAR TO INLET DETAIL UNLESS MODIFYING GUTTER
4. OUTLET CURB CUT WIDTH MAY BE INCREASED ON STEEP GUTTER SLOPES. DESIGNER MAY SPECIFY.
5. CHAMFERED OR FILLET EDGES AT CURB CUTS MAY BE REQUIRED - CHECK WITH MUNICIPALITY.

OUTLET - CURB CUT 1

EDGE TREATMENTS								INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 3.2

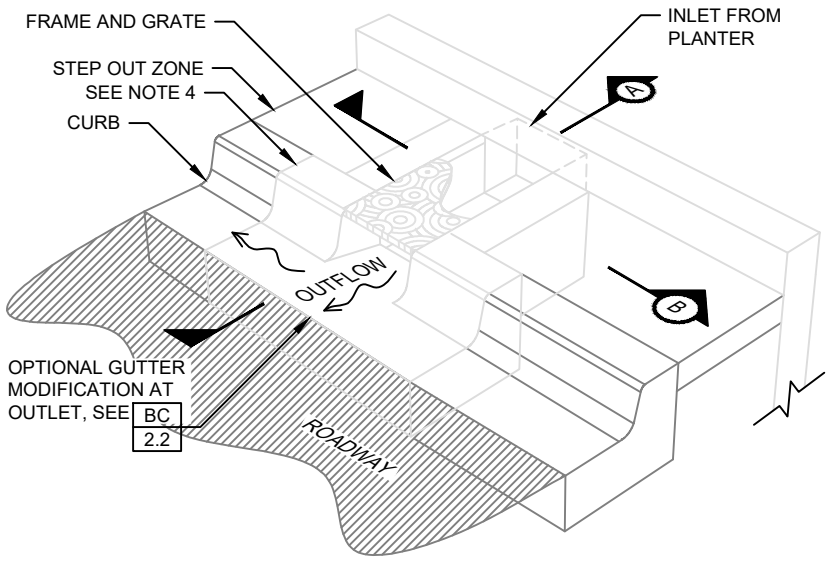
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BIORETENTION COMPONENTS

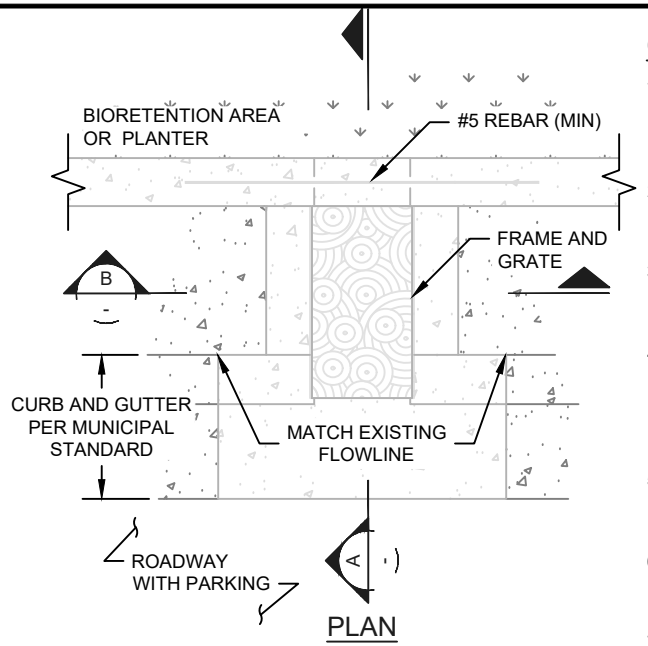
OUTLETS
CURB CUT

DWG NO. BC 3.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



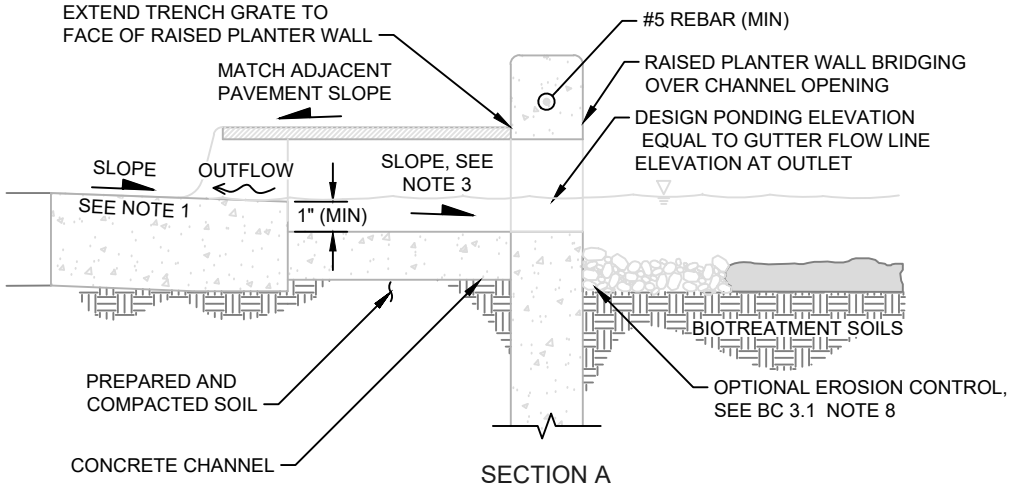
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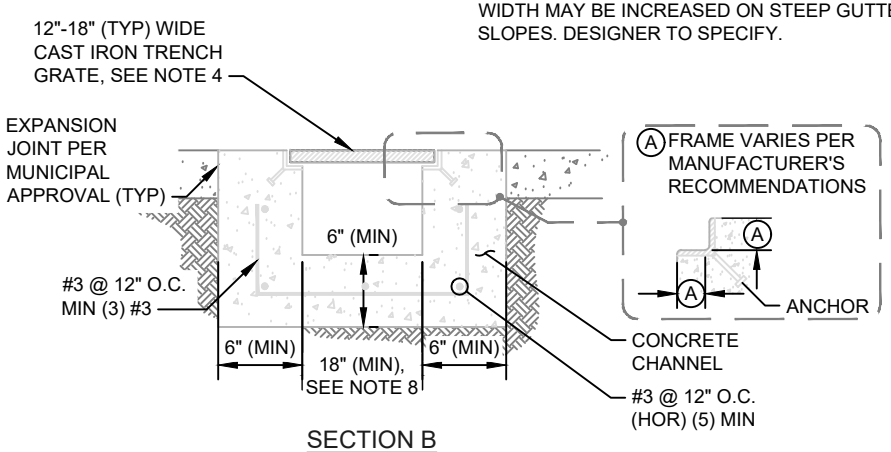
PLAN

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR TRENCH DRAIN ASSEMBLY SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. MATCH GUTTER SLOPE UP AND DOWNSLOPE (UNLESS MODIFYING GUTTER SLOPE INLET DETAIL).
3. SLOPE TO PROVIDE AT LEAST 1 INCH DROP OVER LENGTH OF CHANNEL OR A MINIMUM OF 2 PERCENT, WHICHEVER IS LARGER.
4. ALL TRENCH GRATES SHALL BE REMOVABLE, RATED PER THE ANTICIPATED LOADING, AND BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM, FLUSH OR RECESSED IN GRATE.
5. HORIZONTAL CONTROL JOINTS SHALL BE PROVIDED EVERY 10 LINEAR FEET, OR PER MANUFACTURER'S RECOMMENDATIONS.
6. BOND NEW CURB AND GUTTER TO EXISTING CURB AND GUTTER WITH EPOXY AND DOWEL CONNECTION.
7. APPLY EPOXY BONDING AGENT AT ALL TRENCH DRAIN CONSTRUCTION COLD JOINTS.
8. OUTLET CURB CUT AND CONCRETE CHANNEL WIDTH MAY BE INCREASED ON STEEP GUTTER SLOPES. DESIGNER TO SPECIFY.



SECTION A



SECTION B

OUTLET - TRENCH DRAIN 1

EDGE TREATMENTS								INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 3.3

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REVISED:

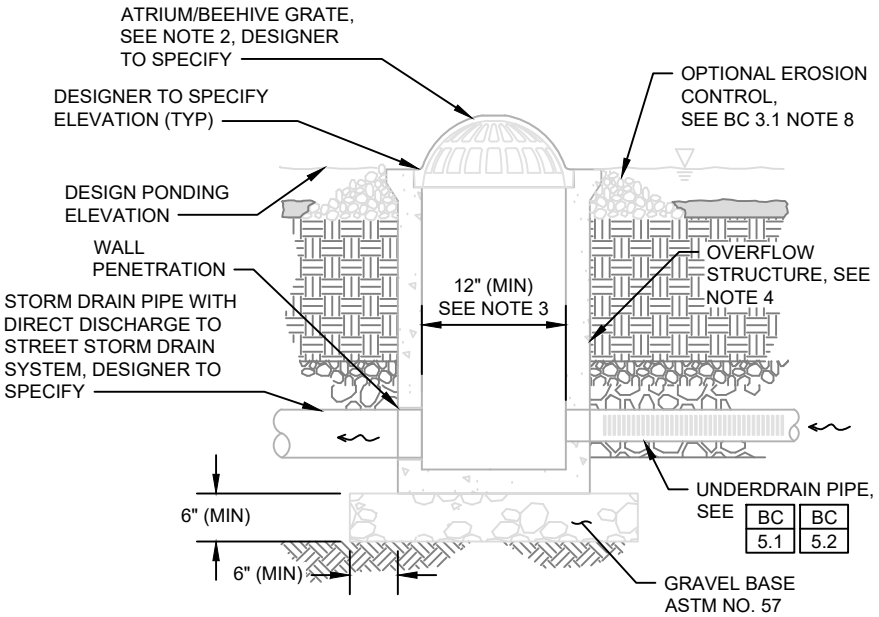
BIORETENTION COMPONENTS

OUTLETS

CURB CUT WITH TRENCH DRAIN

DWG NO. BC 3.3

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



OVERFLOW STRUCTURE AREA DRAIN (1)

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR OVERFLOW STRUCTURES SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. SIZE OF ATRIUM GRATE SHALL MATCH SIZE OF RISER SPECIFIED IN PLANS, SHALL BE REMOVABLE TO PROVIDE MAINTENANCE ACCESS, AND SHALL BE BOLTED IN PLACE OR OUTFITTED WITH APPROVED TAMPER-RESISTANT LOCKING MECHANISM. MAXIMUM OPENINGS IN THE GRATE SHALL BE 4 INCHES. GRATE MATERIAL SPECIFICATIONS SHALL CONSIDER SITE CONDITIONS, E.G. PUBLIC VS. PRIVATE SETTING, TRAFFIC LOADING, UV EXPOSURE, AND PROXIMITY TO BAY. GRATE MODEL MUST MEET MUNICIPAL APPROVAL FOR RIGHT OF WAY PROJECTS.
3. IF INTERIOR DEPTH OF OVERFLOW STRUCTURE EXCEEDS 5 FEET, A PERMANENT BOLTED LADDER AND MINIMUM CLEAR SPACE OF 30 INCH BY 30 INCH IN SHALL BE PROVIDED FOR MAINTENANCE ACCESS. OVERFLOW STRUCTURE CAN BE SMALLER WITH MUNICIPAL APPROVAL.
4. BARREL/BOX AND BASE OF CATCH BASIN MAY BE PRE-CAST WITH REINFORCING STEEL PER MANUFACTURER'S RECOMMENDATIONS, POURED IN PLACE CONCRETE WITHOUT STEEL PER MUNICIPAL STANDARD PLANS AND SPECIFICATIONS, OR NYLOPLAST DRAIN BASIN (2812AG OR EQUAL). ENGINEER TO SPECIFY.
5. GROUT ALL PENETRATIONS, CRACKS, SEAMS, AND JOINTS WITH CLASS "C" MORTAR.

EDGE TREATMENTS								INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION 3.4

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION COMPONENTS

OUTLETS
OVERFLOW STRUCTURES

DWG NO. BC 3.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

PURPOSE:

UNDERDRAINS ARE USED TO COLLECT STORMWATER THAT HAS BEEN FILTERED THROUGH BIOTREATMENT SOIL AND CONVEY THAT TREATED STORMWATER TO A DESIGNATED OUTLET (E.G., PLANTER OVERFLOW STRUCTURE).

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER SHOULD INCLUDE UNDERDRAINS IN FACILITY DESIGN IN THE FOLLOWING SCENARIOS:
   - INFILTRATION IS PROHIBITED OR IMPRUDENT (E.G., FACILITY NEAR SENSITIVE INFRASTRUCTURE OR STEEP SLOPES, RISK OF CONTAMINATION IS HIGH OR SITE GROUNDWATER/SOILS ARE CONTAMINATED, THERE IS POOR INFILTRATION CAPACITY DUE TO TYPE C/D SOILS OR HIGH GROUNDWATER).
   - MAXIMUM SURFACE POOL DRAWDOWN PERIOD CANNOT BE ACHIEVED (SEE **BB 1.1 AND BP 1.1**).
2. AN OUTLET STRUCTURE AND/OR CLEANOUT(S) TO ALLOW MAINTENANCE ACCESS TO ALL PIPES IS REQUIRED FOR FACILITIES WITH UNDERDRAINS.
3. UNDERDRAIN PIPE SHALL HAVE A SMOOTH INTERIOR WALL TO FACILITATE MAINTENANCE WITH PRESSURIZED WATER OR ROOT CUTTING EQUIPMENT.
4. DESIGNER SHOULD SPECIFY THE INSTALLED ELEVATION OF THE UNDERDRAIN PIPE WITHIN THE BIORETENTION FACILITIES AGGREGATE STORAGE LAYER TO PROMOTE INFILTRATION BELOW THE UNDERDRAIN, WHEN FEASIBLE (SEE BC 5.2). DESIGNER SHOULD ALSO CONSIDER THE USE OF ORIFICES OR OTHER CONTROL STRUCTURES TO PROVIDE ADDITIONAL INFILTRATION AND FLOW CONTROL BENEFITS WHERE APPLICABLE.
5. PIPE MATERIAL SHALL BE DESIGNED PER MUNICIPAL CODE.
6. UNDERDRAIN PIPE SHALL BE SLOTTED HDPE SDR 17 OR ACCEPTABLE SUBSTITUTE (E.G. PERFORATED PVC) PER ENGINEER'S SPECIFICATIONS. TO HELP PREVENT CLOGGING, TWO ROWS OF PERFORATIONS MAY BE USED ALONG THE UNDERSIDE OF THE UNDERDRAIN PIPE. THE NOMINAL ROCK DIAMETER SIZE USED IN THE ROCK LAYER SHOULD BE LARGER THAN THE DIAMETER OF THE PERFORATIONS.
7. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ UNDERDRAIN MATERIAL TYPE AND SIZE
- ☐ UNDERDRAIN ELEVATION, SLOPE, AND LOCATION WITHIN BASIN OR PLANTER
- ☐ PIPE BEDDING MATERIAL SPECIFICATION (i.e. AGGREGATE STORAGE LAYER)
- ☐ DISCHARGE LOCATION TO OVERFLOW STRUCTURE
- ☐ CLEANOUT LOCATIONS AND MAINTENANCE ACCESS
- ☐ ORIFICE FLOW CONTROL STRUCTURE(S), AS APPLICABLE

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

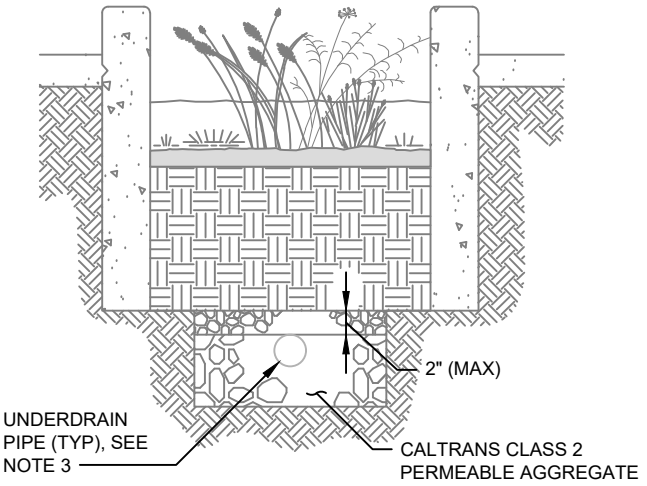
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 5.1

DATE: OCTOBER 2024
VERSION: 2.0
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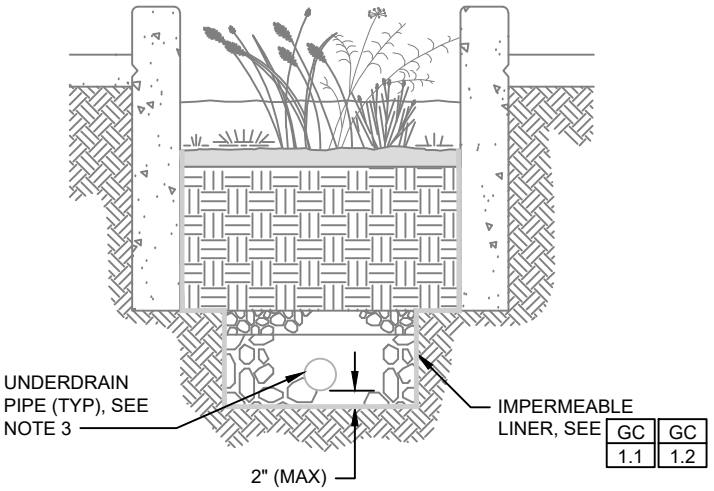
BIORETENTION COMPONENTS
UNDERDRAINS
DESIGNER NOTES

DWG NO. **BC 5.1**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



ELEVATED UNDERDRAIN



UNDERDRAIN WITH LINER
WHERE INFILTRATION PROHIBITED

UNDERDRAIN PLACEMENT ALTERNATIVES

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR UNDERDRAINS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. LONGITUDINAL SLOPE OF UNDERDRAIN PIPE SHALL BE 0.5% MINIMUM.
3. SEE PC 3.4 FOR ADDITIONAL NOTES AND DETAILS REGARDING UNDERDRAIN PIPE.

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 5.2

DATE: OCTOBER 2024
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BIORETENTION COMPONENTS
UNDERDRAINS

DWG NO. BC 5.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

PURPOSE:

CHECK DAMS ARE OFTEN USED IN BIORETENTION FACILITIES AT SLOPED LOCATIONS (ALIGNED PERPENDICULAR TO THE LONGITUDINAL SLOPE OF THE FACILITY) TO REDUCE FLOW VELOCITIES (AND EROSION) THROUGH THE FACILITY AND TO PROMOTE SURFACE PONDING, SUBSURFACE STORAGE, AND INFILTRATION OF STORMWATER. CHECK DAMS CAN BE CONSTRUCTED OF A VARIETY OF MATERIALS INCLUDING CONCRETE, WOOD, METAL, ROCK, OR COMPACTED SOIL.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST ESTABLISH THE HEIGHT AND SPACING OF CHECK DAMS BASED ON THE PONDING DEPTH REQUIRED TO MEET PROJECT HYDROLOGIC PERFORMANCE GOALS AND THE MAXIMUM DESIRED DROP FROM THE SURROUNDING GRADE TO THE FACILITY BOTTOM.
3. CONCRETE CHECK DAM SHALL MEET STRUCTURAL REQUIREMENTS FOR LATERAL BRACING WHEN USED AS LATERAL BRACING. SEE **BC 1.6** AND **BC 1.7**.
4. MATERIALS OTHER THAN CONCRETE MAY BE ALLOWED FOR CHECK DAMS WITH MUNICIPALITY APPROVAL. CHECK DAMS OF ALTERNATE MATERIALS MUST BE DESIGNED BY ENGINEER AND MUST INCLUDE ALL CONNECTION DETAILS.
5. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

THE DESIGNER SHALL SPECIFY THE FOLLOWING, AS APPLICABLE:

- ☐ CHECK DAM TYPE AND MATERIAL
- ☐ CHECK DAM HEIGHT, WIDTH, AND ELEVATION
- ☐ CHECK DAM SPACING

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

EDGE TREATMENTS							INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS						NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7	BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 6.1

DATE: OCTOBER 2024

VERSION: 2.0

REVISED:

BIORETENTION COMPONENTS

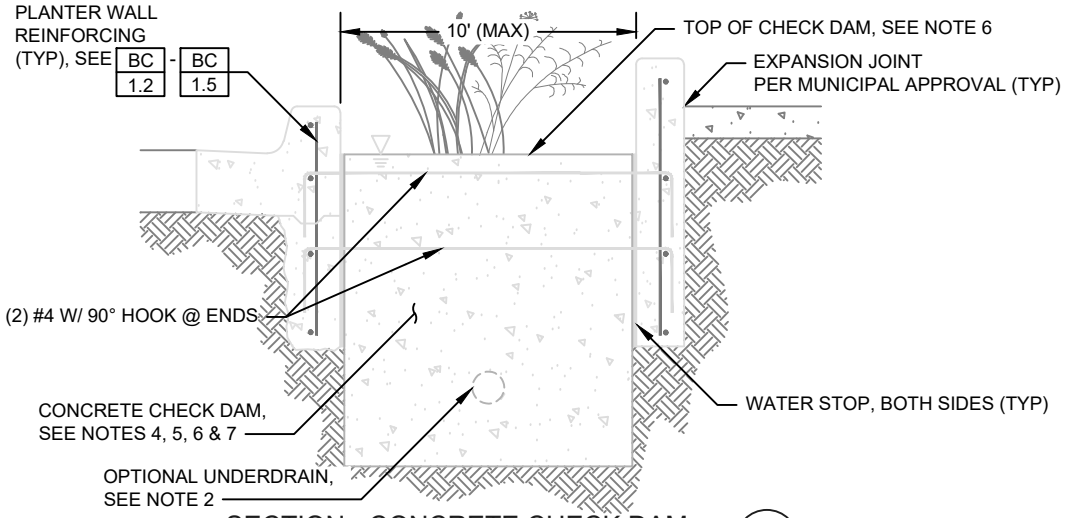
CHECK DAMS

DESIGNER NOTES

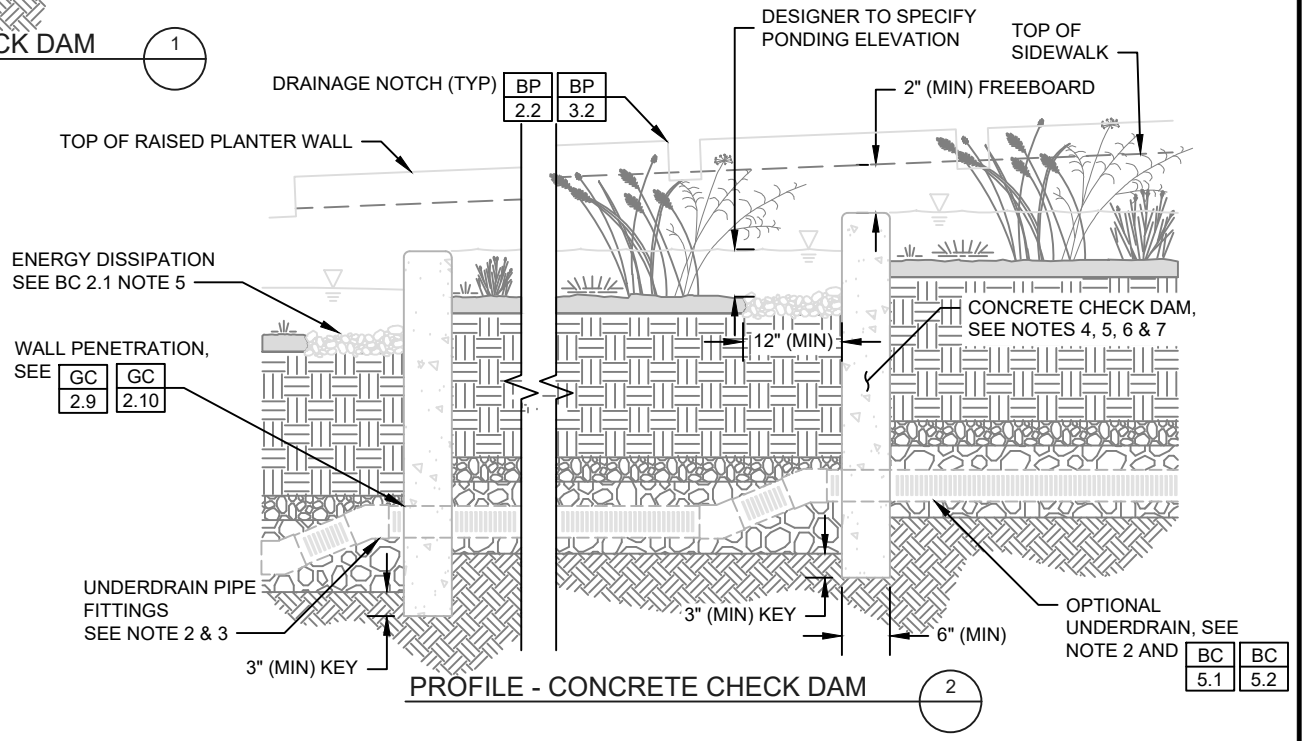
DWG NO.

BC

6.1



SECTION - CONCRETE CHECK DAM 1



PROFILE - CONCRETE CHECK DAM 2

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CHECK DAM ASSEMBLY SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. UNDERDRAIN TO PASS THROUGH CHECK DAM IN NON-PERFORATED PIPE.
3. PIPE FITTINGS SHALL BE USED TO ACCOMMODATE CHANGES IN GRADE, AS NEEDED.
4. CONCRETE CHECK DAM SHALL BE CONTINUOUS (NO JOINTS) AND REINFORCED WITH #4 BAR, PLACED AT 18 INCHES ON CENTER, EACH WAY.
5. CONCRETE CHECK DAM SHALL MEET STRUCTURAL REQUIREMENTS FOR LATERAL BRACING WHEN USED AS LATERAL BRACING. COORDINATE WITH ENGINEER.
6. TOP OF CHECK DAM TO BE LEVEL WITH CREST ELEVATION MATCHING PONDING ELEVATION.
7. CONCRETE CHECK DAM TO EXTEND 3" BEYOND BOTTOM EDGES OF AGGREGATE PER ENGINEER GUIDANCE.

EDGE TREATMENTS								INLETS				OUTLETS				UNDERDRAINS		CHECK DAM	
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			NOTES	COMPONENTS	NOTES	COMPONENTS
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 5.1	BC 5.2	BC 6.1	BC 6.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

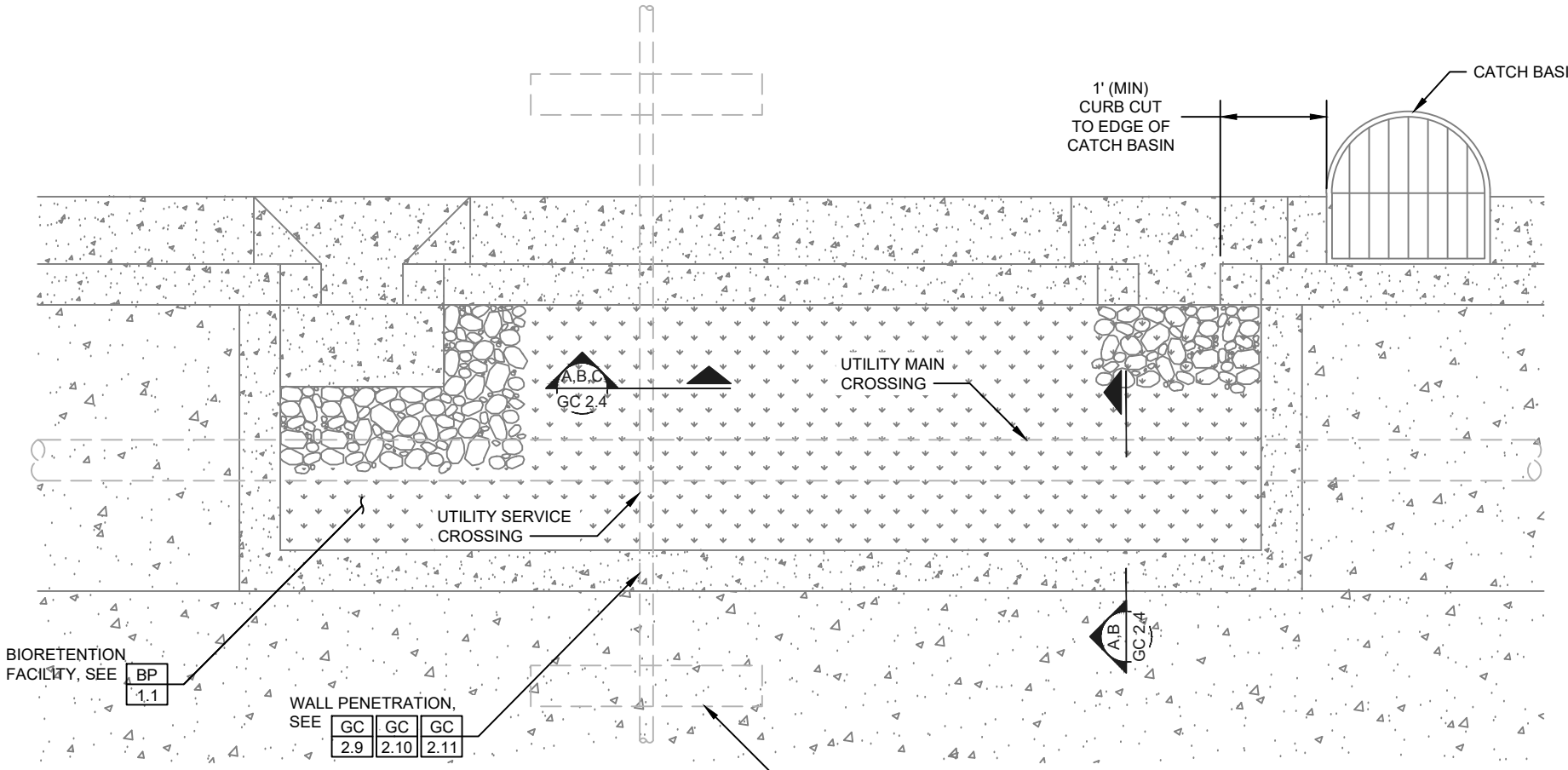
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 6.2

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION COMPONENTS

CHECK DAMS

DWG NO. BC 6.2



CONSTRUCTION NOTES:

1. ABANDONED UTILITIES WITHIN FOOTPRINT OF FACILITY AND OBSERVED DURING CONSTRUCTION MUST BE REMOVED. COORDINATE WITH MUNICIPAL OR PRIVATE OWNER AND ENGINEER.
2. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES		BIORETENTION			PERVIOUS PAVEMENT			WALL PENETRATIONS			TRENCH DAM
GC 2.1	GC 2.2	GC 2.3	GC 2.4	GC 2.5	GC 2.6	GC 2.7	GC 2.8	GC 2.9	GC 2.10	GC 2.11	GC 2.12

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.3

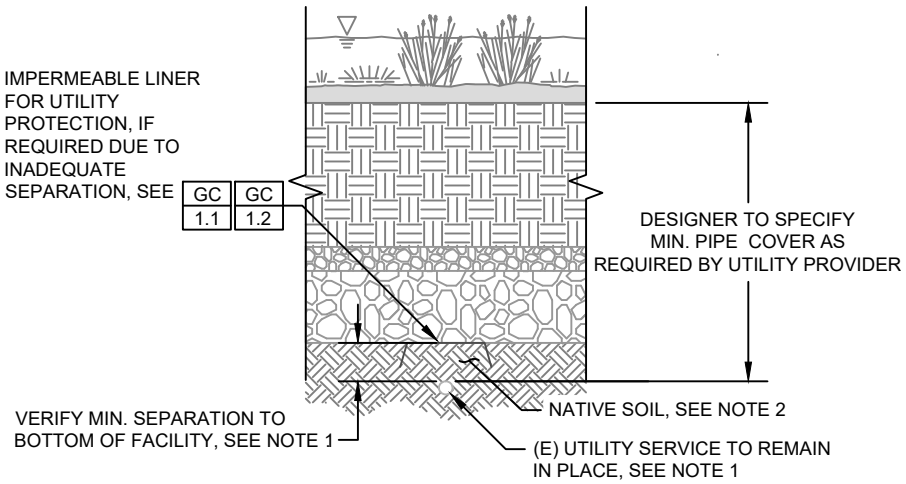
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GENERAL COMPONENTS

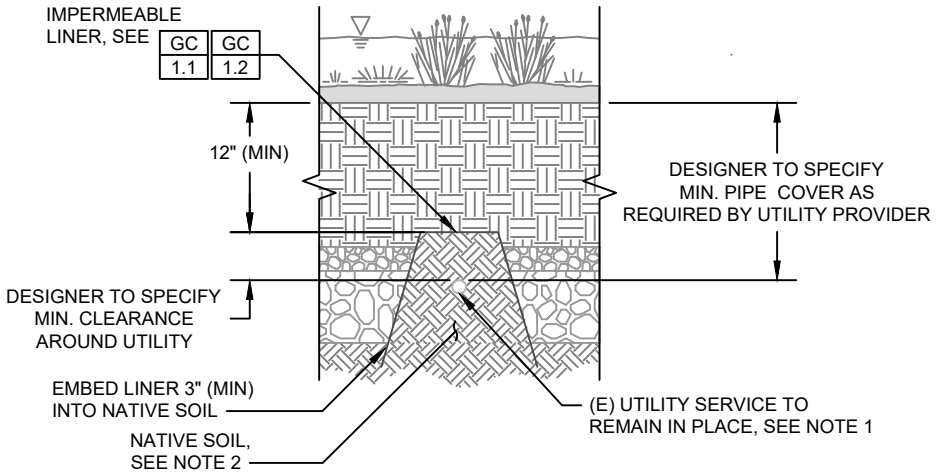
UTILITY CROSSINGS

BIORETENTION

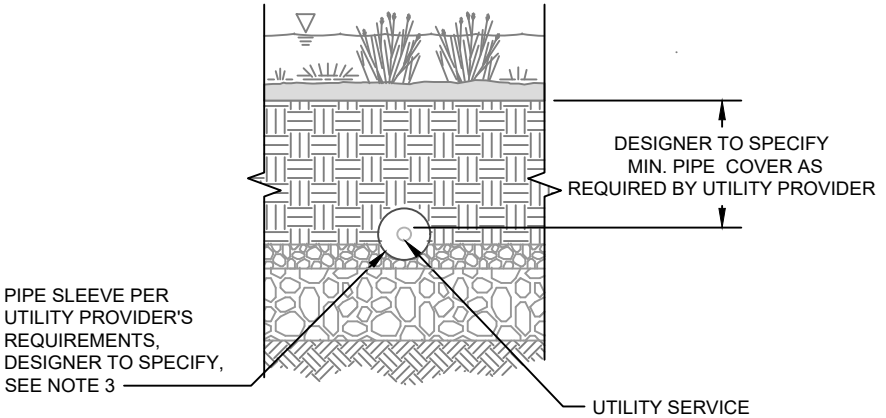
DWG NO. GC 2.3



SHALLOW UTILITY SERVICE UNDER BIORETENTION FACILITY (A)



SHALLOW UTILITY SERVICE WITHIN BIORETENTION FACILITY (B)



SLEEVED UTILITY SERVICE WITHIN BIORETENTION FACILITY (C)

CONSTRUCTION NOTES:

1. CONTRACTOR SHALL LOCATE AND DETERMINE DEPTH OF EXISTING UTILITY WITHIN THE FOOTPRINT OF THE BIORETENTION FACILITY WHILE LIMITING THE AMOUNT OF DISTURBANCE TO THE SOIL/BACKFILL MATERIAL OVER AND AROUND THE UTILITY PIPE. IF ELECTROMAGNETIC UTILITY LOCATING, POTHOLING, OR OTHER METHOD REVEALS THAT THE UTILITY PIPE DOES NOT MEET THE REQUIRED CLEARANCE FROM THE BOTTOM OF THE BIORETENTION FACILITY, THE UTILITY PROVIDER MAY REQUIRE THAT PROTECTION MEASURES, SUCH AS THOSE SHOWN ON THIS PLAN, BE IMPLEMENTED PER THEIR STANDARDS. ANY DISCREPANCIES BETWEEN THE EXISTING UTILITIES SHOWN IN THE DESIGN DRAWINGS AND THE ACTUAL FIELD CONDITIONS SHOULD BE COMMUNICATED TO THE ENGINEER IMMEDIATELY.
2. EXISTING UTILITIES AND NATIVE SOIL AROUND EXISTING UTILITIES SHOULD REMAIN IN PLACE WHERE POSSIBLE. IF A PORTION OR ALL OF THE UTILITY IS UNCOVERED DURING EXCAVATION OR EXISTING SOIL WITHIN 1 FOOT OF THE KNOWN EXISTING UTILITY IS SCARIFIED, NATIVE SOIL OR APPROVED ENGINEERED BACKFILL SHALL BE CAREFULLY PLACED AND COMPACTED AROUND THE UTILITY PER THE UTILITY PROVIDER'S REQUIREMENTS.
3. UTILITY PROVIDER MAY ALLOW UTILITY SERVICES TO BE LEFT IN PLACE AND WRAPPED WITH A WATERTIGHT WRAP OR TAPE IN LIEU OF A SLEEVE. THIS MUST BE APPROVED PRIOR TO THE START OF CONSTRUCTION.

NOTES		BIORETENTION			PERVIOUS PAVEMENT			WALL PENETRATIONS			TRENCH DAM
GC 2.1	GC 2.2	GC 2.3	GC 2.4	GC 2.5	GC 2.6	GC 2.7	GC 2.8	GC 2.9	GC 2.10	GC 2.11	GC 2.12

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Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.4

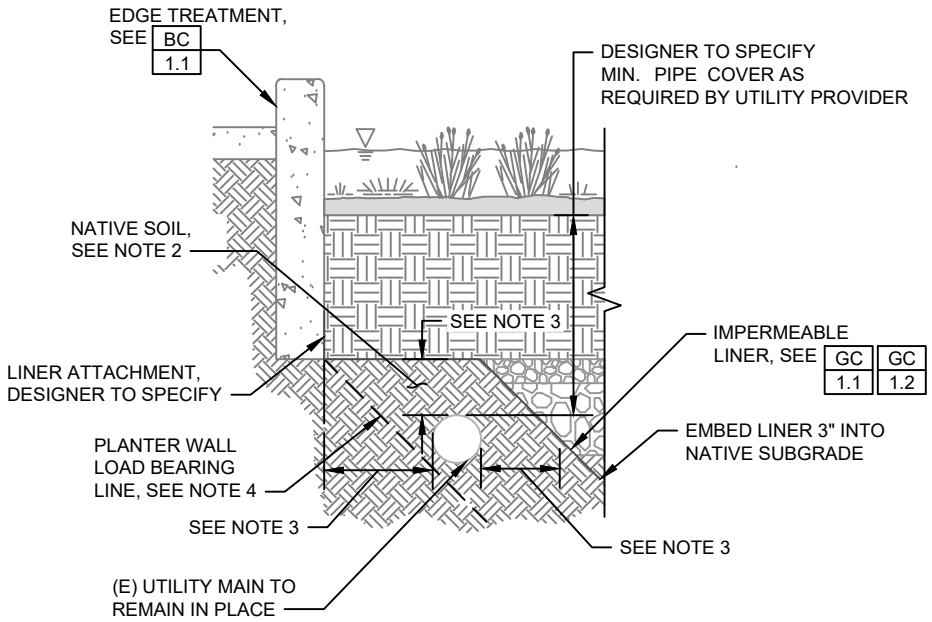
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GENERAL COMPONENTS

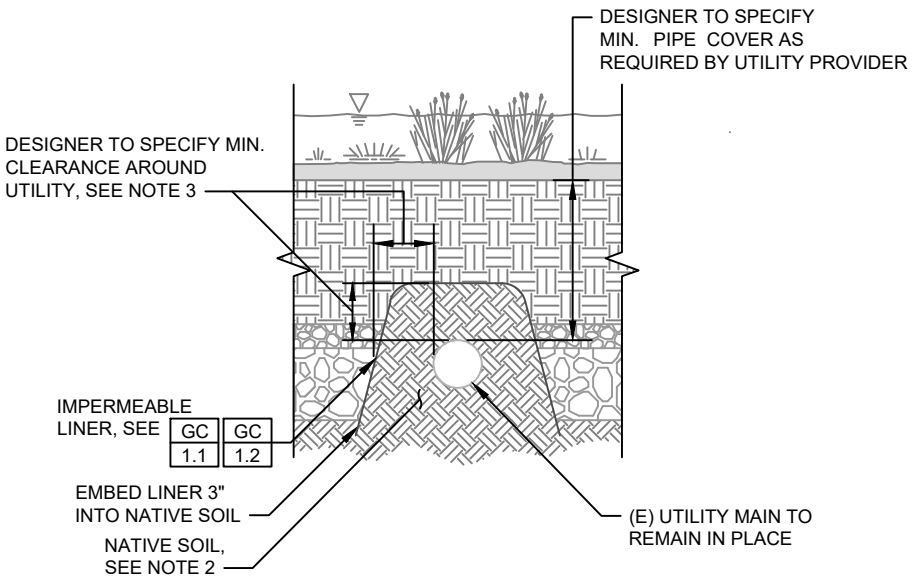
UTILITY CROSSINGS

BIORETENTION SECTIONS (1 OF 2)

DWG NO. GC 2.4



UTILITY MAIN ADJACENT TO PLANTER WALL (A)



SHALLOW UTILITY MAIN WITHIN BIORETENTION FACILITY (B)

CONSTRUCTION NOTES:

1. ANY DISCREPANCIES BETWEEN THE EXISTING UTILITIES SHOWN IN THE DESIGN DRAWINGS AND THE ACTUAL FIELD CONDITIONS SHOULD BE COMMUNICATED TO THE ENGINEER IMMEDIATELY.
2. EXISTING UTILITIES AND NATIVE SOIL AROUND EXISTING UTILITIES SHOULD REMAIN IN PLACE WHERE POSSIBLE. IF A PORTION OR ALL OF THE UTILITY IS UNCOVERED DURING EXCAVATION OR EXISTING SOIL WITHIN 1 FOOT OF THE KNOWN EXISTING UTILITY IS SCARIFIED, NATIVE SOIL OR APPROVED ENGINEERED BACKFILL SHALL BE CAREFULLY PLACED AND COMPACTED AROUND THE UTILITY PER THE UTILITY PROVIDER'S REQUIREMENTS.
3. PROVIDE THE MINIMUM CLEARANCE AROUND THE UTILITY MAIN AND SETBACKS FROM STRUCTURAL ELEMENTS PER THE UTILITY PROVIDER'S REQUIREMENTS.
4. UTILITY MAINS SHALL NOT BE SUBJECT TO LOADING FROM NEW PLANTER WALLS. LOAD BEARING LINES TO BE DETERMINED BY THE GEOTECHNICAL ENGINEER.

NOTES		BIORETENTION			PERVIOUS PAVEMENT			WALL PENETRATIONS			TRENCH DAM
GC 2.1	GC 2.2	GC 2.3	GC 2.4	GC 2.5	GC 2.6	GC 2.7	GC 2.8	GC 2.9	GC 2.10	GC 2.11	GC 2.12

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.5

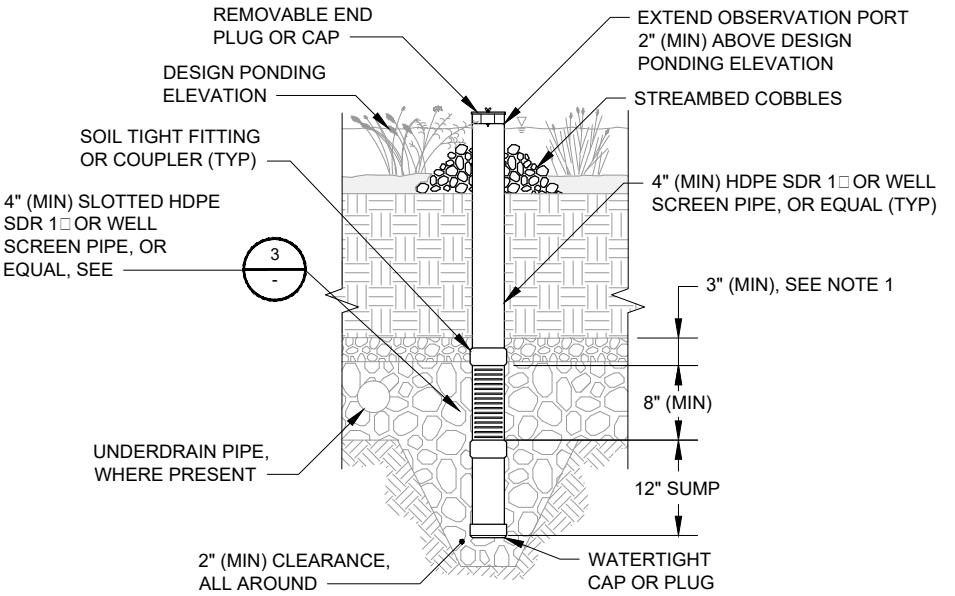
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VERSION: 1.0
REVISED:

GENERAL COMPONENTS

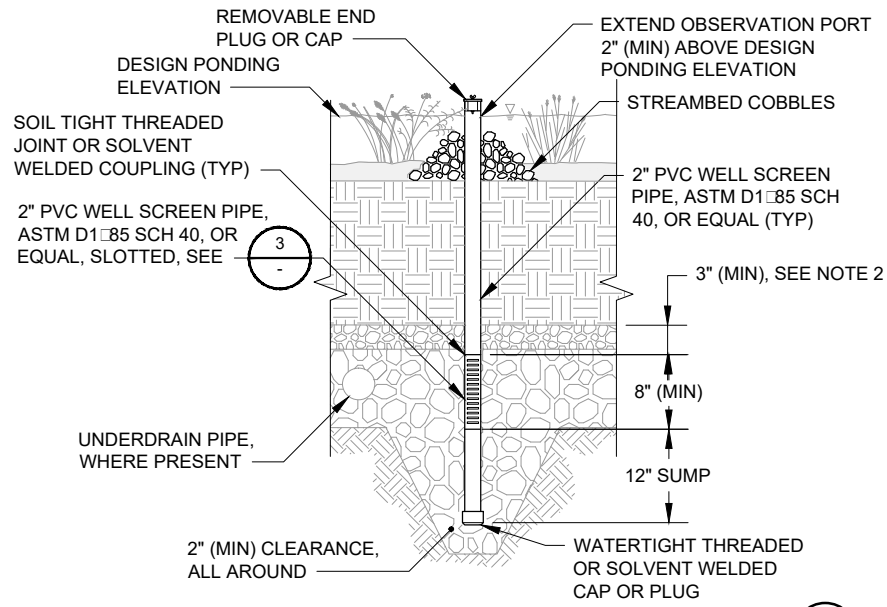
UTILITY CROSSINGS

BIORETENTION SECTIONS (2 OF 2)

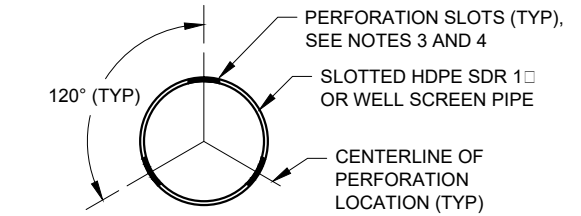
DWG NO. GC 2.5



HDPE OBSERVATION PORT 1



PVC WELL CASING/SCREEN OBSERVATION PORT 2



PIPE SLOT DETAIL 3

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR OBSERVATION PORTS SHALL CONFORM TO SAN FRANCISCO STANDARD SPECIFICATIONS AND APPLICABLE CODES PER SAN FRANCISCO DBI AND PUBLIC WORKS.
2. PROVIDE 3 INCH MINIMUM COVER FROM BOTTOM OF BIORETENTION SOIL TO BEGINNING OF OBSERVATION PORT PERFORATIONS.
3. ALL PERFORATIONS SHALL BE SLOTTED TYPE, MEASURING 0.032 INCH WIDE (MAX), SPACED AT 0.25 INCH (MIN), AND PROVIDING A MINIMUM INLET AREA OF 5.0 SQUARE INCH PER LINEAR FOOT OF PIPE FOR PIPES 4 INCH IN DIAMETER AND LARGER AND 2.0 SQUARE INCHES PER LINEAR FOOT OF PIPE FOR PIPES SMALLER THAN 4 INCHES IN DIAMETER.
4. PERFORATIONS SHALL BE ORIENTED PERPENDICULAR TO LONG AXIS OF PIPE, AND EVENLY SPACED AROUND CIRCUMFERENCE AND LENGTH OF PIPE.
5. ALL FITTINGS SHALL BE SOIL TIGHT, UNLESS NOTED OTHERWISE.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES	COMPONENTS	
GC	GC	GC
4.1	4.2	4.3

San Francisco Water Power Sewer

GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016
VERSION 2.0
REVISED

GENERAL COMPONENTS

OBSERVATION PORT BIORETENTION

DWG NO. GC 4.2

PURPOSE:

BIORETENTION OUTLET MONITORING SYSTEMS ARE DESIGNED TO MONITOR FLOWS IN THE UNDERDRAIN, OVERFLOW, AND OTHER OUTLET PIPES. THESE FLOWS ARE TYPICALLY VERY SMALL, REQUIRING THE USE OF SENSITIVE EQUIPMENT (WEIRS, STILLING WELLS, AND HIGHLY SENSITIVE PRESSURE TRANSDUCERS) TO PRODUCE ACCURATE FLOW ESTIMATES. THESE GUIDELINES WILL HELP THE DESIGNER TO DESIGN A SYSTEM WHICH WILL BE CONDUCIVE TO FLOW MEASUREMENT USING THIS EQUIPMENT.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT THE SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER MUST CONSULT WITH EQUIPMENT MANUFACTURER'S REPRESENTATIVE AND MONITORING PROFESSIONAL OR TECHNICIAN PRIOR TO COMPLETION OF DESIGN.
3. UNDERDRAIN AND BYPASS FLOW SHOULD BE MEASURED WITH THE USE OF VOLUMETRIC PIPE WEIRS, STILLING WELLS, AND PRESSURE TRANSDUCERS.
4. **THE OUTLET AND UNDERDRAIN PIPES SHALL BE AT LEAST 6 INCHES IN DIAMETER AT BIORETENTION MONITORING WEIR LOCATIONS.** A REDUCER COUPLING MAY BE USED TO TRANSITION FROM PIPE DIAMETERS LESS THAN 6 INCHES TO 6 INCHES MINIMUM DIAMETER PROVIDED TRANSITION OCCURS A MINIMUM OF 3 FEET UPSTREAM OF WEIR. THE DESIGNER MUST EVALUATE AND MITIGATE THE IMPACT OF THE PIPE WEIRS ON PIPE CONVEYANCE CAPACITY AND PIPE INVERT ELEVATION.
5. PRESSURE TRANSDUCERS MAY BE VENTED OR UNVENTED. IF UNVENTED, A NEARBY BAROMETRIC TRANSDUCER OF THE SAME MAKE SHOULD BE INSTALLED FOR ATMOSPHERIC PRESSURE CORRECTION.
6. WHEN MEASURING FLOW ENTERING THE MONITORING STRUCTURE:
   - PVC STILLING WELLS MUST BE VENTED ABOVE THE HIGH WATER LINE AND WATER TIGHT BELOW THE HIGH WATER LINE (OR WATER TIGHT WITHIN THE SUMP, IF PERFORATED).
   - INSTALL FLEXIBLE TUBING THROUGH FACE OF PIPE WEIR AND STILLING WELL WALL WITH WATERTIGHT FITTINGS. TUBE SHALL PASS THROUGH WEIR AND EXTEND 2 INCHES BEYOND WEIR FACE TO AVOID MEASURING WATER DEPTH NEAR NAPPE OF WEIR. TUBE SHALL PASS THROUGH THE FACE OF THE WEIR AS FAR FROM WEIR CREST AS PRACTICABLE TO AVOID IMPACTS ON FLOW DYNAMICS.
7. WHEN MEASURING FLOW EXITING THE MONITORING STRUCTURE:
   - PVC STILLING WELLS MUST BE PERFORATED BELOW THE INVERT OF THE OUTLET PIPE. PERFORATIONS SHOULD ALWAYS BE ABOVE THE TOP OF THE PRESSURE TRANSDUCER HOUSING TO PROVIDE A PERMANENT WET POOL FOR THE TRANSDUCER.
   - THE STRUCTURE SHALL BE WATER TIGHT. CALIBRATION OF THE WEIR IN THE OUTLET PIPE WILL BE DIFFICULT IF LARGE VOLUMES OF WATER ARE NEEDED TO INCREASE THE WATER LEVEL IN THE STRUCTURE TO THE INVERT OF THE PIPE WEIR.
8. THE MONITORING STRUCTURE SHOULD BE LARGE ENOUGH TO PROVIDE ACCESS FOR INSTALLATION, MAINTENANCE, AND REMOVAL OF MONITORING EQUIPMENT.
9. THE DESIGNER MUST ENSURE THAT BACKWATER CONDITIONS DO NOT OCCUR IN THE MONITORING STRUCTURE. IF THE VOLUMETRIC WEIRS ARE SUBMERGED DUE TO BACKWATER THEY WILL NOT FUNCTION PROPERLY.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ MONITORING STRUCTURE TYPE/MATERIAL, DIAMETER, AND DEPTH
- ☐ PRESSURE TRANSDUCER TYPE AND SPECIFICATIONS
- ☐ WEIR TYPE, SIZE, AND RATING CURVES
- ☐ CONTROL ELEVATIONS FOR WEIRS, STILLING WELLS, AND PRESSURE TRANSDUCERS
- ☐ MATERIAL TYPE AND SIZE FOR ALL PIPES AND TUBING
- ☐ DIAGRAM WITH ALL OUTLET MONITORING ASSEMBLY COMPONENTS IDENTIFIED OR REQUEST FOR CONTRACTOR SUBMITTAL OF MONITORING ASSEMBLY

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

EDGE TREATMENTS								INLETS				OUTLETS				AGGREGATE STORAGE COMPONENTS	UNDERDRAINS		CHECK DAM		MONITORING		
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS	NOTES	COMPONENTS	
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 4.1	BC 5.1	BC 5.2	BC 6.1	BC 6.2	BC 7.1	BC 7.2	BC 7.3

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 7.1

DATE: OCTOBER 2024

VERSION: 2.0

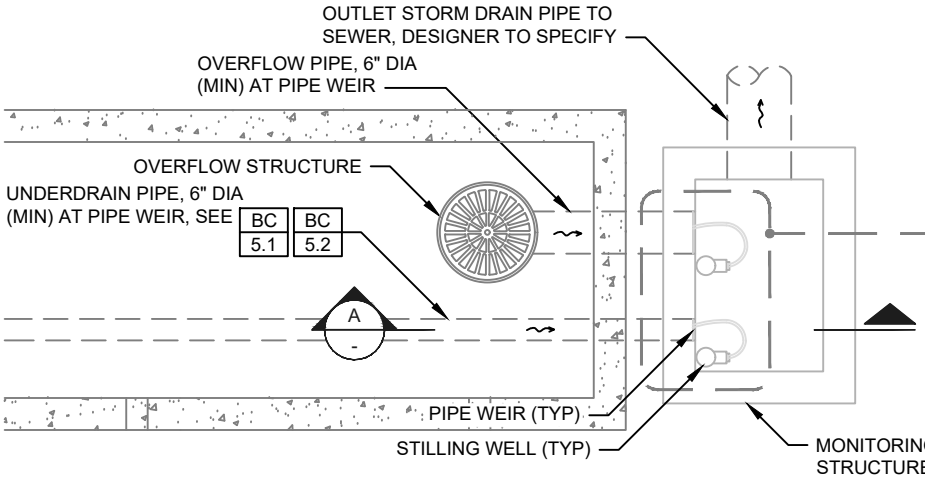
REVISED:

BIORETENTION COMPONENTS

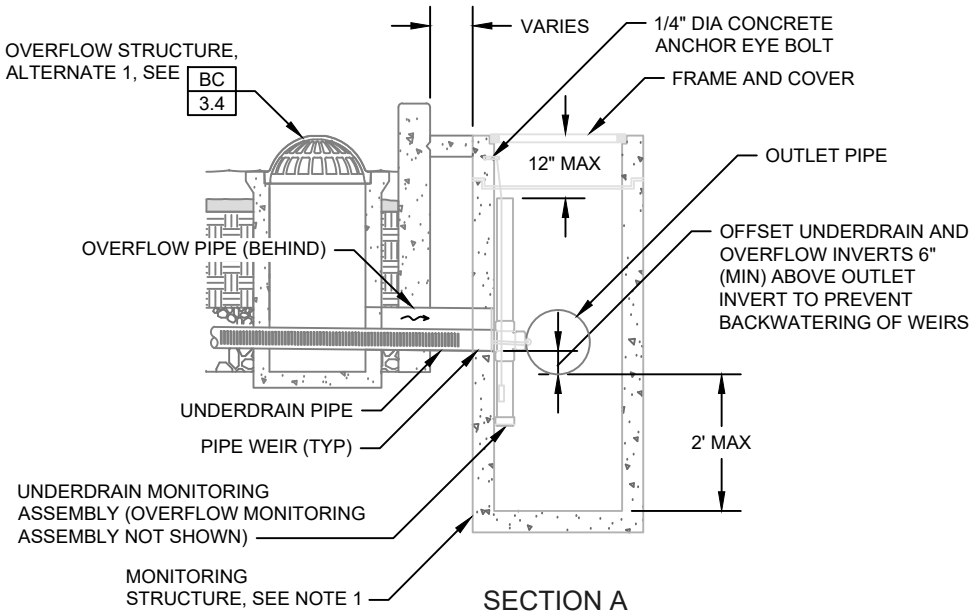
OUTLET MONITORING DESIGNER NOTES

DWG NO.

BC 7.1



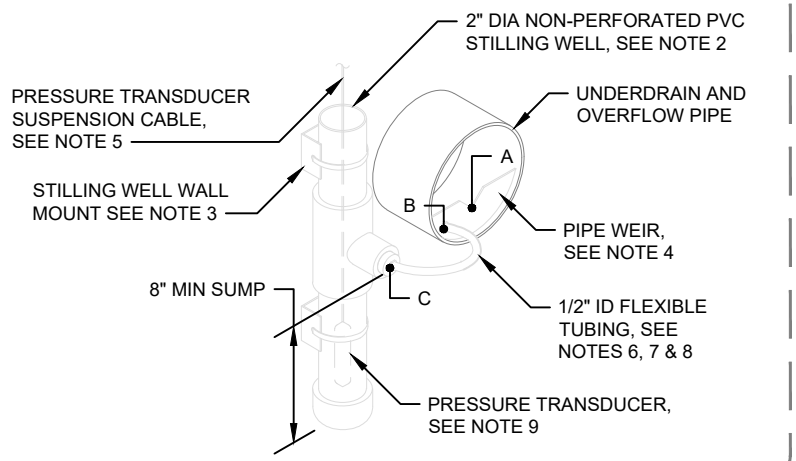
PLAN



SECTION A

UNDERDRAIN AND OVERFLOW PIPE MONITORING ASSEMBLY DETAIL

(APPLIES TO BOTH ASSEMBLIES)



CONSTRUCTION NOTES:

1. MONITORING STRUCTURES WITH AN INTERIOR DEPTH GREATER THAN 5 FEET SHALL HAVE A MINIMUM CLEAR SPACE OF 30 INCH BY 30 INCH ACCESSIBLE BY A PERMANENT BOLTED LADDER.
2. STILLING WELL SHALL BE MOUNTED VERTICALLY AND ALL FITTINGS SHALL BE WATERTIGHT.
3. ATTACH STILLING WELL WITH PREFABRICATED METAL STRUT CHANNEL AND PIPE CLAMPS (2 MINIMUM) PER MANUFACTURERS RECOMMENDATION.
4. PIPE WEIR SHALL BE INSTALLED LEVEL AND WITHIN 1 INCH OF END OF PIPE.
5. PRESSURE TRANSDUCER SUSPENSION CABLE SHALL BE 1/16 INCH COATED STAINLESS STEEL CABLE WITH FERRULED CABLE LOOP AND COMPATIBLE OVAL CARABINER FOR CONNECTION TO CONCRETE ANCHOR EYE BOLT.
6. INSTALL FLEXIBLE TUBING THROUGH FACE OF PIPE WEIR AND STILLING WELL WALL WITH WATERTIGHT FITTINGS. TUBE SHALL PASS THROUGH WEIR AND EXTEND 2 INCHES BEYOND WEIR FACE .TUBE SHALL BE INSTALLED AS FAR FROM WEIR CREST AS PRACTICABLE, SEE DESIGNER NOTES.
7. ATTACH TUBE BELOW WEIR NOTCH (POINT B SHALL BE BELOW POINT A).
8. PROVIDE NEGATIVE SLOPE IN TUBE (POINT C SHALL BE BELOW POINT B).
9. PRESSURE TRANSDUCER SHALL BE RATED FOR ZERO TO 21 PSI OF PRESSURE AND AN ACCURACY OF ±0.1 PERCENT FULL SCALE RANGE OR BETTER AT 25°C.

EDGE TREATMENTS								INLETS				OUTLETS				AGGREGATE STORAGE COMPONENTS	UNDERDRAINS		CHECK DAM		MONITORING		
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS				NOTES	COMPONENTS	NOTES	COMPONENTS	NOTES	COMPONENTS	
BC 1.1	BC 1.2	BC 1.3	BC 1.4	BC 1.5	BC 1.6	BC 1.7		BC 2.1	BC 2.2	BC 2.3	BC 2.4	BC 3.1	BC 3.2	BC 3.3	BC 3.4	BC 4.1	BC 5.1	BC 5.2	BC 6.1	BC 6.2	BC 7.1	BC 7.2	BC 7.3

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 7.2

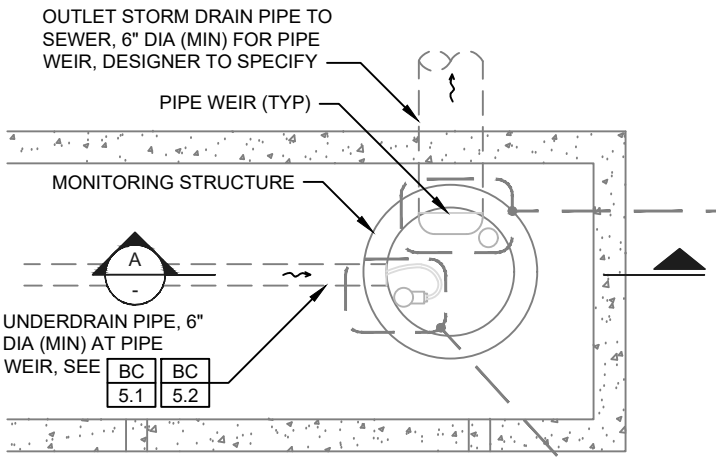
DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

BIORETENTION COMPONENTS

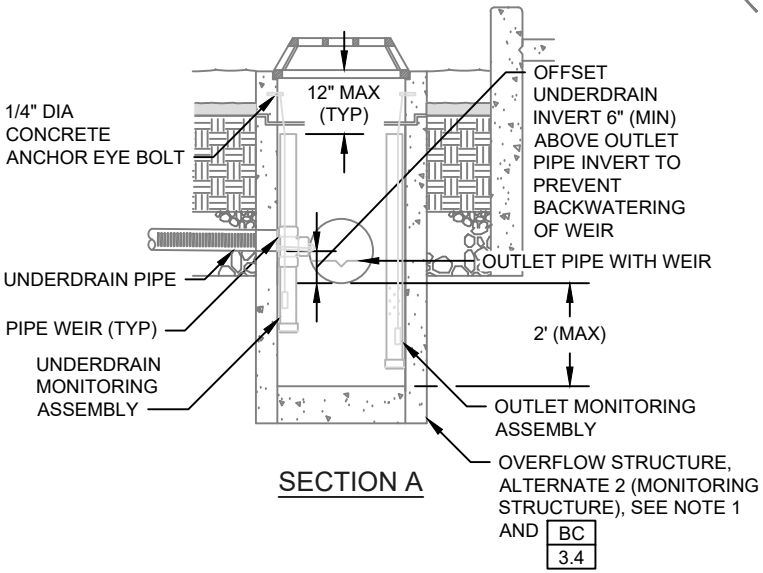
OUTLET MONITORING
EXTERNAL ACCESS STRUCTURE

DWG NO. **BC 7.2**

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

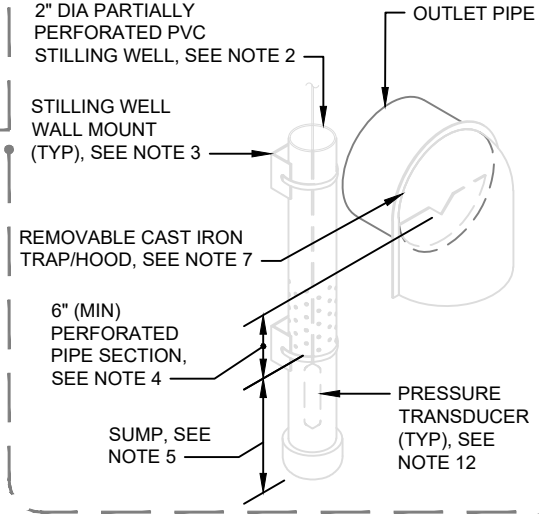


PLAN

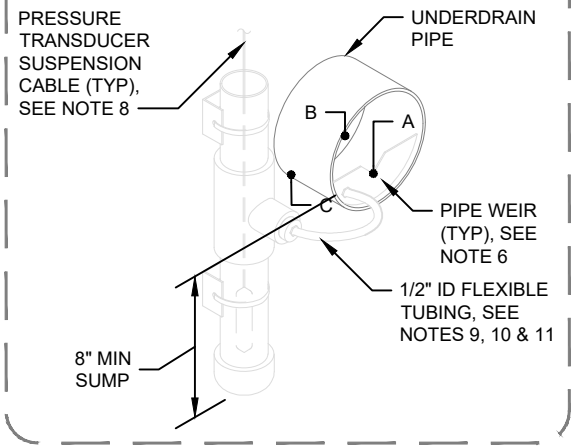


SECTION A

OUTLET PIPE MONITORING ASSEMBLY DETAIL



UNDERDRAIN MONITORING ASSEMBLY DETAIL



CONSTRUCTION NOTES:

1. MONITORING STRUCTURES WITH AN INTERIOR DEPTH GREATER THAN 5 FEET SHALL HAVE A MINIMUM CLEAR SPACE OF 30 INCH BY 30 INCH ACCESSIBLE BY A PERMANENT BOLTED LADDER.
2. STILLING WELL SHALL BE MOUNTED VERTICALLY AND ALL FITTINGS SHALL BE WATERTIGHT.
3. ATTACH STILLING WELL WITH PREFABRICATED METAL STRUT CHANNEL AND PIPE CLAMPS (2 MINIMUM) PER MANUFACTURERS RECOMMENDATION.
4. PROVIDE PERFORATIONS ALONG CIRCUMFERENCE OF STILLING WELL BETWEEN OUTLET PIPE INVERT AND PRESSURE TRANSDUCER SUMP. PERFORATIONS SHALL MEASURE 1/4 INCH DIAMETER (MINIMUM) AT 1 INCH (MAXIMUM) ON-CENTER SPACING, ALL DIRECTIONS.
5. STILLING WELL SUMP SHALL BE NON-PERFORATED AND EXTEND 4 INCHES (MINIMUM) BELOW AND 2 INCHES (MINIMUM) ABOVE PRESSURE TRANSDUCER HOUSING TO ALLOW FOR SEDIMENT ACCUMULATION IN THE BOTTOM OF THE WELL AND PROVIDE A PERMANENT WET POOL FOR THE TRANSDUCER.
6. PIPE WEIR SHALL BE INSTALLED LEVEL AND WITHIN 1 INCH OF END OF PIPE.
7. REMOVABLE CAST IRON TRAP/HOOD SHALL BE NEENAH R-3701 SERIES, NEENAH R-3711 SERIES OR EQUAL. INSTALL TRAP/HOOD PER MANUFACTURERS RECOMMENDATION.
8. PRESSURE TRANSDUCER SUSPENSION CABLE SHALL BE 1/16 INCH COATED STAINLESS STEEL CABLE WITH FERRULED CABLE LOOP AND COMPATIBLE OVAL CARABINER FOR CONNECTION TO CONCRETE ANCHOR EYE BOLT.
9. INSTALL FLEXIBLE TUBING THROUGH FACE OF PIPE WEIR AND STILLING WELL WALL WITH WATERTIGHT FITTINGS. TUBE SHALL PASS THROUGH WEIR AND EXTEND 2 INCHES BEYOND WEIR FACE. TUBE SHALL BE INSTALLED AS FAR FROM WEIR CREST AS PRACTICABLE, SEE DESIGNER NOTES.
10. ATTACH TUBE BELOW WEIR NOTCH (POINT B SHALL BE BELOW POINT A).
11. PROVIDE NEGATIVE SLOPE IN TUBE (POINT C SHALL BE BELOW POINT B).
12. PRESSURE TRANSDUCER SHALL BE RATED FOR ZERO TO 21 PSI OF PRESSURE AND AN ACCURACY OF ±0.1 PERCENT FULL SCALE RANGE OR BETTER AT 25°C.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

EDGE TREATMENTS								INLETS				OUTLETS				AGGREGATE STORAGE	UNDERDRAINS		CHECK DAM		MONITORING		
NOTES	COMPONENTS							NOTES	COMPONENTS			NOTES	COMPONENTS			COMPONENTS	NOTES	COMPONENTS	NOTES	COMPONENTS	NOTES	COMPONENTS	
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Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

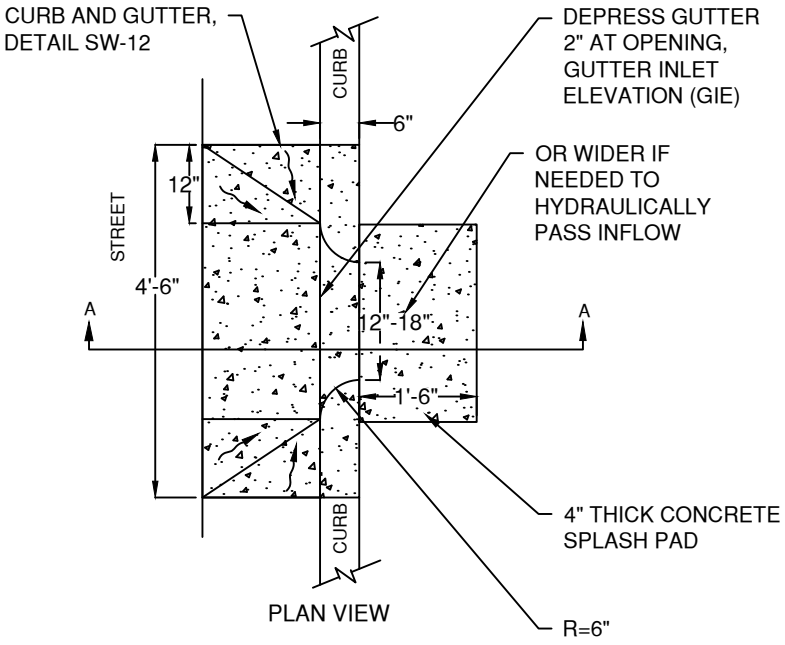
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION BC 7.3

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

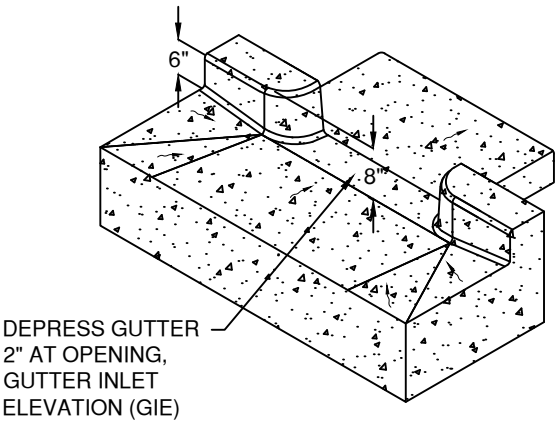
BIORETENTION COMPONENTS

OUTLET MONITORING
INTERNAL CATCH BASIN MONITORING

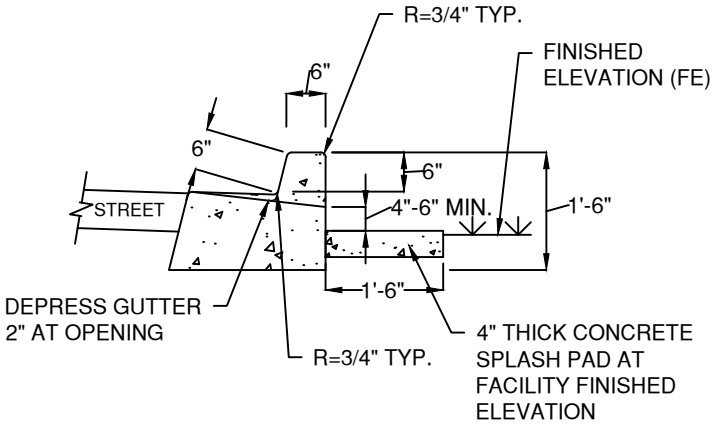
DWG NO. **BC 7.3**



PLAN VIEW



PERSPECTIVE VIEW



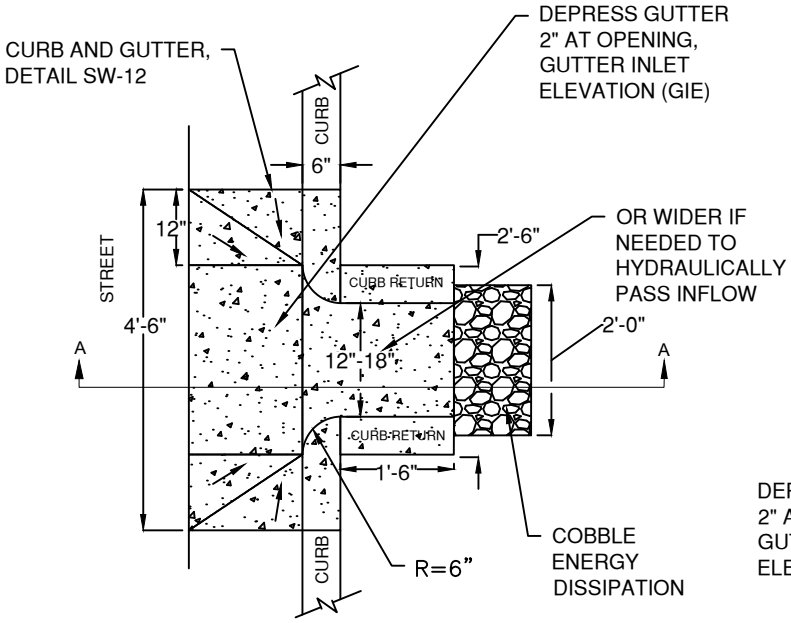
SECTION A-A

BIORETENTION DESIGN NOTES

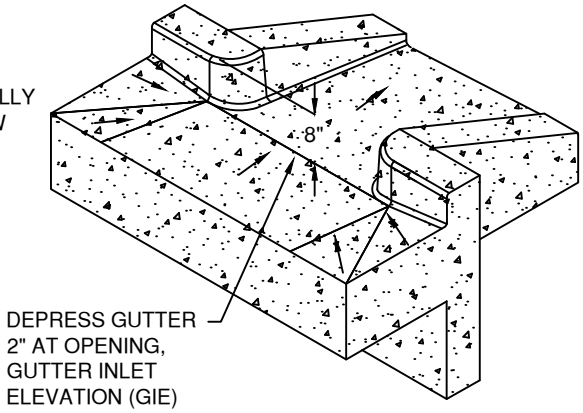
1. FOR USE WITH STORMWATER FACILITIES WITH FLAT BOTTOMS.
2. PROVIDE SPOT ELEVATIONS ON PLANS (FE, OE, GIE, IE). SEE DETAIL SW-2, SW-2A, SW-4 OR SW-4A.
3. CURB AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.
4. CURB HEIGHT MAY BE REDUCED TO 4-INCHES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

CONSTRUCTION NOTES

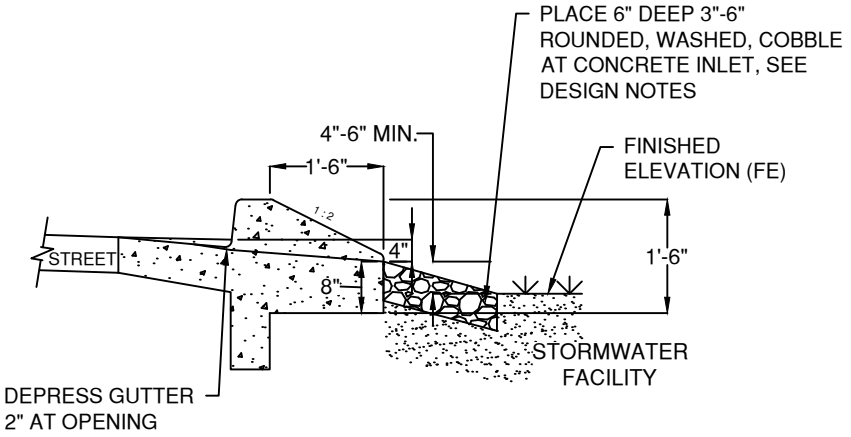
1. AFTER CONSTRUCTION PLACE SAND BAGS AT GUTTER OPENINGS TO KEEP STORM FLOWS FROM ENTERING FACILITY UNTIL VEGETATION IS ESTABLISHED.



PLAN VIEW



PERSPECTIVE VIEW



SECTION A-A

BIORETENTION DESIGN NOTES

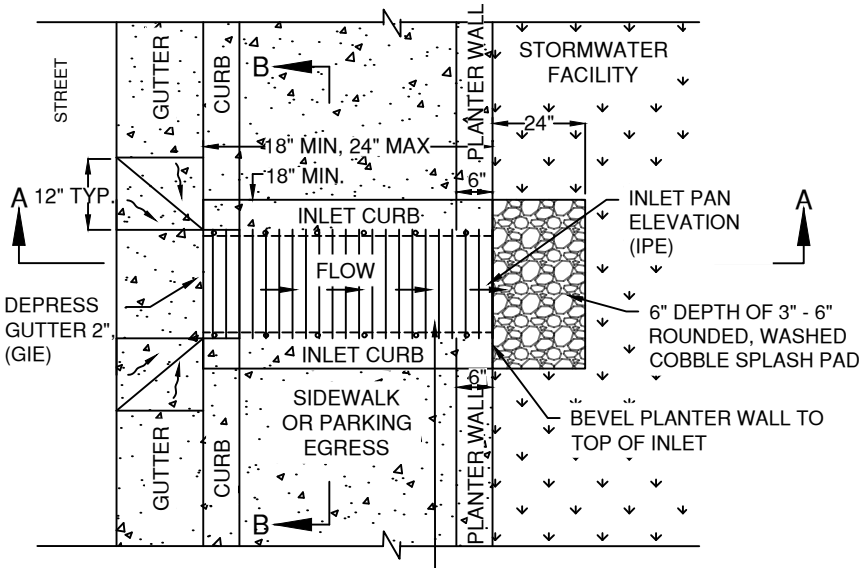
1. FOR USE WITH STORMWATER FACILITIES WITH SIDE SLOPES.
2. PROVIDE SPOT ELEVATIONS ON PLANS (FE, OE, GIE, IE). SEE DETAIL SW-1, SW-1A, SW-3 OR SW-3A.
3. CURB AND WALL DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO APPROVAL BY CITY ENGINEER.
4. WHERE INLET FLOW VELOCITY IS HIGH,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

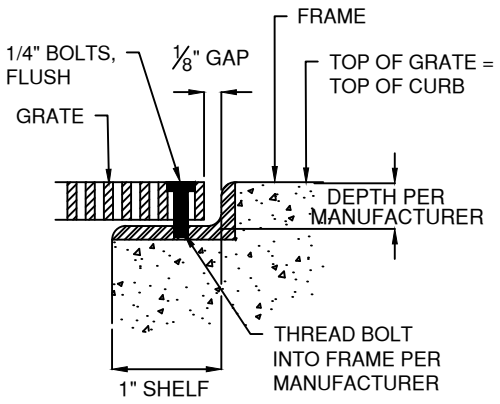
CONSTRUCTION NOTES

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

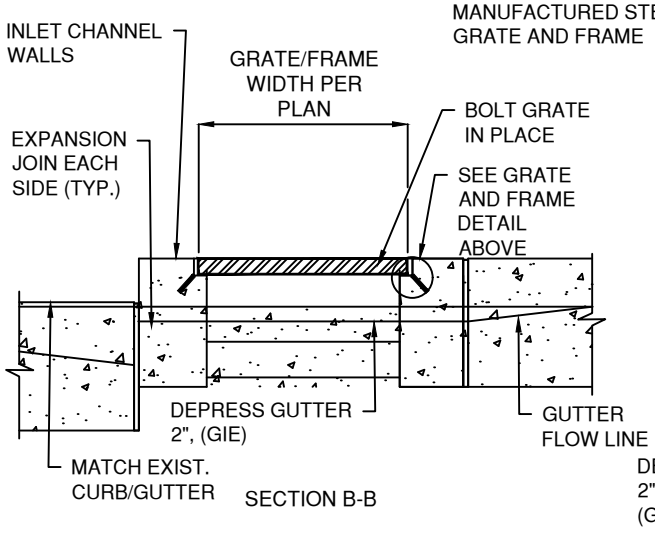
LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

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

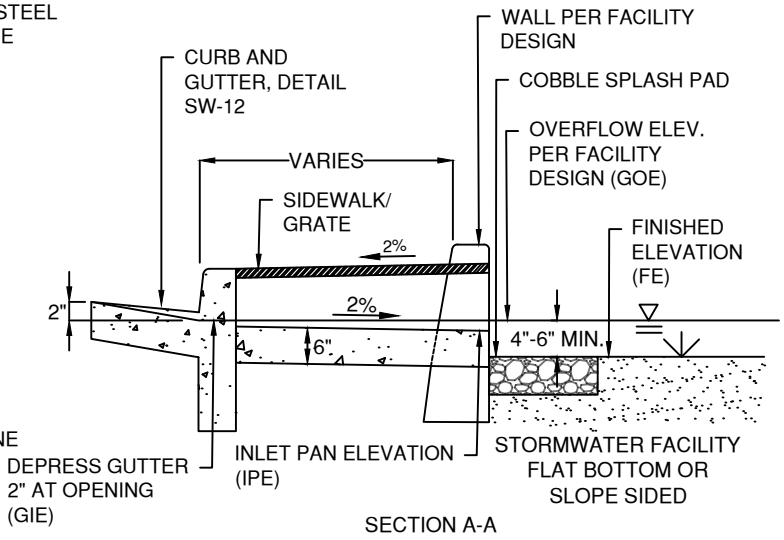




GRATE AND FRAME



SECTION B-B



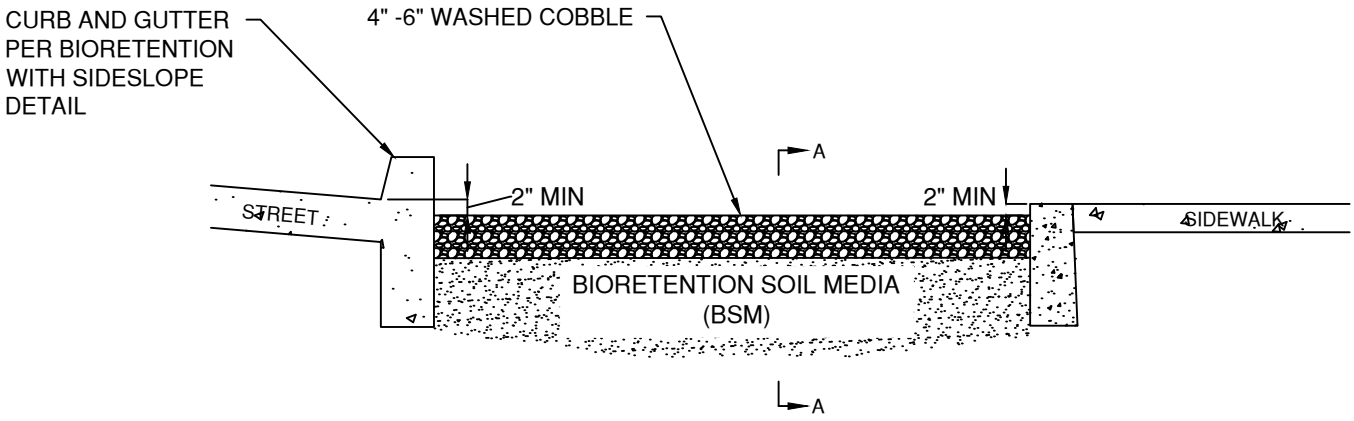
SECTION A-A

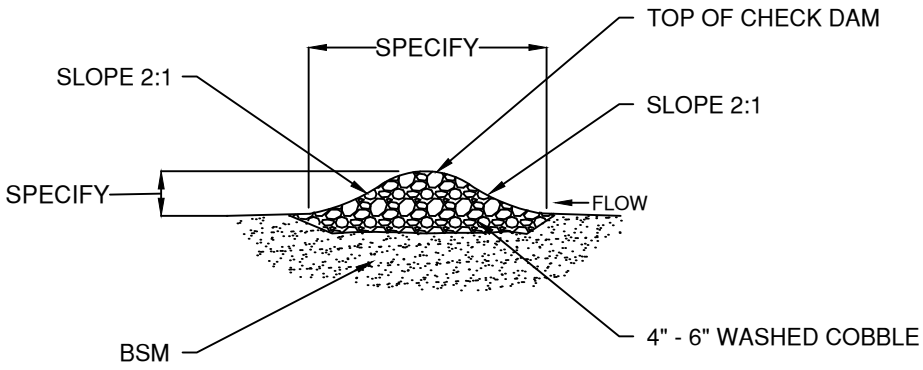
BIORETENTION DESIGN NOTES

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

CONSTRUCTION NOTES

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





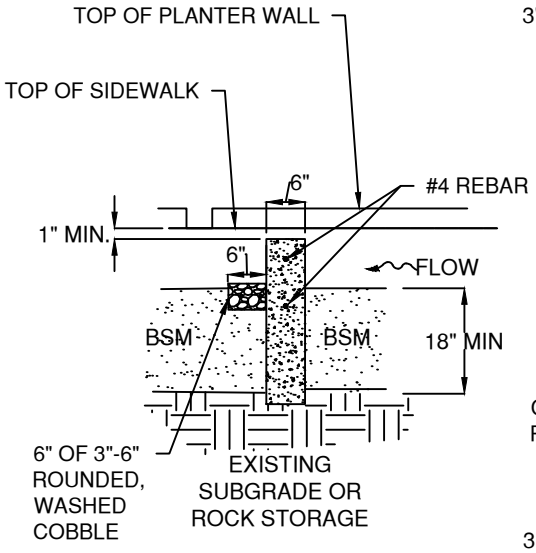
SECTION A-A

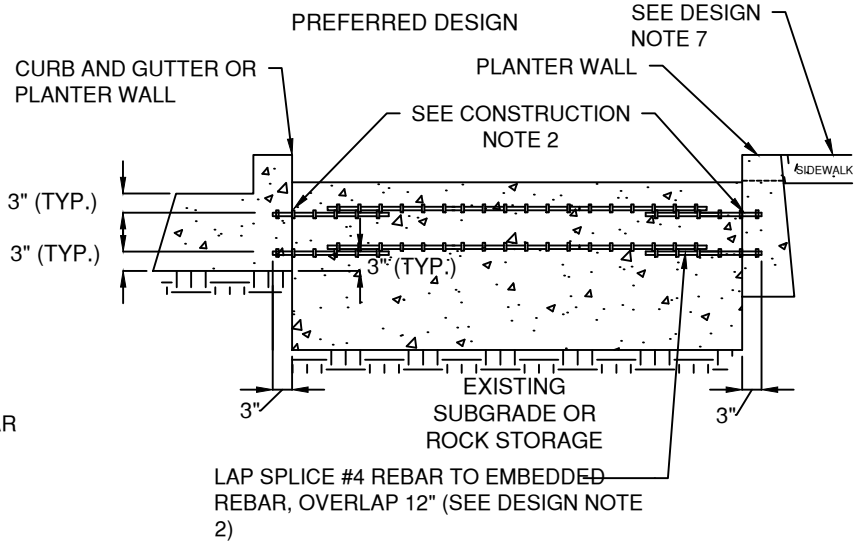
BIORETENTION DESIGN NOTES

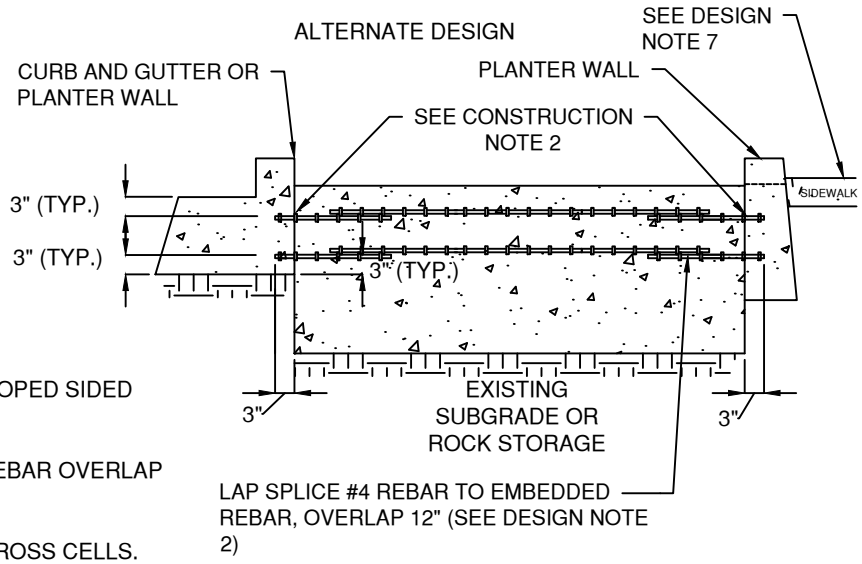
1. FOR USE WITH STORMWATER FACILITIES WITH SLOPED SIDES.
2. BEST SUITED FOR FACILITIES WITH <= 2% LONGITUDINAL SLOPE.
3. PROVIDE ELEVATIONS AND STATIONING AND/OR DIMENSIONING FOR CHECK DAMS.
4. SPACE CHECK DAMS TO MAXIMIZE PONDING ACROSS ENTIRE CELL.
5. ENSURE THAT CHECK DAM ELEVATIONS DO NOT CAUSE STORMWATER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

CONSTRUCTION NOTES

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





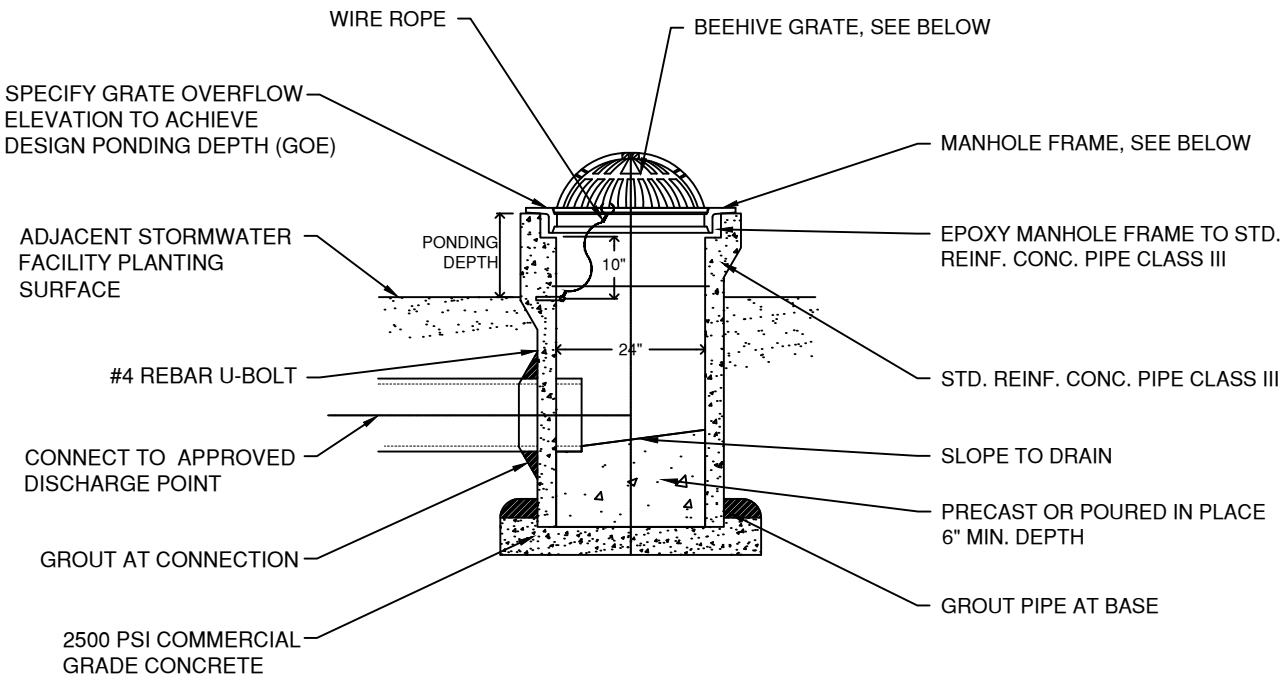


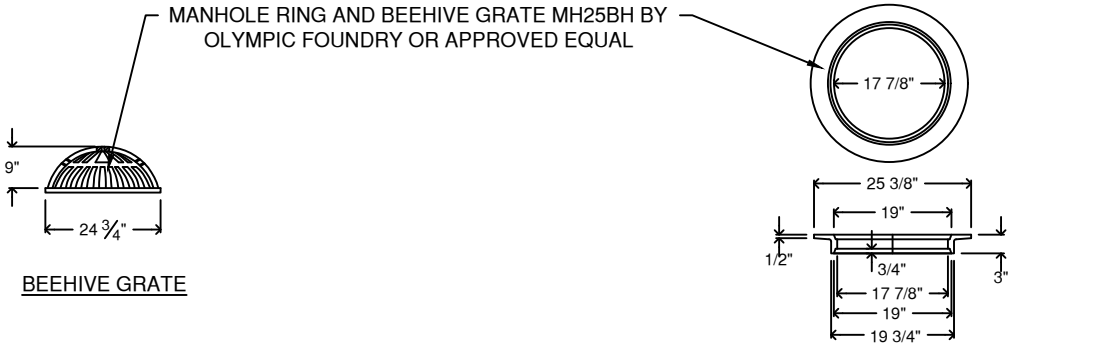
BIORETENTION DESIGN NOTES

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

CONSTRUCTION NOTES

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





BEEHIVE GRATE

24"x4" REVERSIBLE MANHOLE FRAME

DESIGN NOTES

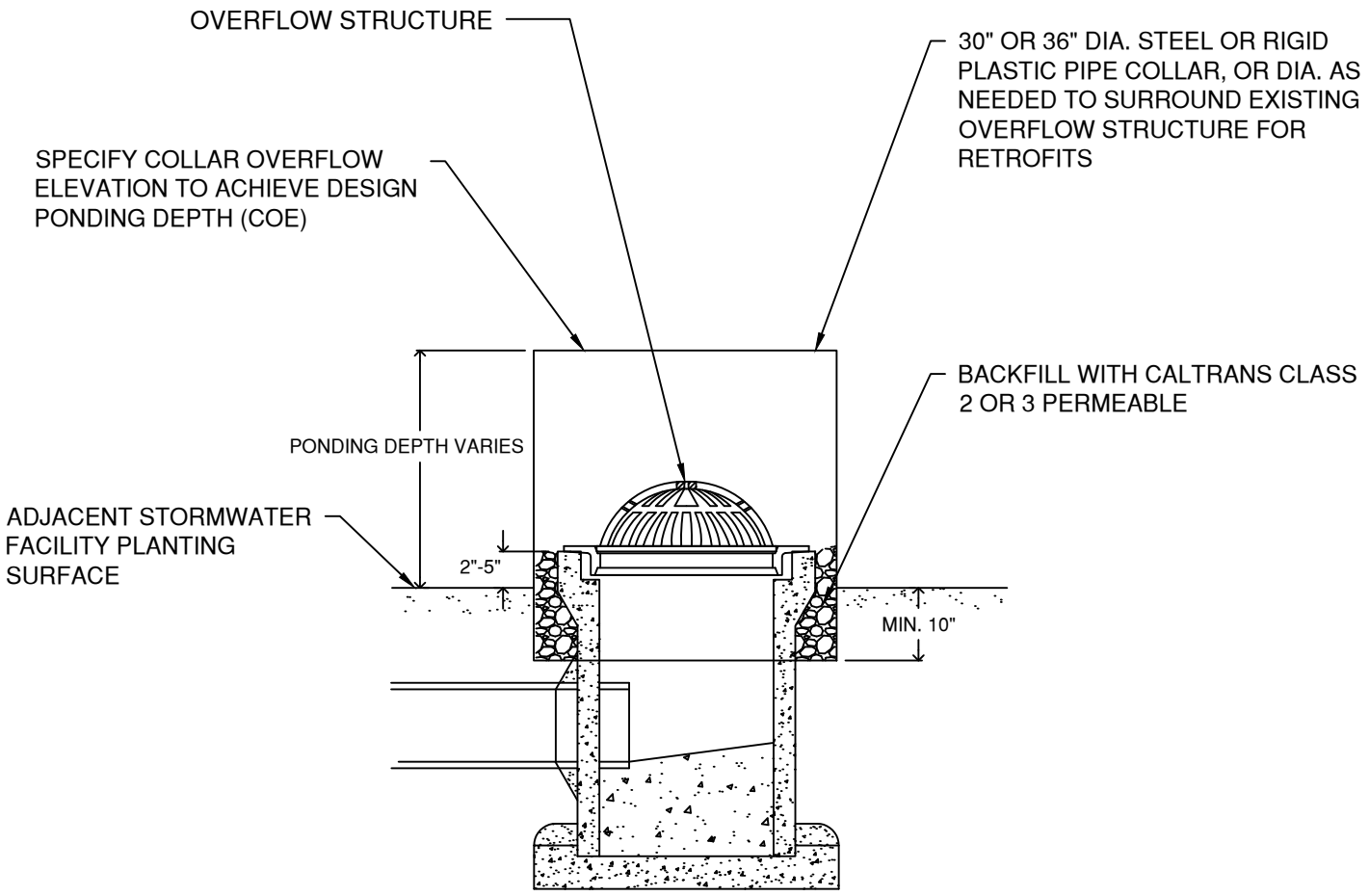
1. PROVIDE GRATE OVERFLOW ELEVATION ON PLANS.
2. TO INCORPORATE FLEXIBILITY INTO DESIGN OVERFLOW ELEVATION OR CORRECT ELEVATION OF AN EXISTING STRUCTURE, INSTALL OVERFLOW COLLAR, PER DETAIL SW-22A.
3. IN PRIVATE SITES NOT IN CITY R/W THE PROJECT CIVIL ENGINEER MAY PROPOSE ALTERNATIVES FOR GRATE INSTALLATIONS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

CONSTRUCTION NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

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

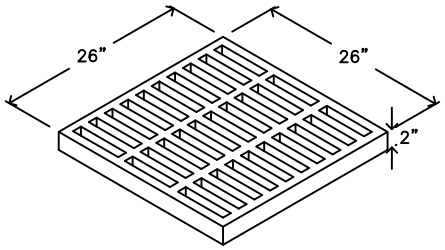
2. PROVIDE COLLAR OVERFLOW ELEVATION (COE) ON PLANS.

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

CONSTRUCTION NOTES

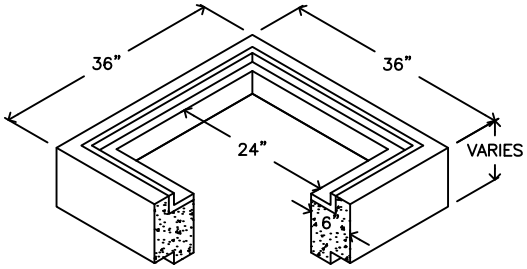
1. CENTER COLLAR ON OVERFLOW GRATE.

C.I. GRATE

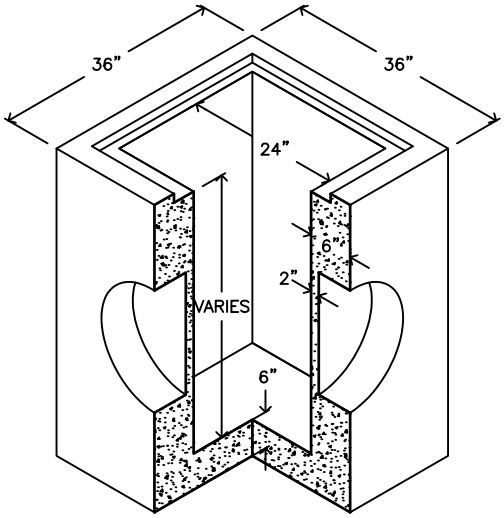


C.I. FRAME

EXTENSION



BOTTOM



DESIGN NOTES

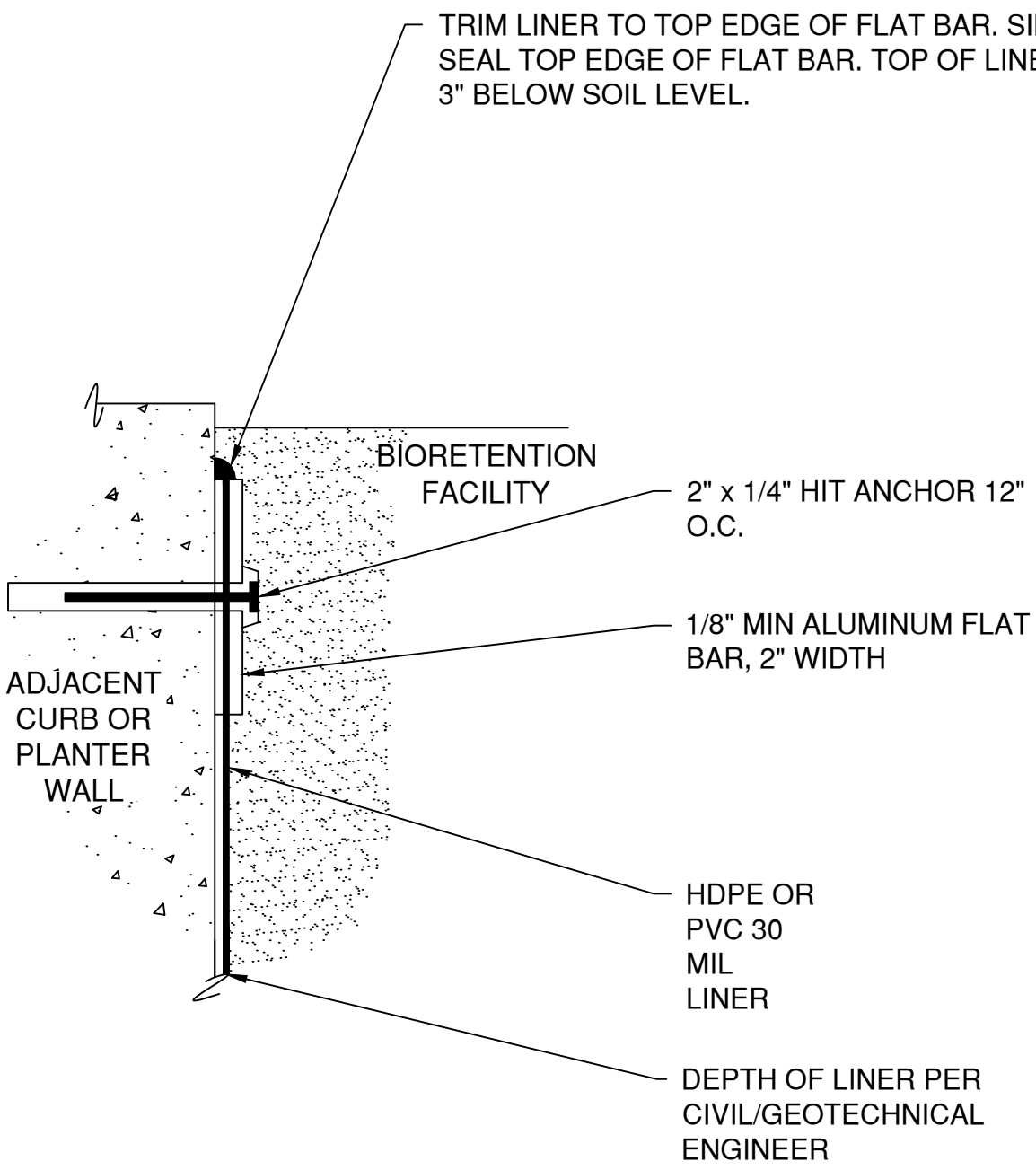
1. PROVIDE GRATE OVERFLOW ELEVATION ON PLANS.
2. PROVIDE EXTENSION OVERFLOW ELEVATION (COE) ON PLANS.
3. ON PRIVATE SITES NOT IN CITY RIGHT-OF-WAY THE PROJECT CIVIL ENGINEER MAY PROPOSE ALTERNATIVES FOR GRATE INSTALLATIONS USING ALTERNATIVE MANUFACTURER'S PRODUCTION/CONFIGURATION.

CONSTRUCTION NOTES

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

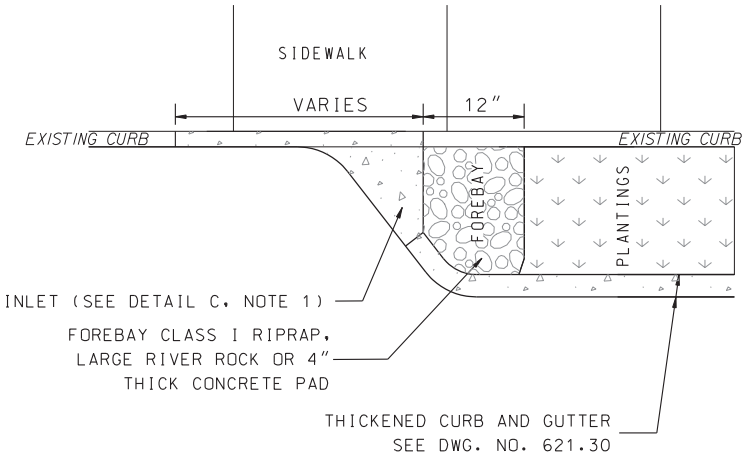
LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

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

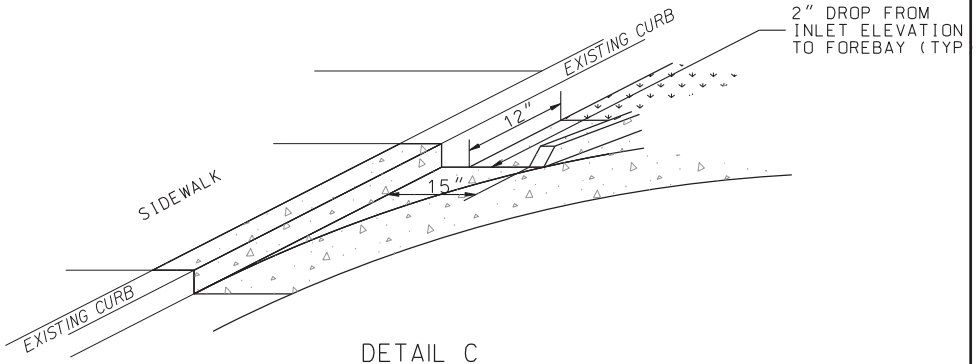


LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

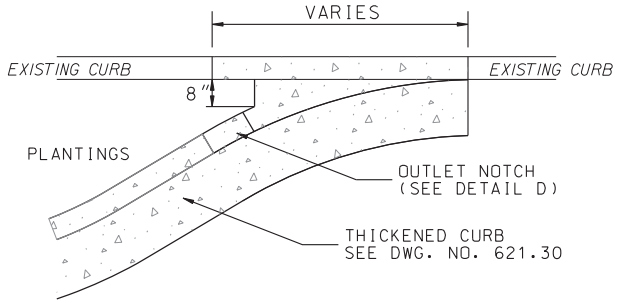
CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY:	IMPERMEABLE LINER CONNECTION	STANDARD PLAN NO. SW-24
	VERSION: 08/31/2017	USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	SHEET 1 OF 1



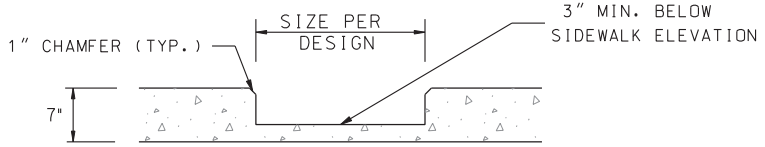
DETAIL A
INLET PLAN VIEW



DETAIL C
INLET ISOMETRIC VIEW



DETAIL B
OUTLET CURB PLAN



DETAIL D
OUTLET NOTCH

NOTES

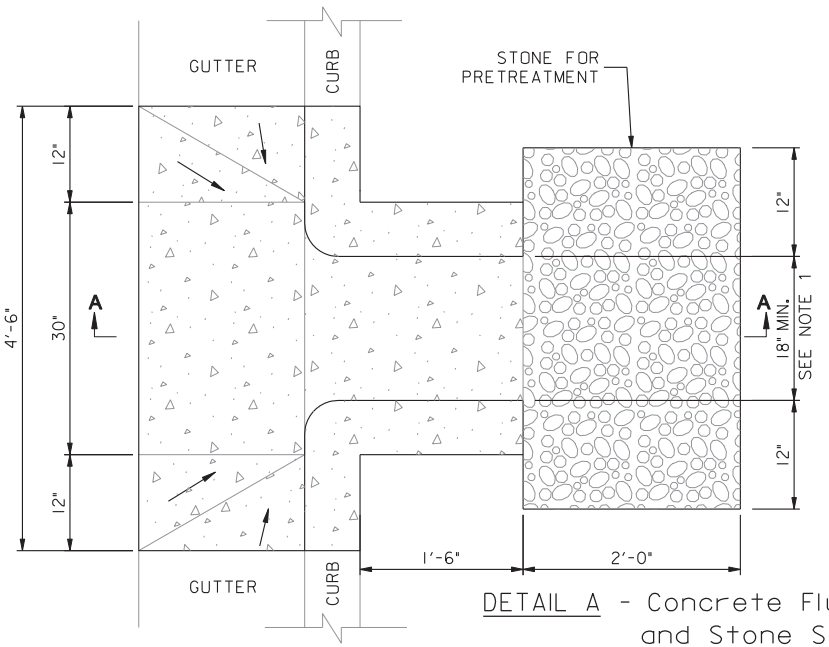
1. INLET MAY BE MODIFIED TO METER THE AMOUNT OF FLOW ENTRY TO STORMWATER FACILITY

			RECOMMENDED: Ravindra D Gavit DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
REVISED			
ISSUED:			
		REFERENCE	

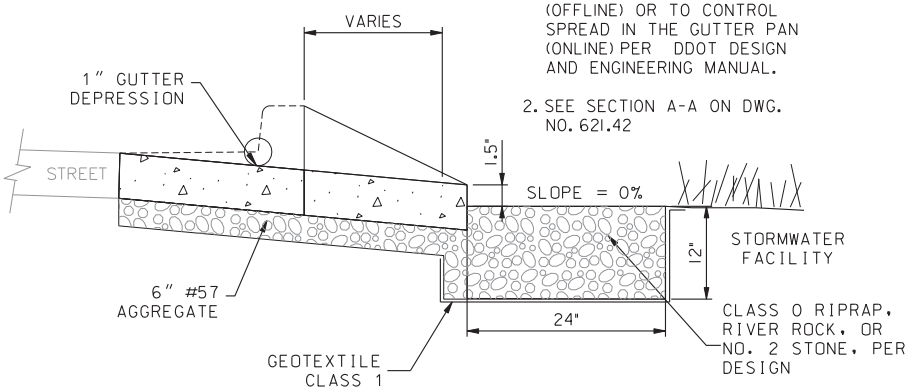
INLET AND OUTLET FOR CURB EXTENSION BIORETENTION

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.40



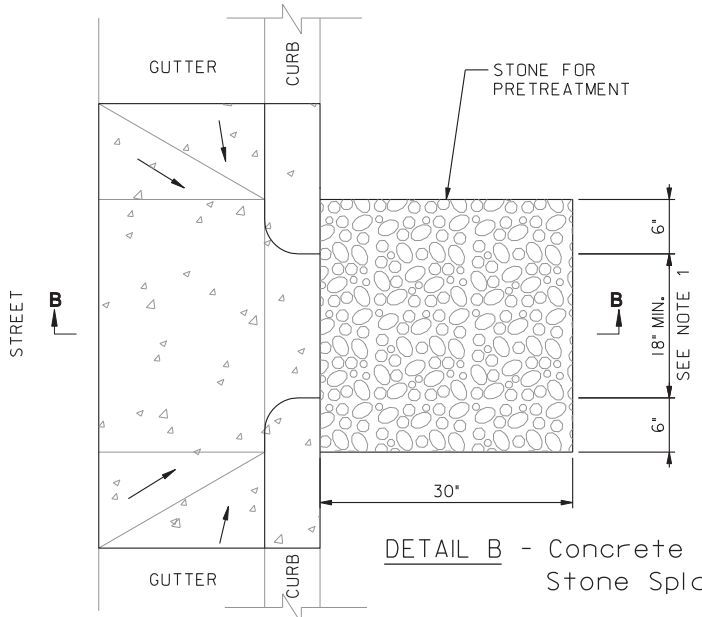
DETAIL A - Concrete Flume with Wingwalls and Stone Splash Pad



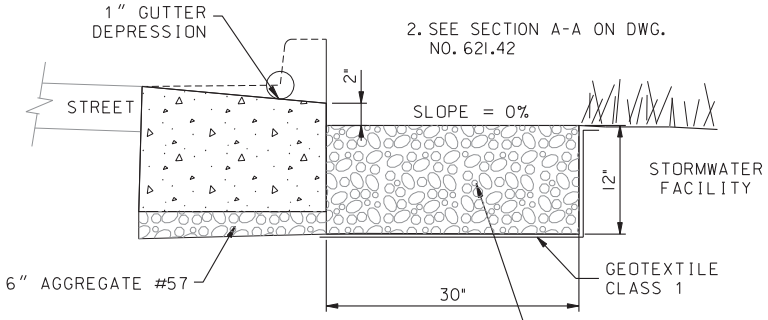
SECTION A-A

NOTES:

1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 1.2" RAINFALL (OFFLINE) OR TO CONTROL SPREAD IN THE GUTTER PAN (ONLINE) PER DDOT DESIGN AND ENGINEERING MANUAL.
2. SEE SECTION A-A ON DWG. NO. 621.42



DETAIL B - Concrete Flume with Stone Splash Pad



SECTION B-B

NOTES:

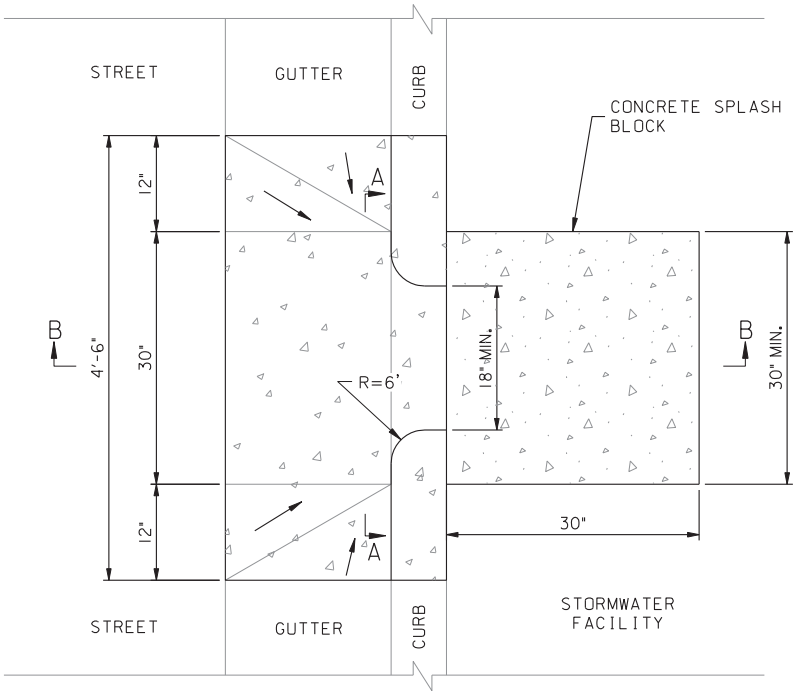
1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 1.2" RAINFALL (OFFLINE) OR TO CONTROL SPREAD IN THE GUTTER PAN (ONLINE) PER DDOT DESIGN AND ENGINEERING MANUAL.
2. SEE SECTION A-A ON DWG. NO. 621.42

			RECOMMENDED: Ravindra D. Ganis DEPUTY CHIEF ENGINEER
DATE	APPR.		
REVISED			APPROVED: CHIEF TRANSPORTATION ENGINEER
ISSUED:		REFERENCE	

CURB CUT WITH SPLASH PAD – 1

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

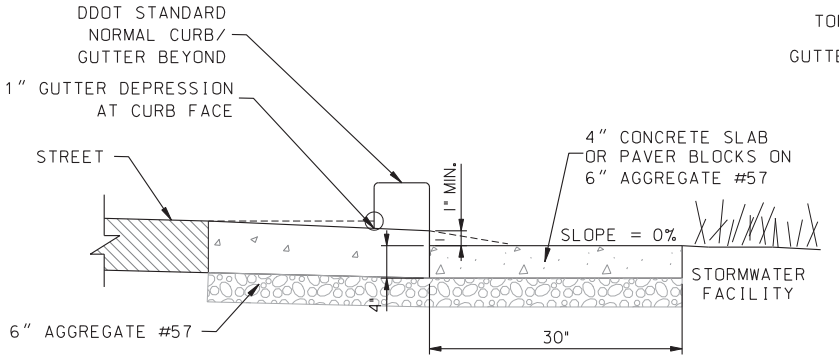
DWG. NO. 621.41



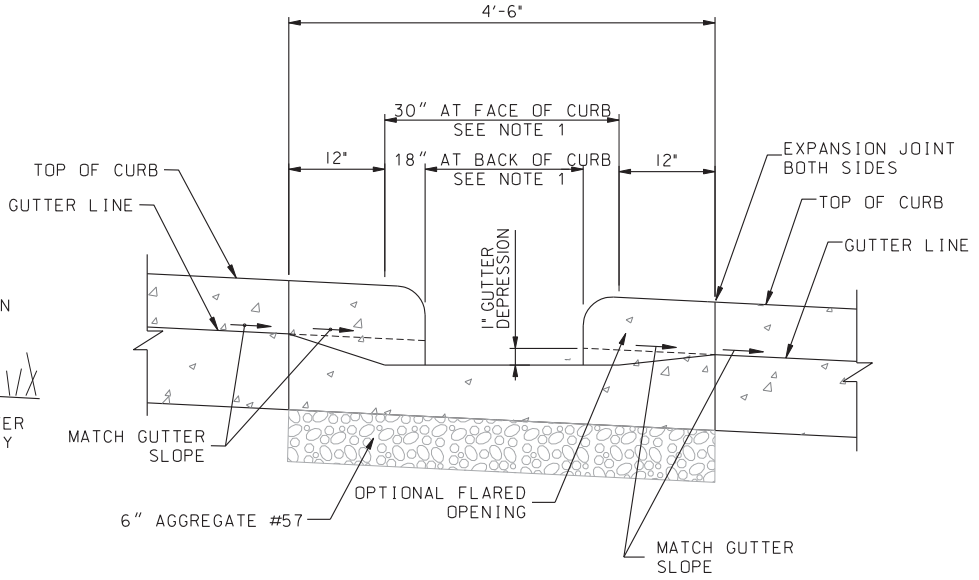
PLAN VIEW

NOTES:

1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUT SHALL BE SIZED TO CONVEY 1.2" RAINFALL (OFFLINE) OR TO CONTROL SPREAD IN THE GUTTER PAN (ONLINE) PER DDOT DESIGN AND ENGINEERING MANUAL.



SECTION B-B



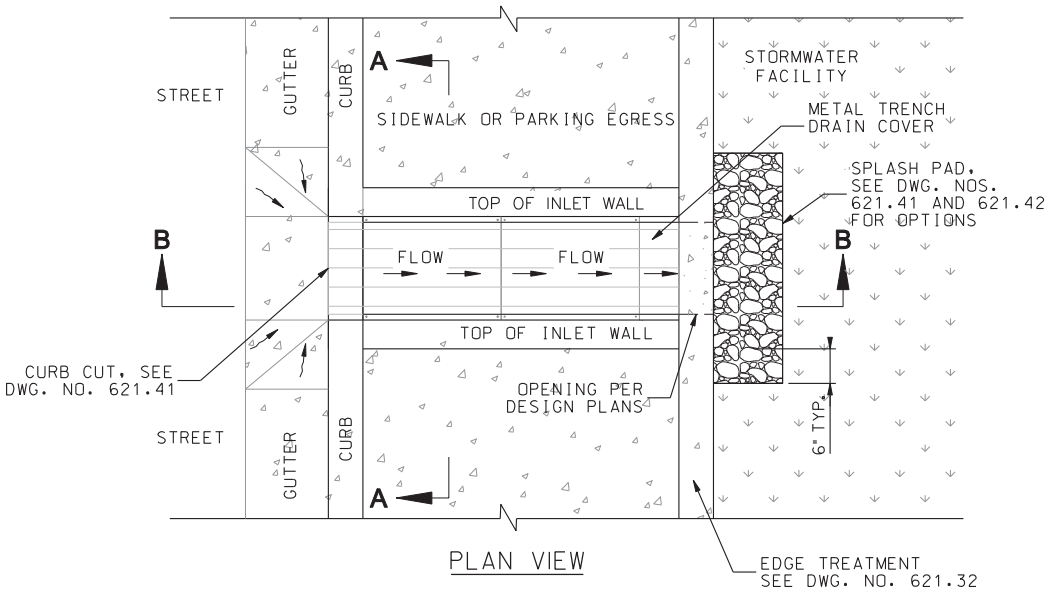
SECTION A-A

			RECOMMENDED: Ravindra D Gonit DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
REVISED			
ISSUED:			
		REFERENCE	

CURB CUT WITH SPLASH PAD – 2

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

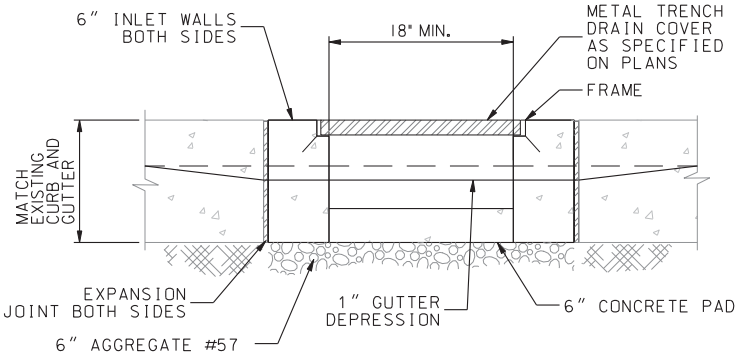
DWG. NO. 621.42



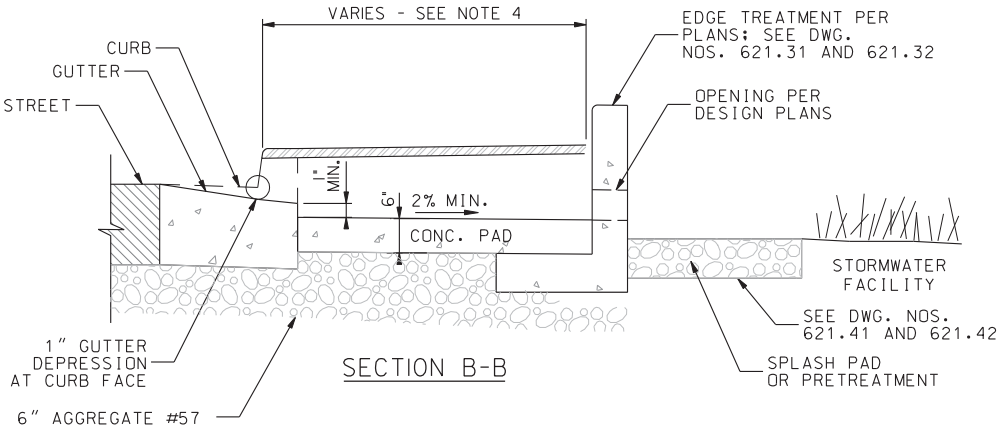
PLAN VIEW

NOTES:

1. CURB OPENING DIMENSION SHOWN IS A MINIMUM. CURB CUTS SHALL BE SIZED TO CONVEY 1.2" RAINFALL (OFFLINE) OR TO CONTROL SPREAD IN THE GUTTER PAN (ONLINE) PER DDOT DESIGN AND ENGINEERING MANUAL.
2. REFER TO DESIGN PLANS FOR SIZE AND TYPE OF GRATE.
3. METAL TRENCH DRAIN COVER TO BE BOLTED DOWN (THEFT PROTECTED) BUT REMOVABLE.
4. FOR DIMENSIONS AND SLOPES, SEE DESIGN PLANS.



SECTION A-A



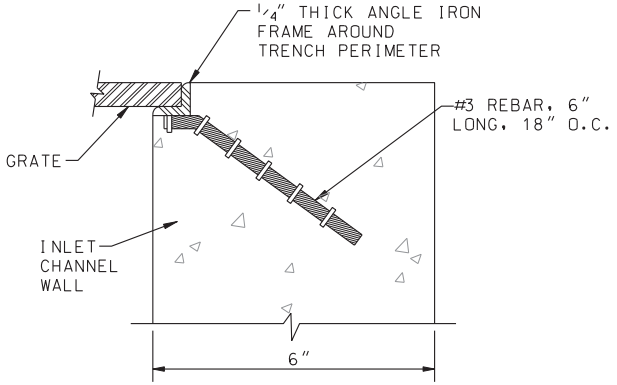
SECTION B-B

			RECOMMENDED: Ravindra D. Ganiti DEPUTY CHIEF ENGINEER
DATE	APPR.		
REVISED			APPROVED: CHIEF TRANSPORTATION ENGINEER
ISSUED:			
		REFERENCE	

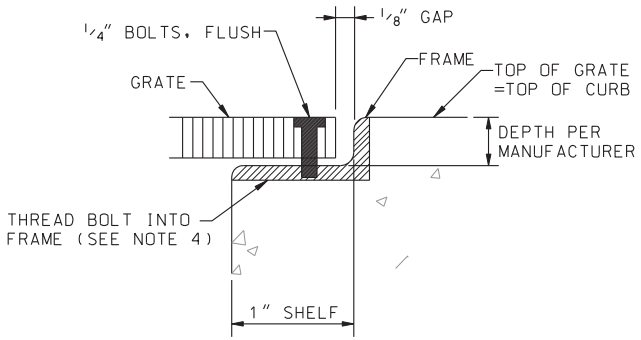
CURB CUT METAL TRENCH DRAIN COVER-1

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.43



FRAME DETAIL



GRATE ATTACHMENT DETAIL

CONSTRUCTION NOTES:

1. CAST IRON, NATURAL FINISH.
2. NO OPENING GREATER THAN 3/8".
3. PROTECT THREADED HOLES IN FRAME FROM CLOGGING DURING FRAME INSTALLATION.
4. GRATE TO BE RATED FOR H-20 LOADING, WITH A NON-SLIP SURFACE HAVING A STATIC COEFFICIENT OF FRICTION BETWEEN 0.60 AND 1.0 PER ASTM C1020. GRATES ON INCLINES GREATER THAN 4% SHALL HAVE A COEFFICIENT OF 0.80 TO 1.0.
5. WAVY GRATE AS SHOWN OR APPROVED ADA COMPLIANT EQUIVALENT.

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REVISED		
ISSUED:		
		REFERENCE

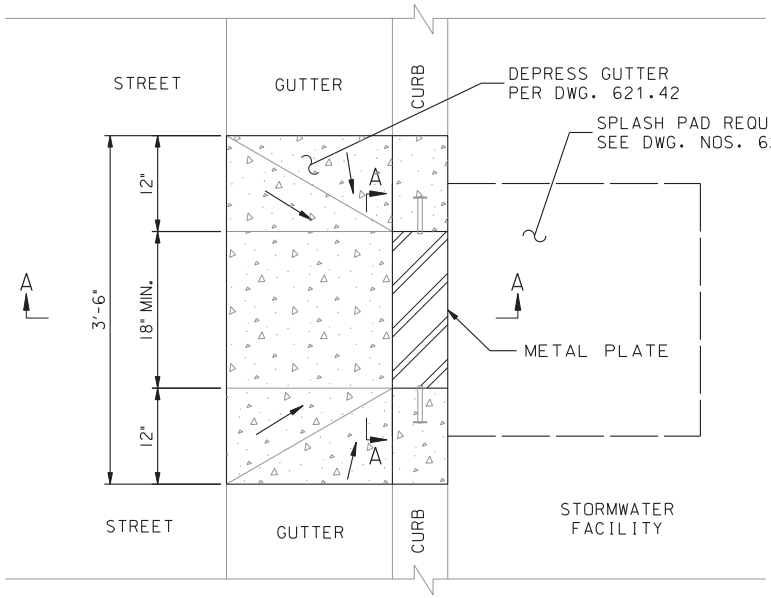
RECOMMENDED: Ravindra D. Ganvir
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

CURB CUT METAL TRENCH DRAIN COVER-2

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

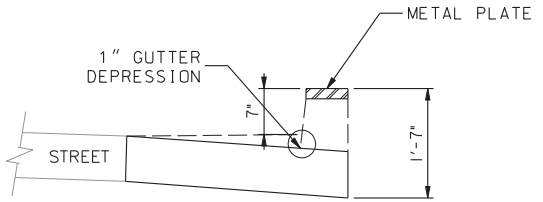
DWG. NO. 621.44



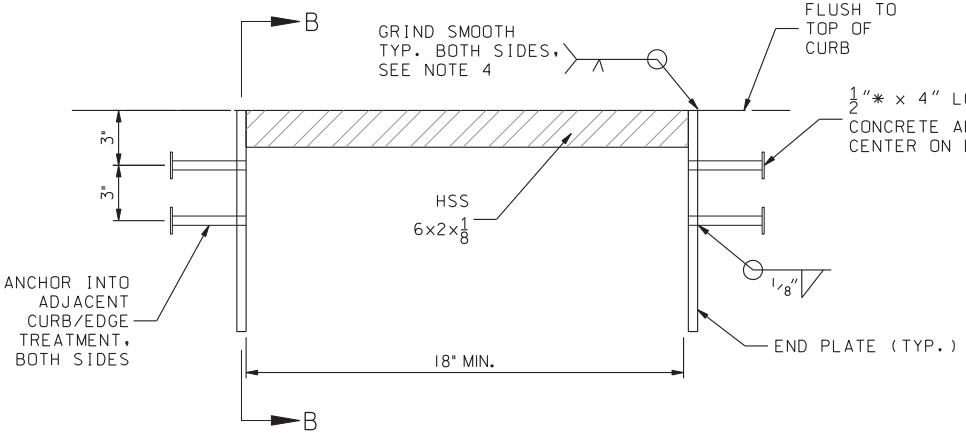
PLAN VIEW

NOTES:

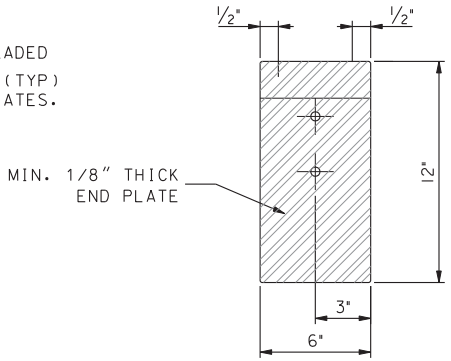
1. PLATE OVER CURB CUT MAY BE OMITTED WITH DDOT APPROVAL.
2. HEADED CONCRETE ANCHORS SHALL MEET THE REQUIREMENTS OF ASTM A-108.
3. HSS 6 x 2 x 1/8 CHANNEL SHALL MEET THE REQUIREMENTS OF ASTM A-500 GRADE B.
4. END PLATES SHALL MEET THE REQUIREMENTS OF ASTM A-36.
5. ENTIRE ASSEMBLY SHALL BE HOT DIP GALVANIZED IN ACCORDANCE WITH ASTM A-123.
6. DESIGN VERTICAL WHEEL LOAD IS 8.5 KIPS (1/2 OF TANDEM AXLE WEIGHT SPECIFIED IN FHWA-HOP-06-105).
7. SINGLE BEVEL GROOVE WELD.
8. ALTERNATE MATERIAL FOR ASSEMBLY (E.G. CAST IRON, GRAY IRON) MAY BE USED PER DESIGN PLANS.



SECTION A-A



ELEVATION



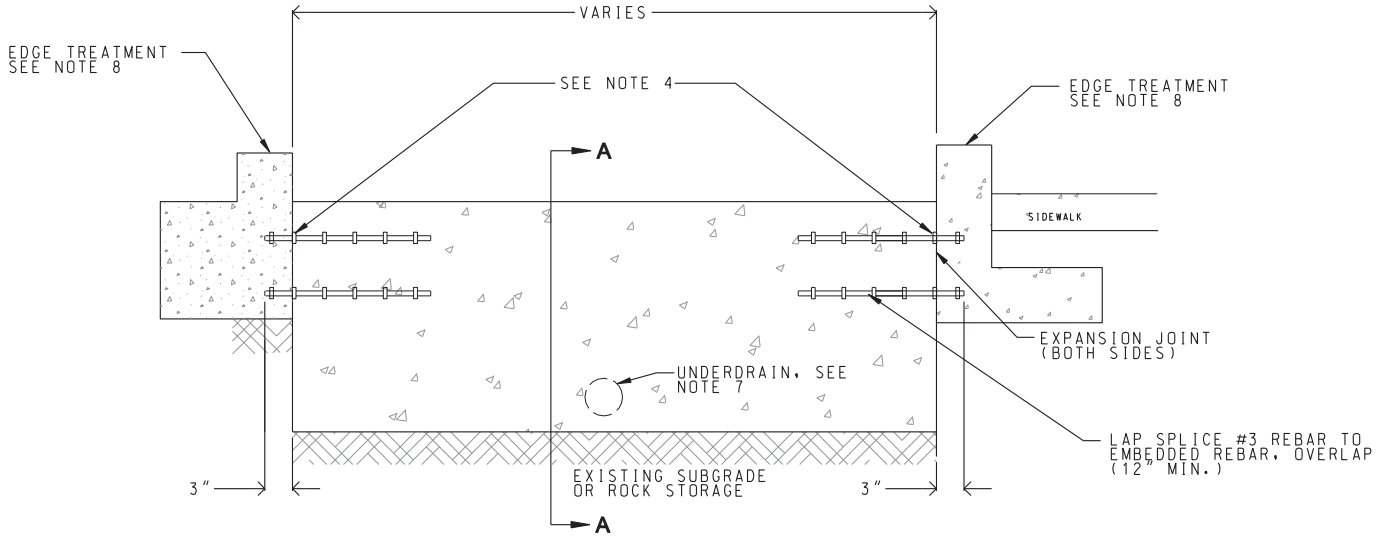
SECTION B-B

			RECOMMENDED: Ravindra D. Ganiti DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED: CHIEF TRANSPORTATION ENGINEER
REVISED			
ISSUED:		REFERENCE	

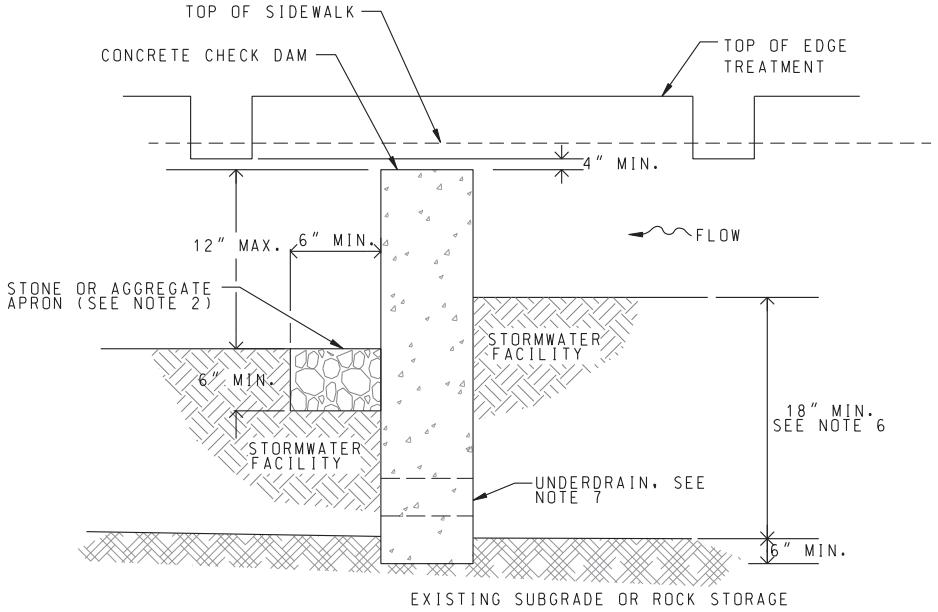
METAL PLATE OVER CURB CUT

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.45



ELEVATION



SECTION A-A

NOTES:

1. LOCATIONS, HEIGHTS, AND WIDTHS OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. SIZE OF STONE OR AGGREGATE APRON TO BE SPECIFIED IN THE DESIGN PLANS.
3. CONCRETE CHECK DAM SHALL BE CONTINUOUS (NO JOINTS).
4. EMBED #3 REBAR 3" MIN. INTO EDGE TREATMENT ON BOTH SIDES (2 PER SIDE).
5. THIS CHECK DAM MAY BE USED IN PLANTERS OR CURB EXTENSIONS.
6. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
7. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE.
8. FOR EDGE TREATMENT OPTIONS, SEE DWG. NOS. 621.30 TO 621.32.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

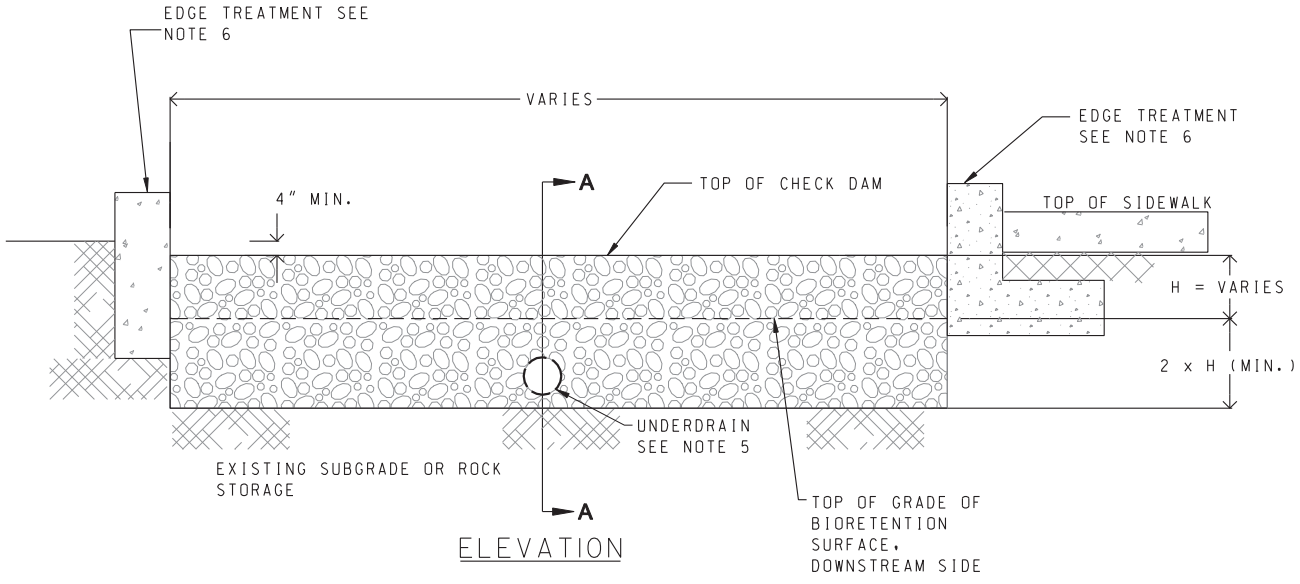
RECOMMENDED: Ravindra D. Ganvir
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

CONCRETE CHECK DAM

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

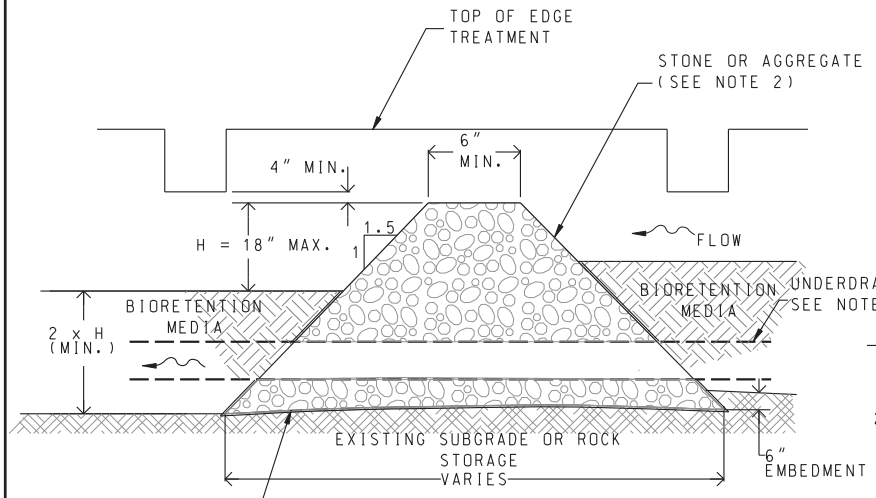
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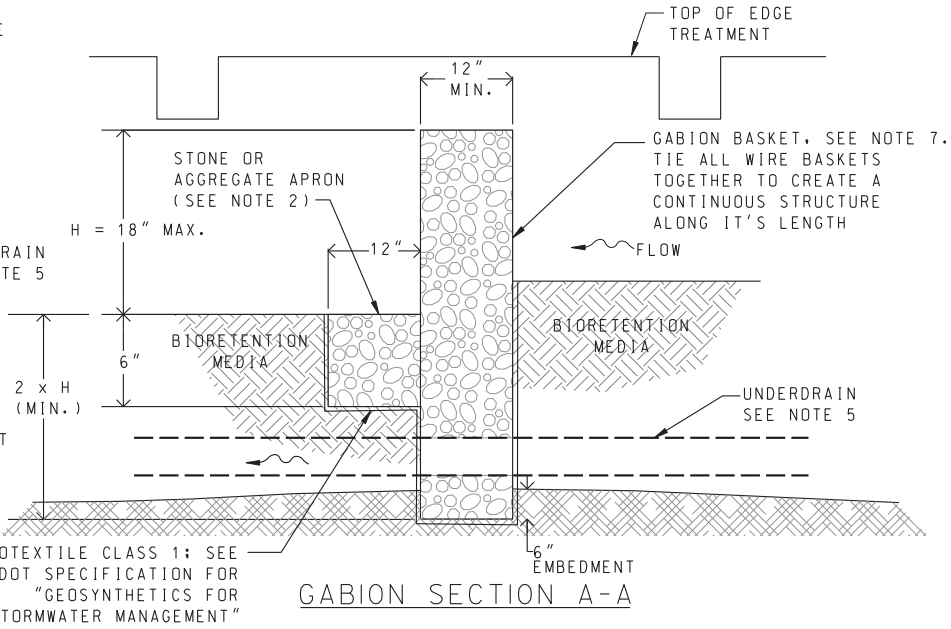
ELEVATION

NOTES:

1. LOCATIONS, HEIGHTS, AND WIDTHS OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS
2. SIZE OF STONE OR AGGREGATE APRON TO BE SPECIFIED IN THE DESIGN PLANS.
3. THIS CHECK DAM MAY BE USED IN SWALES, PLANTERS, AND CURB EXTENSIONS.
4. DEPTH OF CHECK DAM VARIES DEPENDING ON DEPTH OF FACILITY.
5. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE.
6. FOR EDGE TREATMENT OPTIONS, SEE DWGS NOS. 621.30 TO 621.32.
7. PROVIDE GABION BASKET, WELDED MESH TYPE WHEN UNDERDRAIN IS USED.



SLOPED SECTION A-A



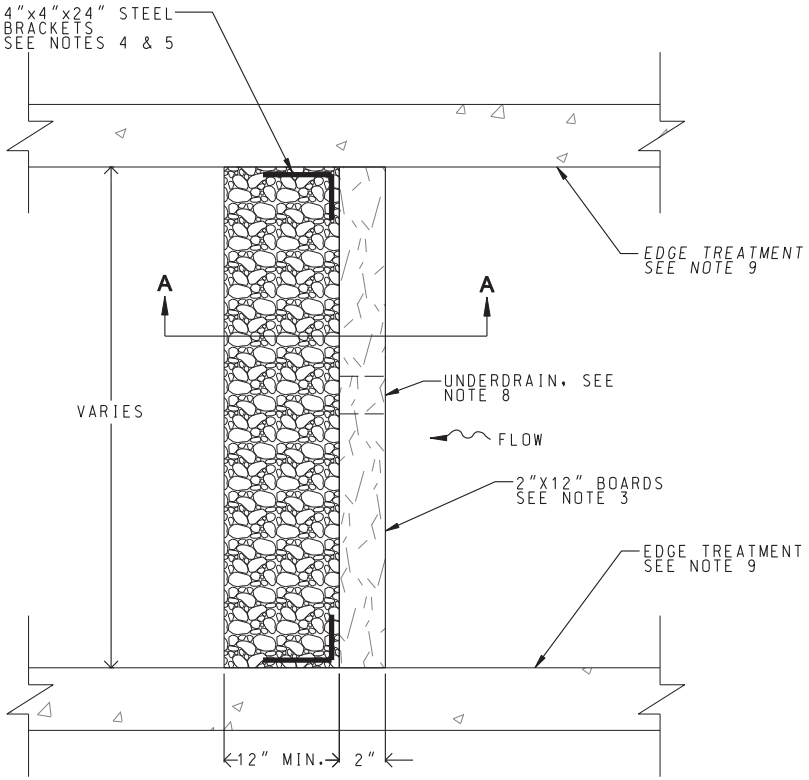
GABION SECTION A-A

			RECOMMENDED: Ravindra D. Ganik DEPUTY CHIEF ENGINEER
DATE	APPR.		
REVISED			APPROVED: CHIEF TRANSPORTATION ENGINEER
ISSUED:		REFERENCE	

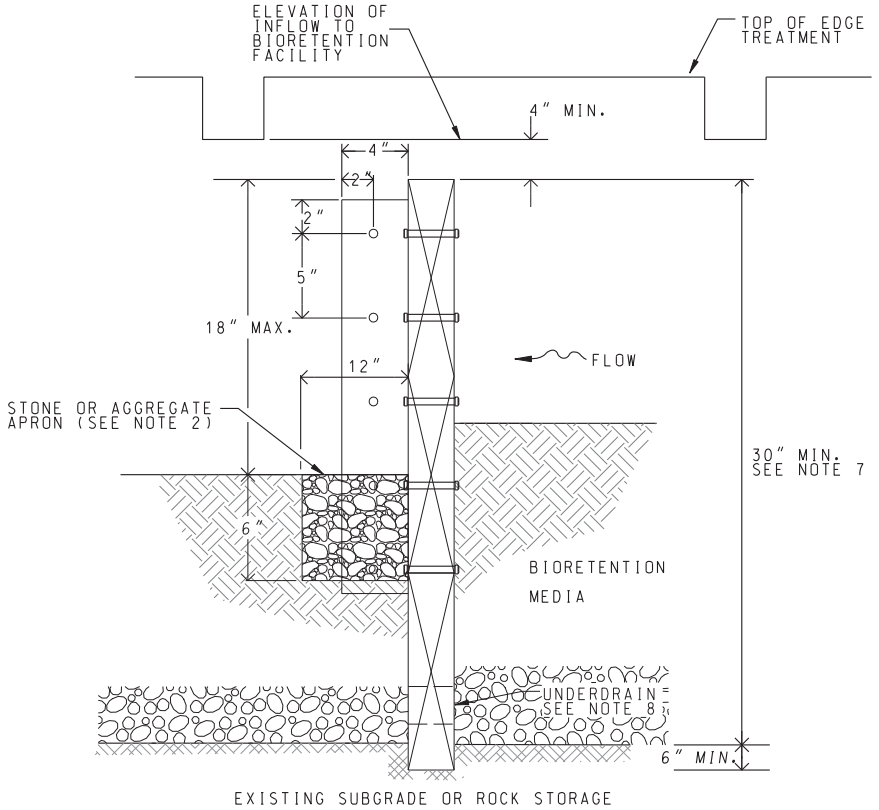
ROCK CHECK DAMS

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.61



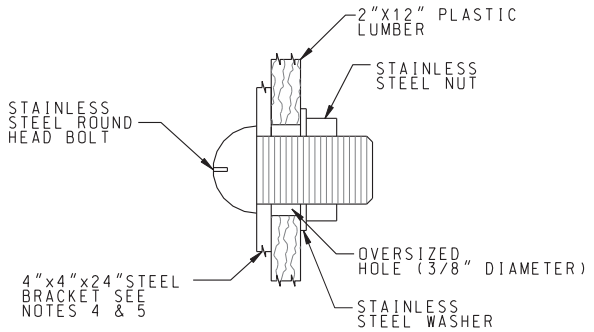
PLAN



SECTION A-A

NOTES:

1. LOCATIONS, HEIGHTS, AND WIDTHS OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. SIZE OF STONE OR AGGREGATE APRON TO BE SPECIFIED IN THE DESIGN PLANS.
3. BOARDS TO BE PLASTIC LUMBER AND CONTINUOUS ALONG ITS LENGTH. OTHER MANUFACTURED PRODUCTS MAY BE USED WITH DDOT APPROVAL.
4. ALL FASTENERS TO BE STAINLESS STEEL OR GALVANIZED. BOLTS TO BE 5/16 "DIAMETER.
5. BRACKET TO BE MADE OF 3/16 " MIN. STEEL.
6. THIS CHECK DAM MAY BE USED IN BIORETENTION PLANTERS OR CURB EXTENSIONS.
7. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
8. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE. GAPS AROUND PIPE TO BE FILLED WITH POLYURETHANE FOAM.
9. FOR EDGE TREATMENT OPTIONS, SEE DWG. NOS. 621.30 TO 621.32.



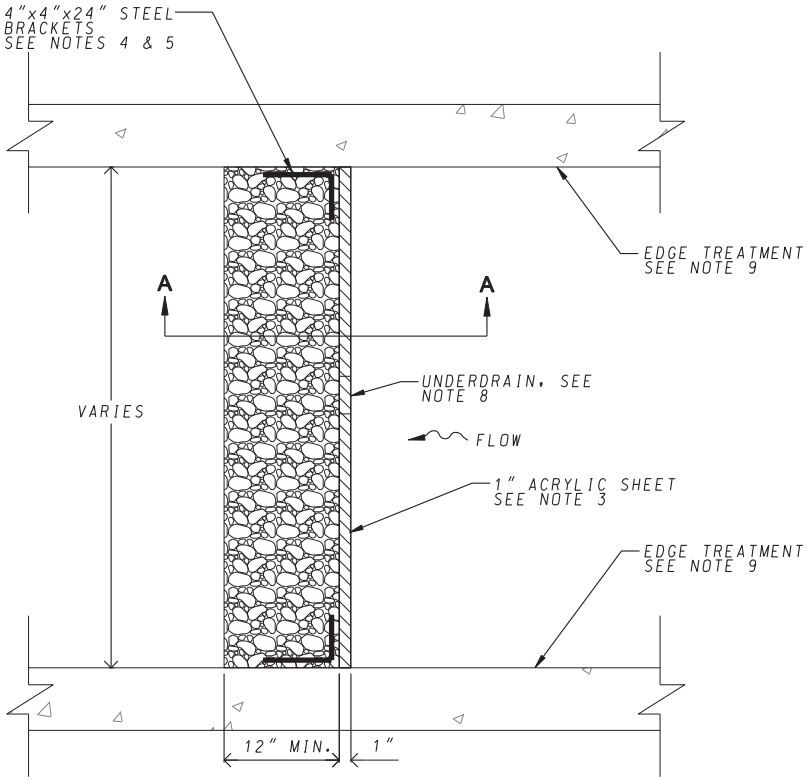
PLASTIC LUMBER BOLTING DETAIL

			RECOMMENDED: Ravindra D Gavvis DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED:
REVISED			
ISSUED:			CHIEF TRANSPORTATION ENGINEER
		REFERENCE	

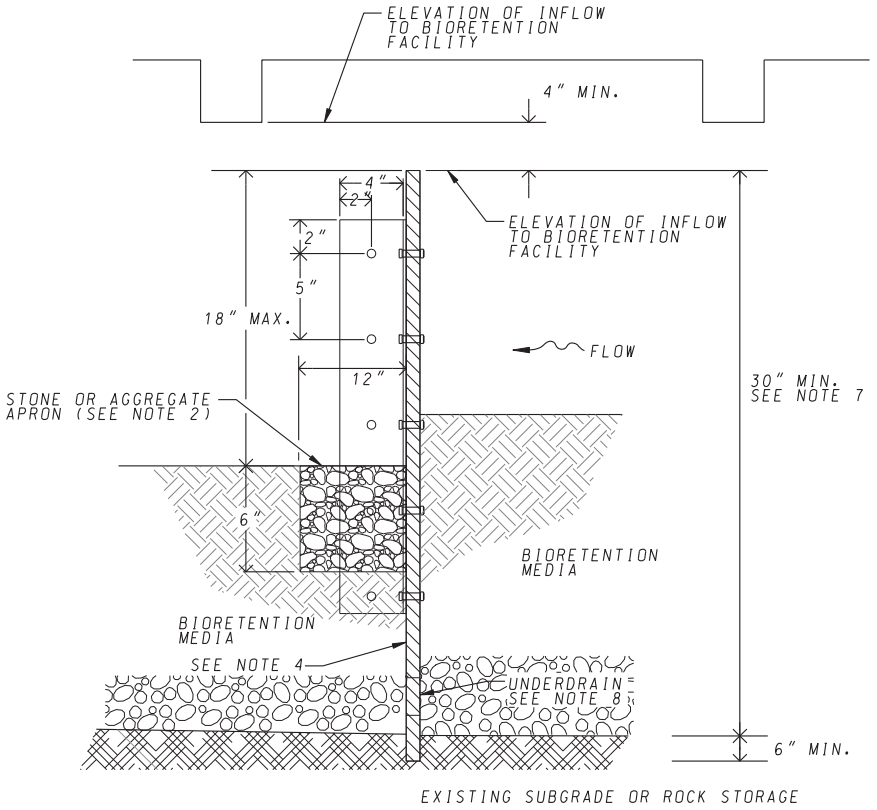
PLASTIC LUMBER CHECK DAM

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.62



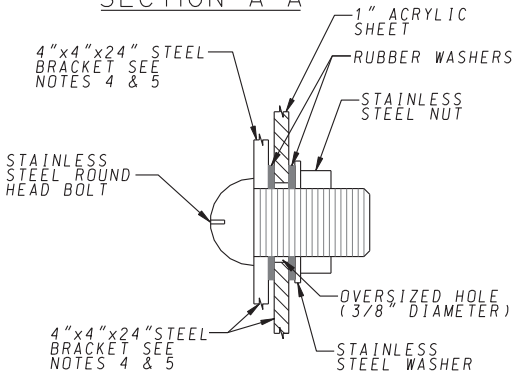
PLAN



SECTION A-A

NOTES:

1. LOCATIONS, HEIGHTS, AND WIDTHS OF CHECK DAMS TO BE SPECIFIED IN THE DESIGN PLANS.
2. SIZE OF STONE OR AGGREGATE APRON TO BE SPECIFIED IN THE DESIGN PLANS.
3. SHEETS TO BE CELL-CAST AND CONTINUOUS ALONG THEIR LENGTH. OTHER MANUFACTURED PRODUCTS MAY BE USED WITH DDOT APPROVAL.
4. ALL FASTENERS TO BE STAINLESS STEEL OR GALVANIZED. BOLTS TO BE 5/16 " DIAMETER.
5. BRACKET TO BE MADE OF 3/16 " MIN. STEEL.
6. THIS CHECK DAM MAY BE USED IN BIORETENTION PLANTERS OR CURB EXTENSIONS.
7. DEPTH OF CHECK DAM VARIES DEPENDING ON THE DEPTH OF THE FACILITY.
8. IF PRESENT, UNDERDRAIN TO PASS THROUGH CHECK DAM IN A NON-PERFORATED PVC PIPE. GAPS AROUND PVC PIPE TO BE FILLED WITH POLYURETHANE FOAM.
9. FOR EDGE TREATMENT OPTIONS, SEE DWG. NOS. 621.30 TO 621.32.



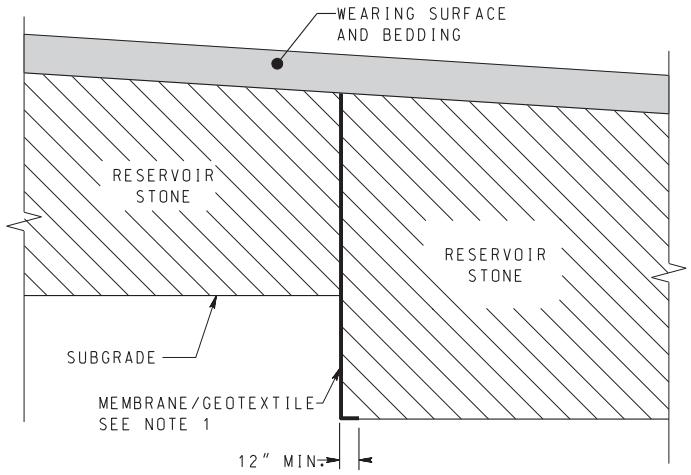
ACRYLIC SHEET BOLTING DETAIL

			RECOMMENDED: Ravindra D. Gavini DEPUTY CHIEF ENGINEER
DATE	APPR.		APPROVED:
REVISED			
ISSUED:			CHIEF TRANSPORTATION ENGINEER
		REFERENCE	

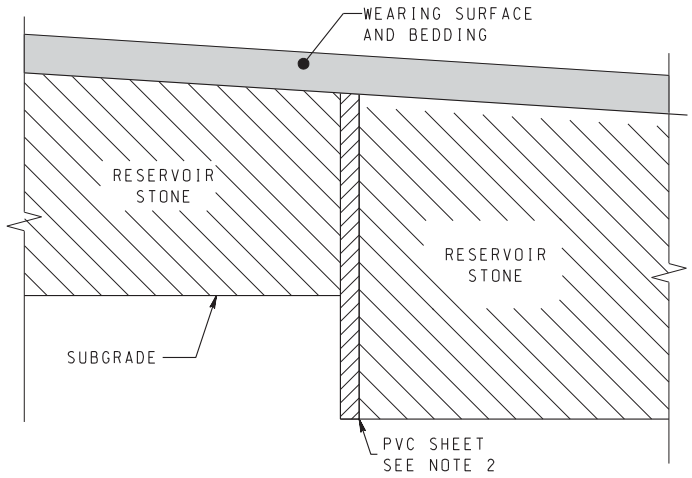
ACRYLIC SHEET CHECK DAM

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.63



MEMBRANE/GEOTEXTILE CHECK DAM
NOT TO SCALE



PVC SHEET CHECK DAM
NOT TO SCALE

NOTES:

1. WATERPROOF MEMBRANE OR LOW PERMEABILITY GEOTEXTILE (PERMITTIVITY OF 0.05 SEC^{-1} OR LESS)
2. SHEET TO BE 3/8" PVC SHEET TYPE I, GRAY.

DATE	APPR.	
REVISED		
ISSUED:		
		REFERENCE

RECOMMENDED: Ravindra D. Gavini
DEPUTY CHIEF ENGINEER

APPROVED:
CHIEF TRANSPORTATION ENGINEER

ALTERNATE PERMEABLE PAVEMENT CHECK DAMS

DISTRICT OF COLUMBIA
DEPARTMENT OF TRANSPORTATION

DWG. NO. 621.64

SE

2.1.4 Trench Drain

Description

A trench drain is a shallow concrete trench with a grate or solid cover over the top of the trench that allows stormwater runoff from the street to enter a stormwater management practice (SMP). The trench drain allows the stormwater to be conveyed across a distance while maintaining the grades of the surrounding surfaces through the use of the grate or solid cover.

Specifications

- Trench drains shall be heavy duty with bolted grate or solid cover. All bolts shall be stainless steel or as recommended by manufacturer.
- All grates or covers used shall be ADA compliant.
- All concrete used for trench drains shall have a minimum specified compressive strength of 3500 pounds per square inch (psi) per ACI 318 / ASTM C39 unless otherwise specified.
- Trench drain assembly shall be in accordance with the attached PWD Trench Drain Assembly detail.
- PWD currently approves Neenah R-4999 with "Riverwalk" pattern or approved equal.
- Trench Draining rates must comply with AASHTO H-20 loading requirements.

Additional Considerations/Options

Trench drains are manufactured and sized for many different site conditions and should be selected accordingly. In addition, some trench drain grates and covers offer decorative features or can add design interest based on their patterns or color. Lastly, because metal grates or covers can become slippery when wet, additional considerations should be given to addressing this issue such as the use of slip resistant materials, textured surfaces, or other measures.

Applicability

May use where it is necessary to convey stormwater runoff from the street to the surface of an SMP while traversing a path of travel such as a sidewalk. Typically applied on stormwater planters.

Submittal Requirements

If a trench drain or trench drain assembly other than that specified above is proposed, submit a detail of proposed trench drain including configuration and details of all proposed sizes, materials, manufacturer, and product number of all items used for the trench drain.

References

- PWD Green Infrastructure Standard Details (dated December 6, 2012)
- PWD Green Master Specification (dated September 25, 2012)

Attachments

- PWD Trench Drain Assembly detail

Trench Drain Examples



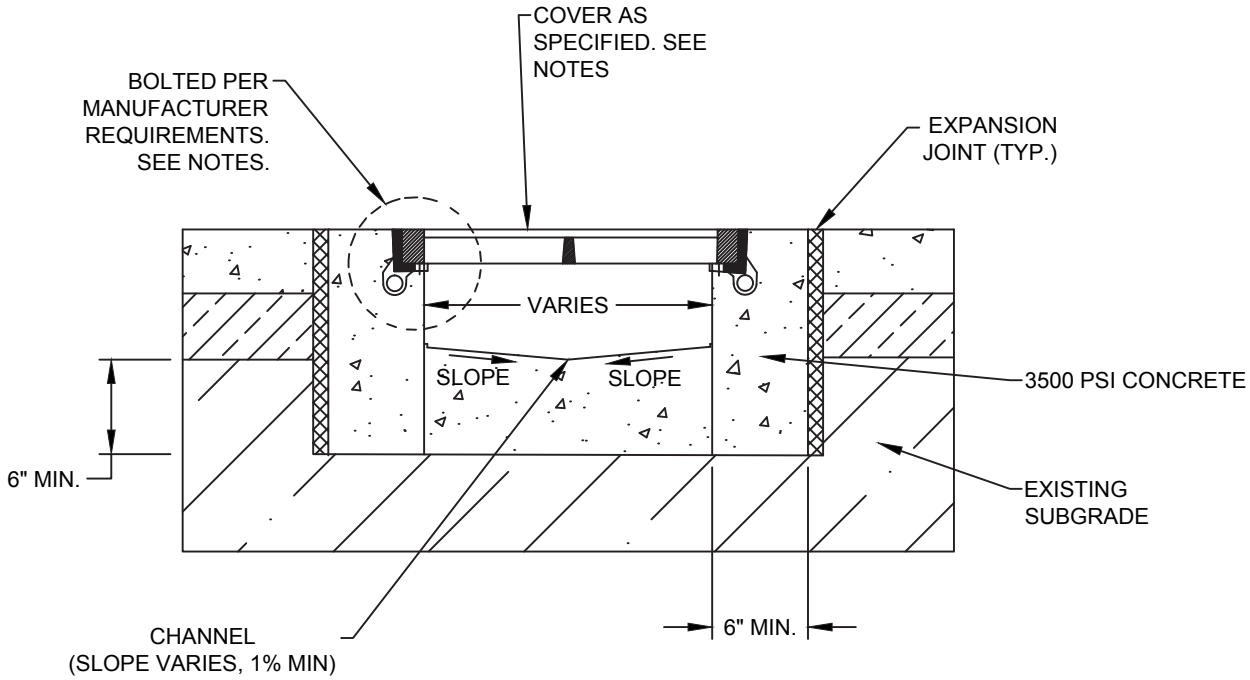




SE

NOTES:

1. MUST BE HEEL SAFE AND ADA COMPLIANT
2. MUST BE H-20 LOADING
3. MUST BE BOLTABLE



SECTION

2014

TRENCH DRAIN ASSEMBLY

SE

2.5.1 Wheel Guard

Description

A wheel guard is a plate that is placed across a curb opening to cover the opening and to maintain a constant surface along the top of the curb. By maintaining the top of curb, wheel guards help prevent car wheels from entering the curb opening. Wheel guards are also sometimes referred to as wheel stops.

Specifications

- Wheel guards shall be steel plate with a minimum tensile strength of 35,000 pounds per square inch (psi) and in conformance with PWD Standards Specifications for Gray and Ductile Iron.
- Bolts and attachments shall be stainless steel (Grade 304 or 316).

Additional Considerations/Options

Other materials may be applicable and beneficial to use as wheel guards such as strong composite plastics. Also, wheel guards of different materials, patterns, and colors can offer decorative features or can add design interest.

Applicability

Must use on openings that are parallel to traffic. Typically applied on stormwater bump-outs.

Submittal Requirements

If a wheel guard material other than that specified above is proposed, submit a detail of proposed wheel guard including configuration and details of all proposed sizes, materials, manufacturer, and product number of all items used for the wheel guard.

References

- PWD Standards Specifications for Gray and Ductile Iron
- PWD Green Master Specification (dated September 25, 2012)

Attachments

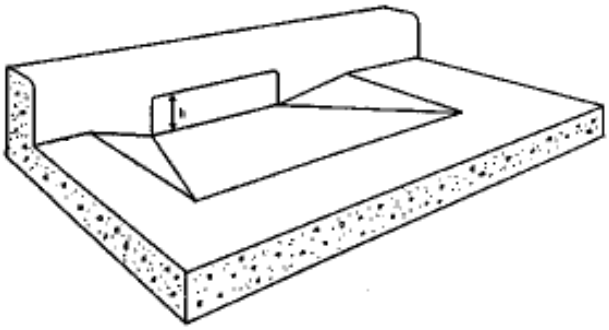
Not applicable.





SE

2.5.2 Gutter Apron





Description

A gutter apron is a section of concrete that is placed along the gutter line in front of curb openings that have a restriction along the top of the opening, such as City Inlets and trench drains. The concrete for gutter aprons is cast-in-place and provides an increased cross slope as well as tapered sides that slope toward the curb opening. Gutter aprons help form and maintain inlet openings, particularly in cases where there is limited curb reveal to begin with or after milling/repaving operations where the new pavement could potentially block the original curb opening. Gutter aprons also help to increase the inlet capacity by directing water towards the curb openings.

Specifications

- Concrete used for gutter aprons shall have a minimum specified compressive strength of 3500 pounds per square inch (psi) per ACI 318/ASTM C39. All concrete shall conform to PWD's Standard Specifications for Masonry Concrete.

Additional Considerations/Options

Limit slopes of aprons to prevent creating a tripping hazard. In addition, aprons that create a drop of more than 8-inches at the face of the curb could prohibit car doors from opening.

Applicability

May use on curb opening type inlets such as City Inlets and trench drains or other curb openings where there is a restriction along the top of the opening such as a curb cut or depressed curb with a wheel guard installed. The size and location of gutter aprons must be approved on a case-by-case basis by the Highway Division of the Streets Department. However, gutter aprons proposed in parking lanes that are not likely to be cleared for traffic have the best likelihood of being approved. Typically applied on stormwater bump-outs and stormwater planters.

Submittal Requirements

Submit a detail of proposed gutter apron including proposed location as well as configuration and details of proposed dimensions and slopes.

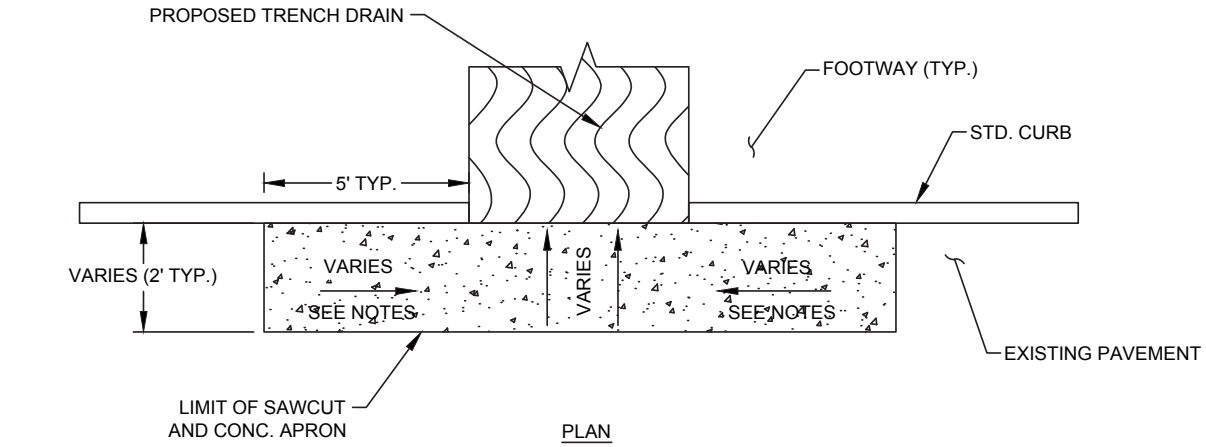
References

- PWD's Standard Specifications for Masonry Concrete
- PWD Green Master Specification (dated September 25, 2012)
- PWD Green Infrastructure Standard Details (dated December 6, 2012)

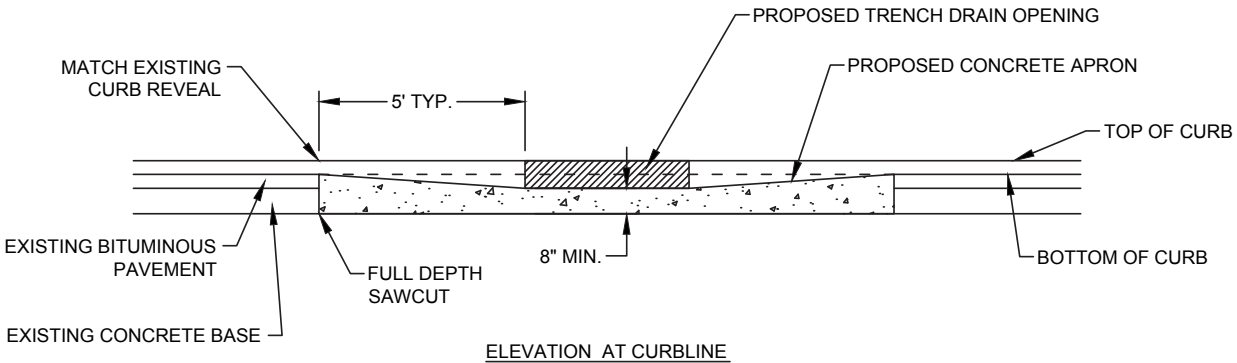
Attachments

- PWD Concrete Apron at City Inlets detail
- PWD Concrete Apron at Trench Drain detail

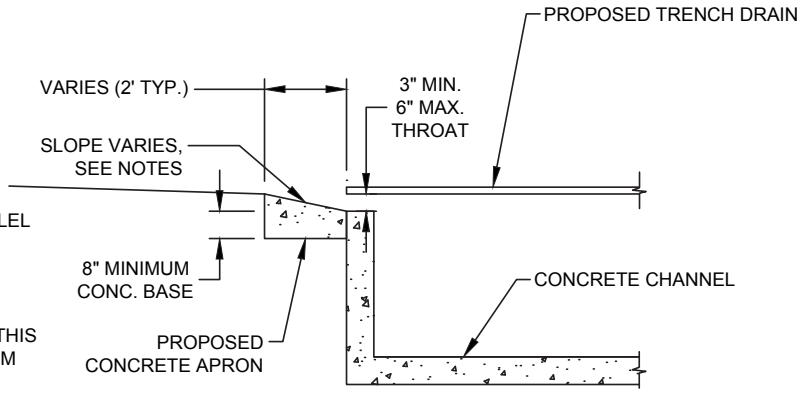
SE



PLAN



ELEVATION AT CURBLINE



NOTES:
1. MAXIMUM SLOPE OF APRON PARALLEL TO CURB IS 2%. THIS VALUE IS SUBJECT TO REVIEW FROM THE STREETS DEPARTMENT.
2. MAXIMUM SLOPE OF APRON PERPENDICULAR TO CURB IS 15%. THIS VALUE IS SUBJECT TO REVIEW FROM THE STREETS DEPARTMENT.

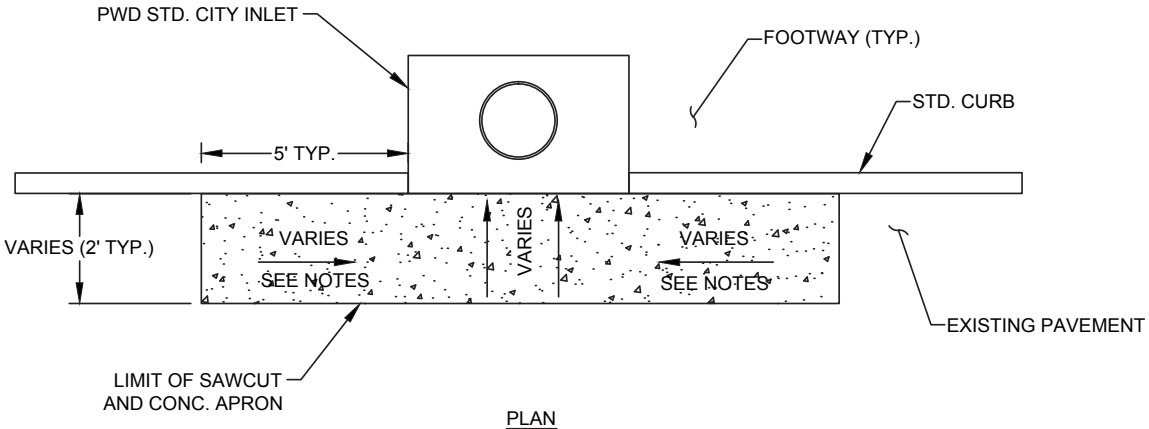
SECTION

Green Streets

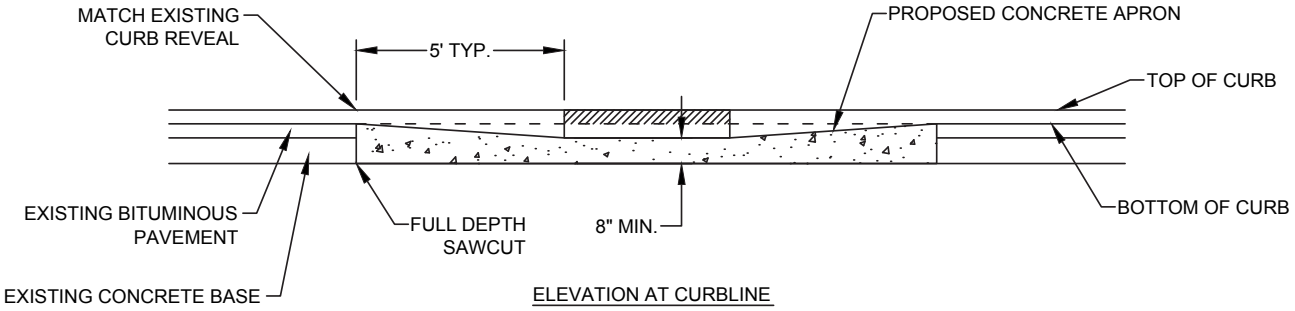
2014

CONCRETE APRON AT TRENCH DRAIN

SE

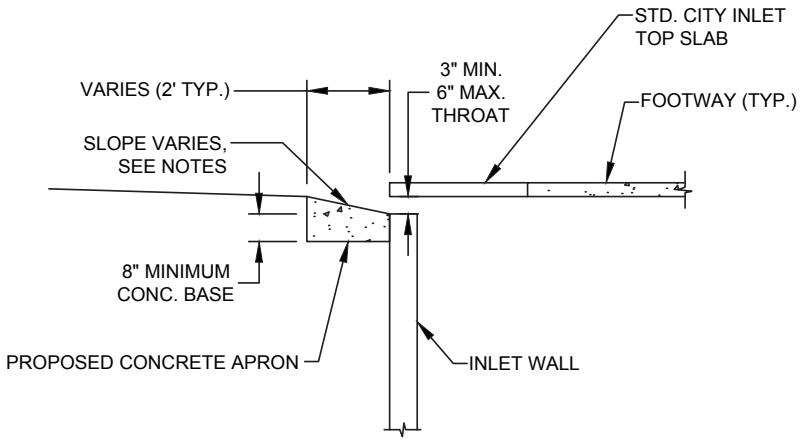


PLAN



ELEVATION AT CURBLINE

NOTES:
1. MAXIMUM SLOPE OF APRON PARALLEL TO CURB IS 2%.
2. MAXIMUM SLOPE OF APRON PERPENDICULAR TO CURB IS 15%.



SECTION

2014

CONCRETE APRON AT CITY INLETS

ED

4.1.1 Splash Pad

Description

A splash pad is a combination of hardscape materials placed in the form of a physical pad that provides a hard surface for stormwater entering a stormwater management practice (SMP) to run across, or "splash" against, before flowing over the surface of the SMP, thereby dissipating energy of the incoming stormwater.

Specifications

- Any concrete used for splash pads shall have a minimum specified compressive strength of 3500 pounds per square inch (psi) per ACI 318 / ASTM C39 and shall conform to PWD's Standard Specifications for Masonry Concrete.
- Loose materials (e.g. stone, brick, cobbles, etc) should be placed and secured such that it is not removable by hand.

Additional Considerations/Options

There are various options for splash pad materials, colors, and geometry that can provide decorative features or design interest while being designed to adequately reduce the velocity, energy, and turbulence of the flow entering an SMP to prevent erosive potential of the surface material in the SMP.

Applicability

Must use on the surface of an SMP whenever stormwater is concentrated and the energy of the water needs to be dissipated unless another approved energy dissipation design component or method is used. Typically applied on stormwater planters and stormwater bump-outs.

Submittal Requirements

If a splash pad other than one of the attached PWD example splash pad details is proposed, submit a detail of proposed configuration and details of all proposed sizes, materials, and colors used for the splash pad.

References

- PWD Green Infrastructure Standard Details (dated December 6 2012)
- PWD Green Master Specification (dated September 25, 2012)

Attachments

PWD Example Splash Pad details:

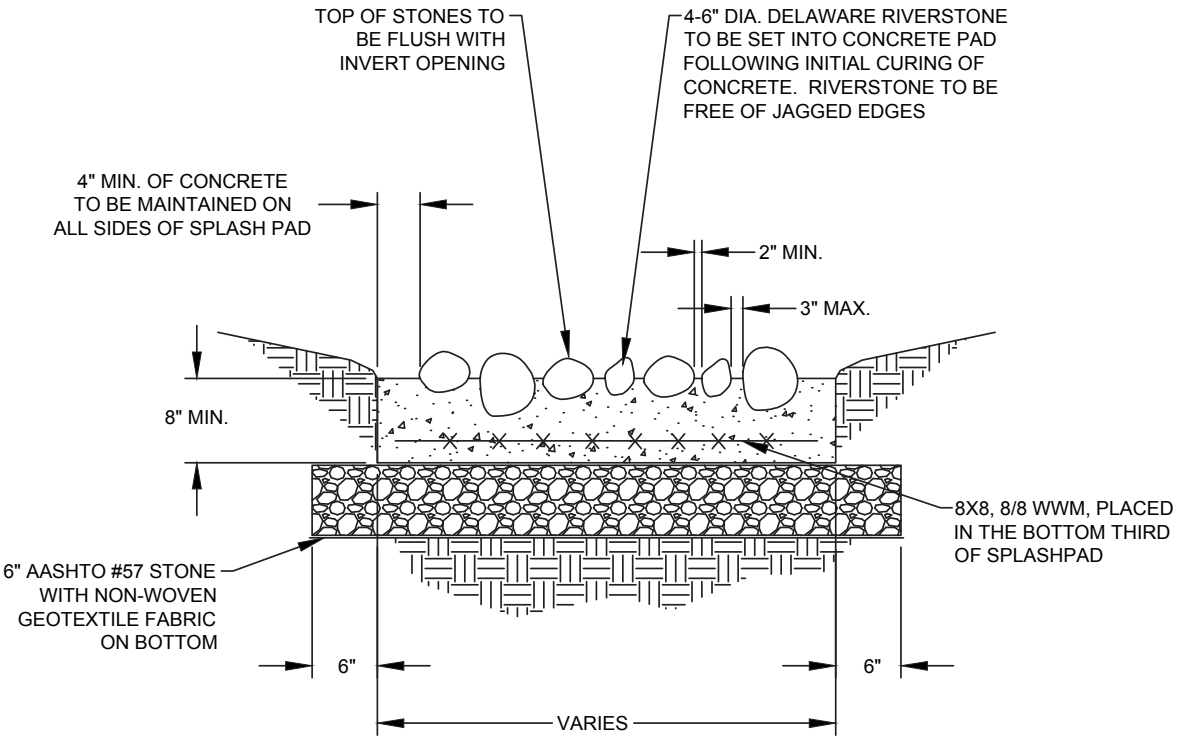
- Rock Splash Pad
- Brick Splash Pad







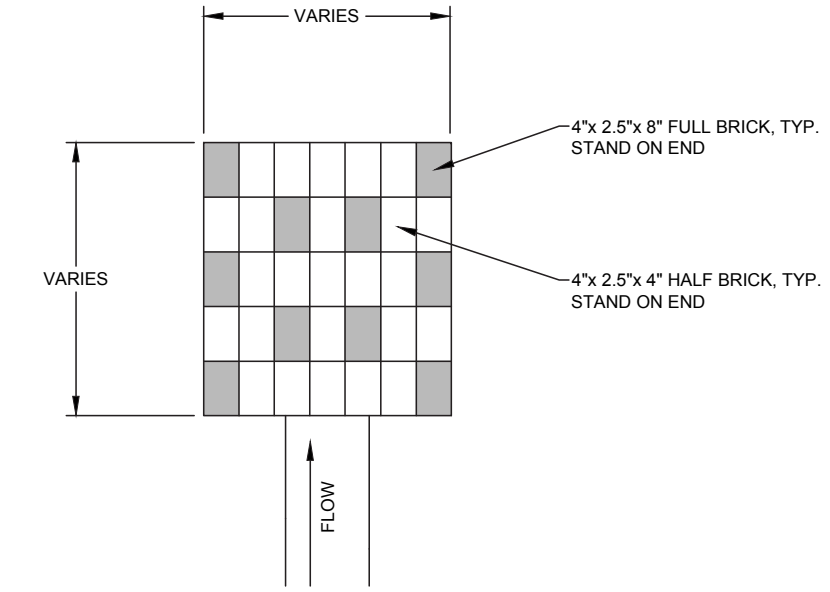
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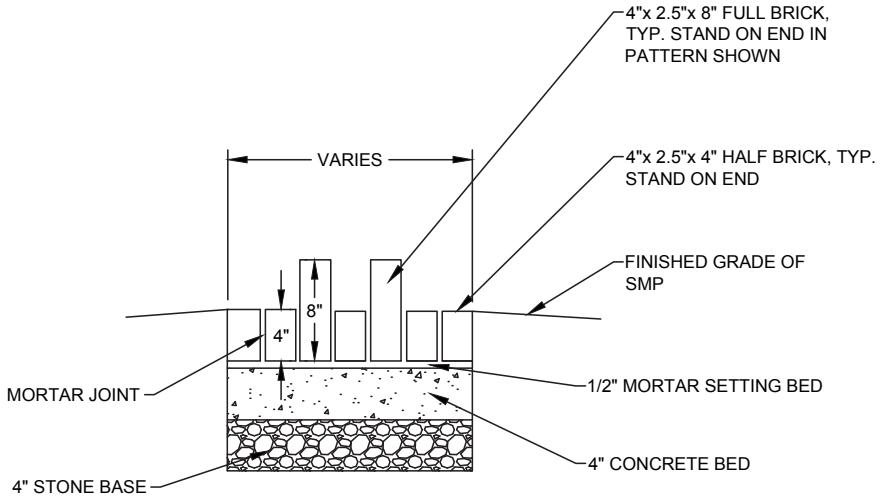
2014

ROCK SPLASH PAD

ED



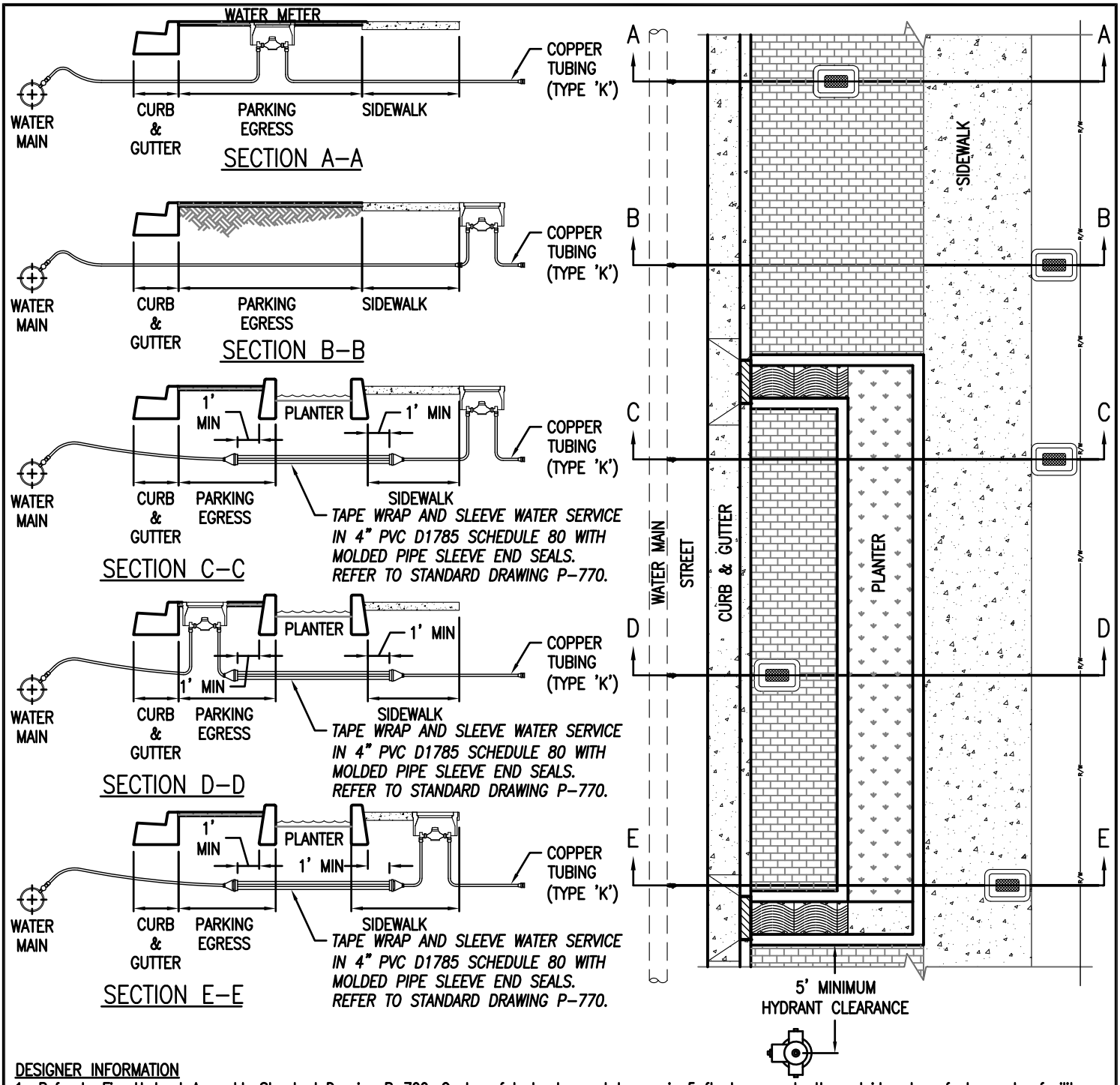
PLAN



SECTION

2014

BRICK SPLASH PAD



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P–700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A. Option B or C can be used only if a minimum of 3' is available between the back of sidewalk and the Right–of–Way line. Option D and E can only be used for an existing service and when other options are infeasible, where a minimum of 1' is available between the back of sidewalk and the Right–of–Way line, and it requires a Design Exception from PBOT to be obtained by the project owner. In addition, for Option D, 3' minimum parking egress area is required for placement of 1' or smaller water meter, and 5' minimum for placement of 1.5" and 2" water meter.
3. Refer to 1" Service Assembly Standard Drawing P–780. For larger services or other appurtenances, contact PWB development services at (503) 823–7368. Water service line must be 2 ft min. from bottom of stormwater facility blended soil.
4. Maintain 2 ft skin–to–skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross–section views are not required on construction plans.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Meter & Hydrant Locations

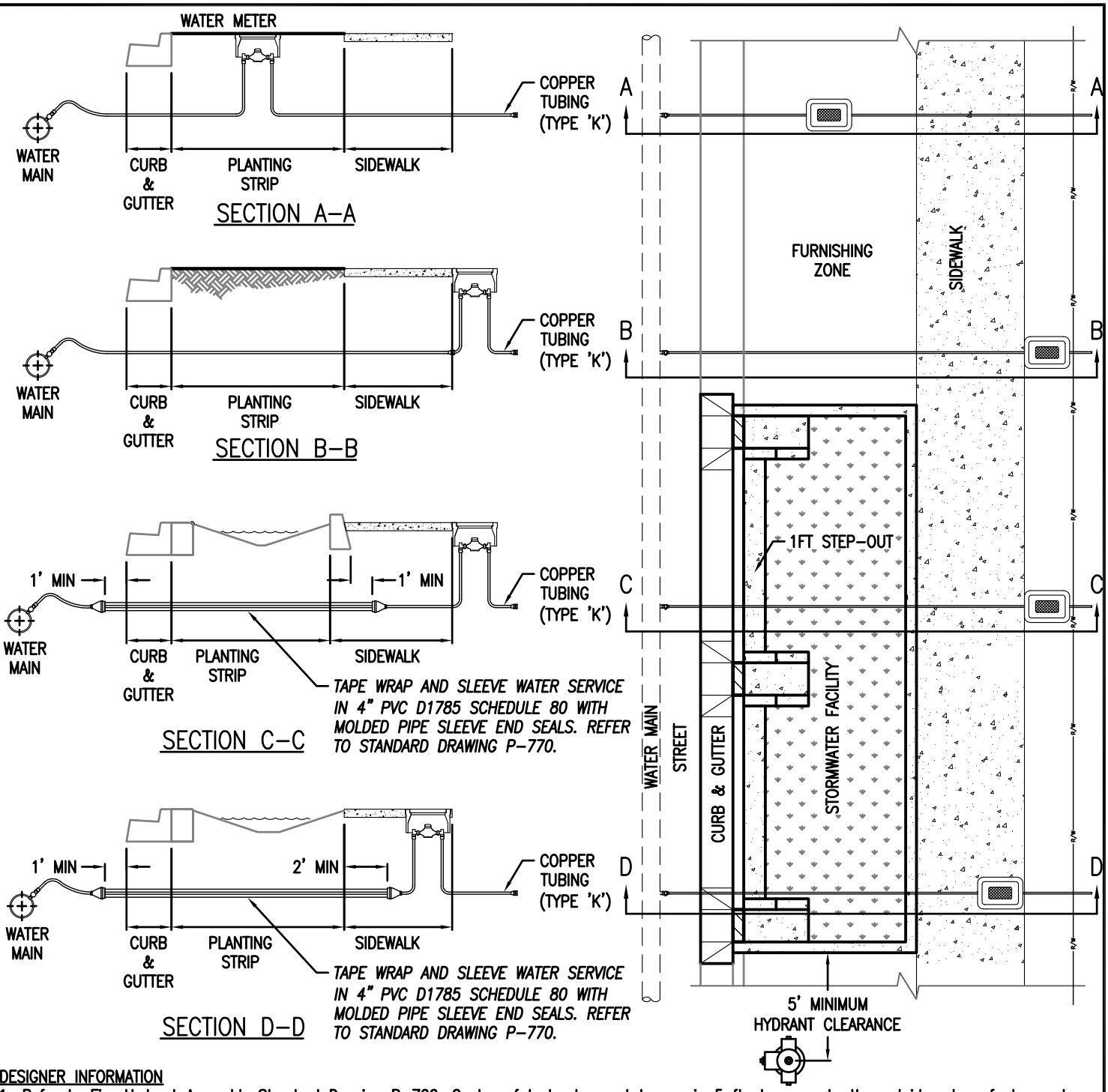
Planters

Bureau of Environmental Services

NUMBER

SW–316A

7–1–2016



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P–700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A. Option B or C can be used only if a minimum of 3' is available between back of sidewalk and the Right–of–Way line. Option D can only be used for an existing service when other options are infeasible, where a minimum of 1' is available between the back of sidewalk and the Right–of–Way line, and it requires a Design Exception from PBOT, to be obtained by the project owner.
3. Refer to 1" Service Assembly Standard Drawing P–780. For larger services or other appurtenances, contact PWB development services at (503) 823–7368. Water service line must be 2 ft min. from bottom of stormwater facility blended soil.
4. Maintain 2 ft skin–to–skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross–section views are not required on construction plans.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Meter & Hydrant Locations

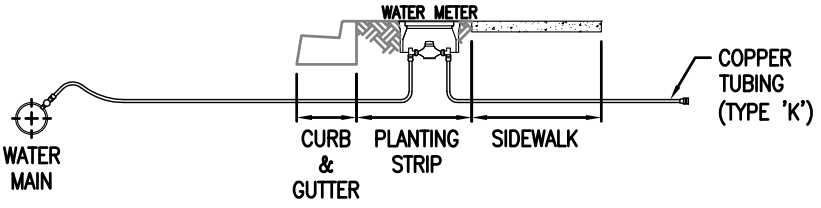
Planter with 1' Step–out

Bureau of Environmental Services

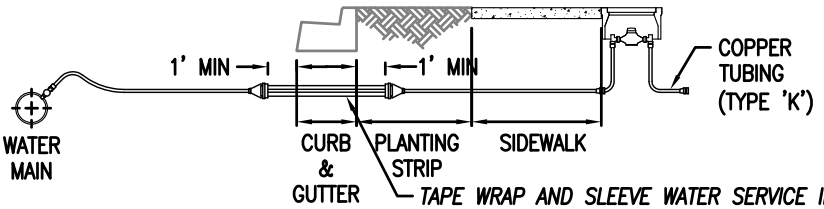
NUMBER

SW–316B

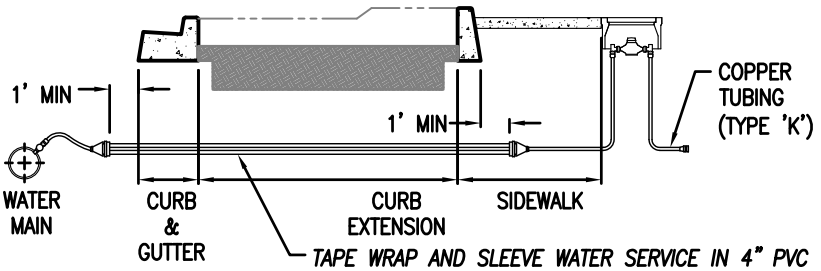
7–1–2016



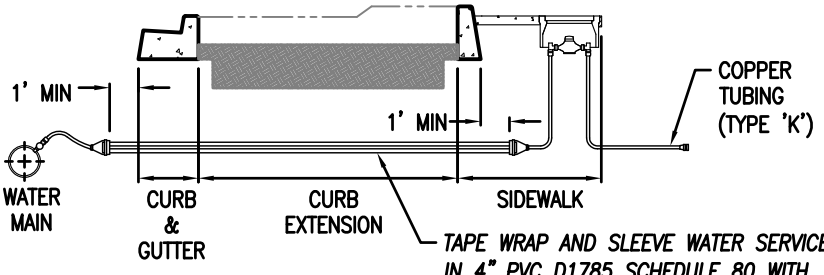
SECTION A–A



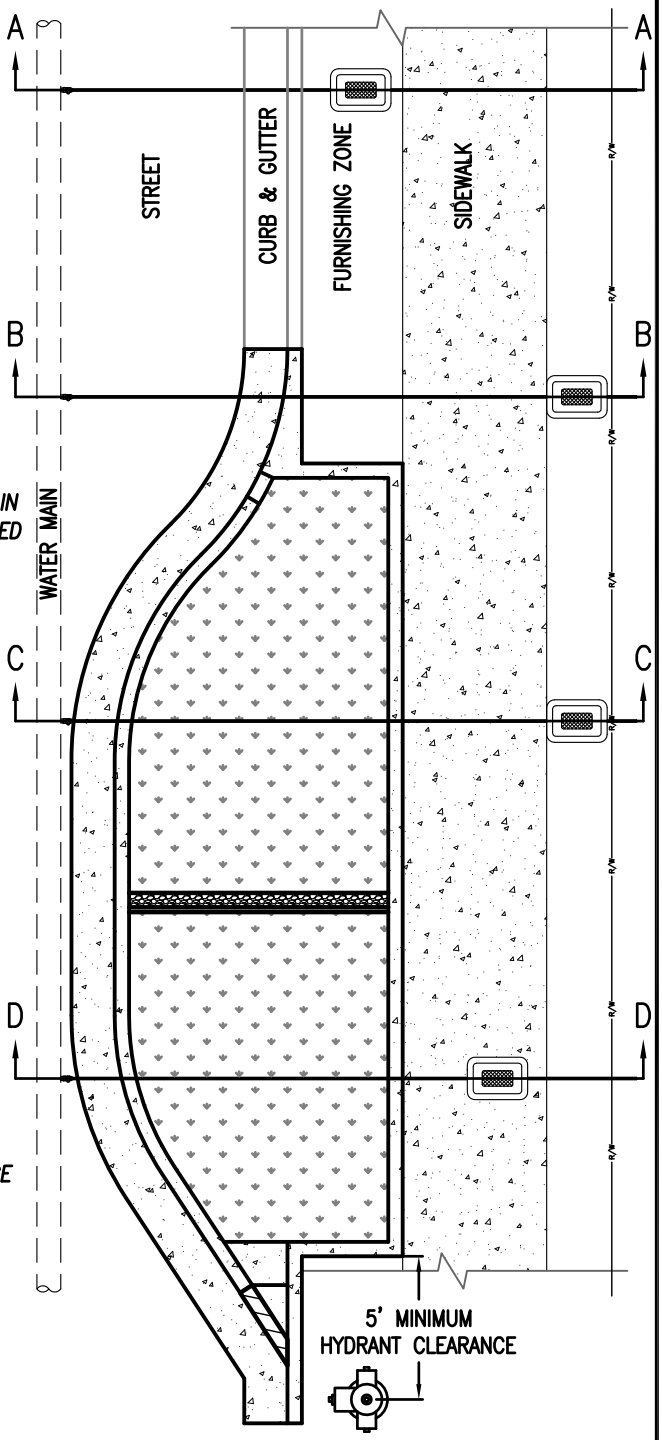
SECTION B–B



SECTION C–C



SECTION D–D



DESIGNER INFORMATION

1. Refer to Fire Hydrant Assembly Standard Drawing P–700. Center of hydrants must have min 5 ft clearance to the outside edge of stormwater facility.
2. Standard meter location is Option A, if Furnishing Zone is a minimum of 3' wide. Option B or C can be used only if a minimum of 3' is available between the back of sidewalk and the Right–of–Way line. Option D can only be used for an existing service when other options are infeasible, where a minimum of 1' is available between the back of sidewalk and the Right–of–Way line, and it requires a Design Exception from PDOT to be obtained by Project Engineer.
3. Refer to 1" Service Assembly Standard Drawing P–780. For larger services or other appurtenances, contact PWB development services at (503) 823–7368. Water service line must be 2 ft min. from bottom of stormwater facility imported soil blend.
4. Maintain 2 ft skin–to–skin separation distance between the face of gutter pan and the water main. If water main is < 2 ft from face of gutter pan, the water main must be relocated unless otherwise approved by PWB. Verification of water main depth is required prior to PWB approval.
5. Cross–section views are not required on construction plans.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Meter & Hydrant Locations

Curb Extensions

Bureau of Environmental Services

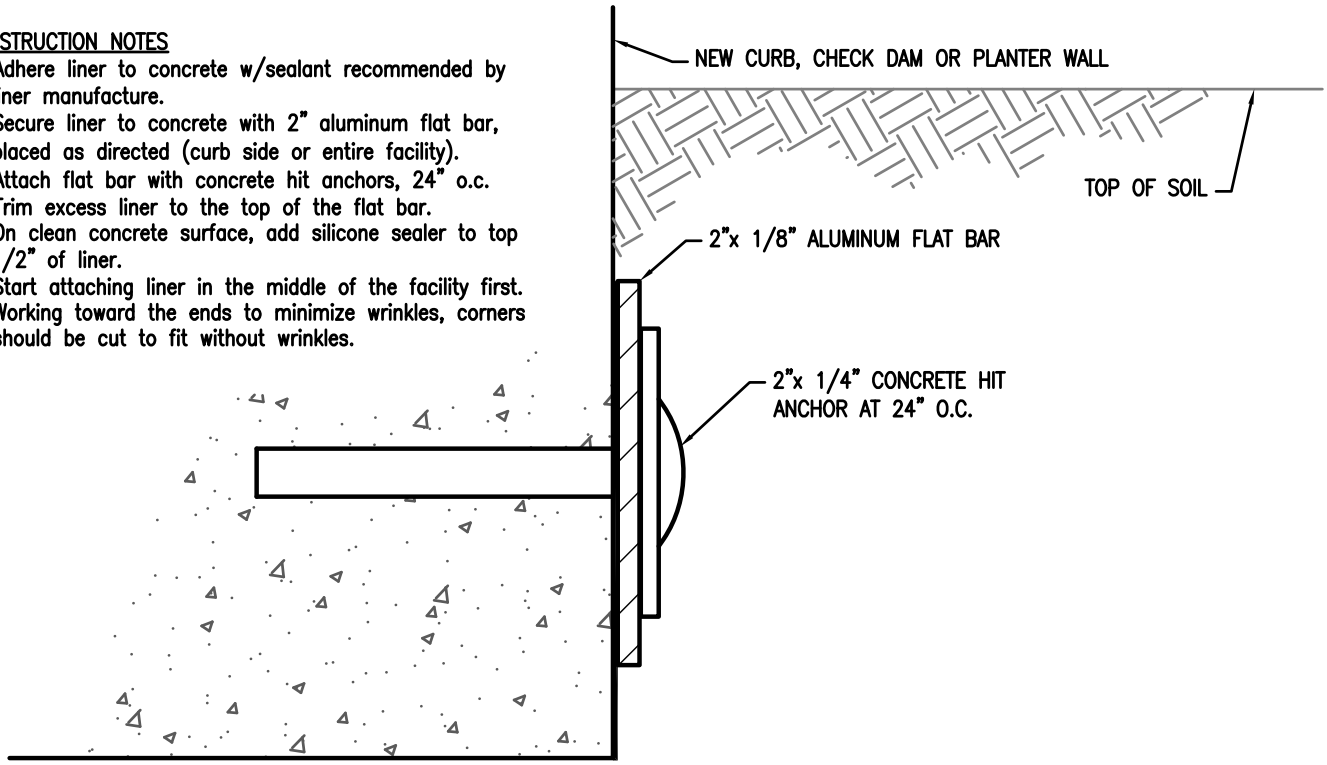
NUMBER

SW–324

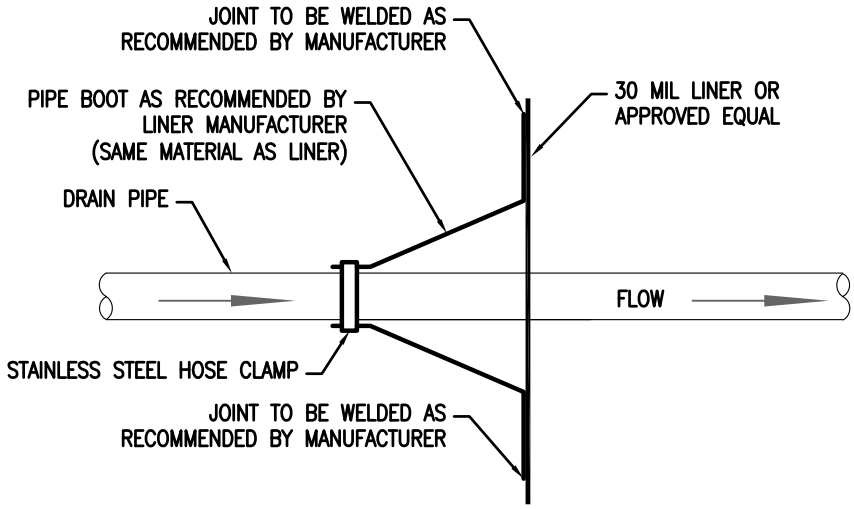
7–1–2016

CONSTRUCTION NOTES

1. Adhere liner to concrete w/sealant recommended by liner manufacture.
2. Secure liner to concrete with 2" aluminum flat bar, placed as directed (curb side or entire facility).
3. Attach flat bar with concrete hit anchors, 24" o.c.
4. Trim excess liner to the top of the flat bar.
5. On clean concrete surface, add silicone sealer to top 1/2" of liner.
6. Start attaching liner in the middle of the facility first. Working toward the ends to minimize wrinkles, corners should be cut to fit without wrinkles.



LINER ATTACHMENT



PIPE BOOT

DESIGNER INFORMATION

1. Liner materials to be HDPE. Liner to extend from top of blended soil to the bottom of excavation.
2. 3" of concrete is required on all sides of attachment. Adjust sidewalk depth as necessary.
3. Liner required when face of new curb is less than 2' from OD of adjacent water main.
4. Liner required on neighborhood collectors and higher street classifications.
5. Liner may be required on local streets with transit routes, higher traffic volumes, or when a facility is adjacent to travel lane at the discretion of the City Engineer.
6. In the Columbia South Shore Well Field Wellhead Protection Area or areas with contaminated soils the facility must be completely lined with a 40 mil liner unless facility's bottom and sides are monolithic concrete.
7. Liners may be required near basements or other underground structures.
8. Trees allowed in lined facilities only at the discretion of City of Portland staff.

– DRAWING NOT TO SCALE –

STORMWATER MANAGEMENT MANUAL TYPICAL DETAILS

– Green Streets –

Liner Attachment & Pipe Boot Detail

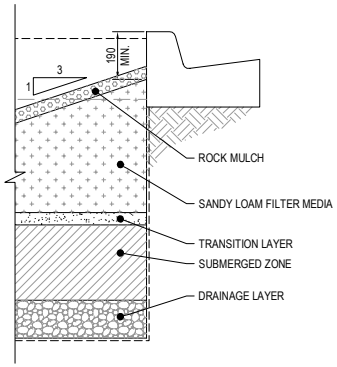
Additional Details

Bureau of Environmental Services

NUMBER

SW–360

7–1–2016

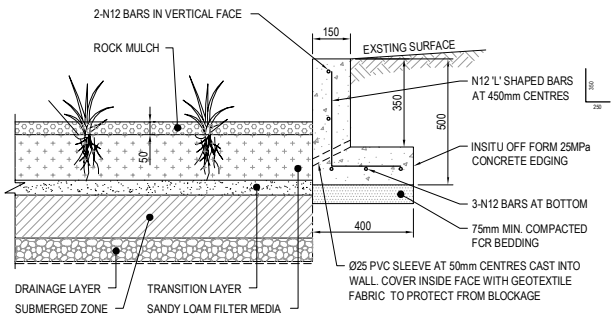


DETAIL
SCALE 1:10



IMAGE
NTS

BATTERED EDGE TREATMENT

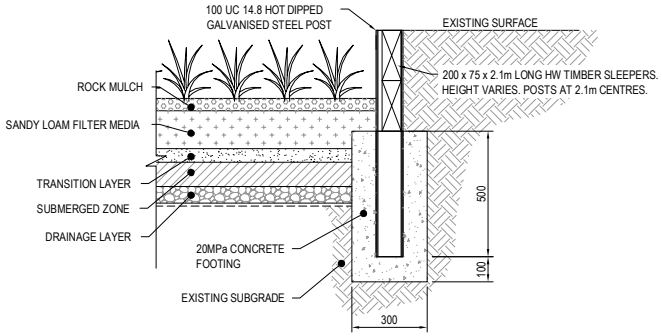


DETAIL
SCALE 1:10



IMAGE
NTS

CONCRETE EDGE TREATMENT



DETAIL
SCALE 1:10



IMAGE
NTS

TIMBER RETAINING WALL TREATMENT

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.

0 100 200 300 400 500mm
SCALE 1:10 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
EDGE TREATMENT - MATERIALS

Moreland City Council

DEVELOPED BY GHD

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scale	1:10 for A4	job no.	31-30117
date	JULY 2013	rev no.	0

approved (PD) S. GRAHAM SK006

INFILTRATION

PURPOSE:

SUBSURFACE INFILTRATION SYSTEMS, ALSO KNOWN AS DRY WELLS, STORMWATER DRAINAGE WELLS, INFILTRATION GALLERIES, AND SEEPAGE PITS, CONTROL PEAK FLOWS AND VOLUMES OF STORMWATER RUNOFF THROUGH SUBSURFACE STORAGE AND INFILTRATION INTO NATIVE SOIL. WATER IS ALSO TREATED AS IT FILTERS THROUGH THE GRAVEL, SAND (IF PROVIDED), AND NATIVE SOIL.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT PLAN AND SECTION DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. SUBSURFACE INFILTRATION SYSTEMS ARE CONSIDERED CLASS V INJECTION WELLS AND SUBJECT TO THE U.S. EPA UNDERGROUND INJECTION CONTROL (UIC) PROGRAM. SUBSURFACE INFILTRATION SYSTEMS MUST BE REGISTERED WITH EPA REGION IX PRIOR TO COMING ONLINE.
3. FIELD-TESTED INFILTRATION RATES OF NATIVE SOILS MUST BE BETWEEN 0.5 (INCHES PER HOUR) AND 5 (INCHES PER HOUR). FOR SITES WITH INFILTRATION RATES GREATER THAN 5 IN/HR, SUBSURFACE INFILTRATION SYSTEMS MAY STILL BE ALLOWED PROVIDED THAT THE RUNOFF IS FULLY TREATED USING UPSTREAM BMPS OR BY INSTALLING A MINIMUM OF 18 INCHES OF ASTM C33 SAND WITH AN INFILTRATION RATE LESS THAN 5 INCHES PER HOUR AT THE BASE OF THE FACILITY.
4. SUBSURFACE STORAGE DRAWDOWN TIME (I.E. TIME FOR MAXIMUM SUBSURFACE STORAGE VOLUME TO INFILTRATE INTO SUBGRADE AFTER THE END OF A STORM) SHOULD NOT EXCEED 48 HOURS. DRAWDOWN TIME IS CALCULATED AS THE MAXIMUM SUBSURFACE STORAGE DEPTH DIVIDED BY THE NATIVE SOIL INFILTRATION RATE.
5. SUBSURFACE INFILTRATION SYSTEM SUBGRADES SHOULD BE LEVEL, REGARDLESS OF ANY LONGITUDINAL SLOPE OF THE SITE, TO PROMOTE EQUAL SUBSURFACE DISTRIBUTION OF RUNOFF.
6. DEPENDING ON THE HEIGHT AND AREA OF THE PROPOSED SUBSURFACE INFILTRATION SYSTEM, ADDITIONAL STRUCTURAL CONSIDERATIONS MAY BE REQUIRED TO ADDRESS EARTH PRESSURE AND/OR SURFACE LOADING.
7. SUBSURFACE INFILTRATION SYSTEMS ARE MOST COMMONLY USED TO MANAGE STORMWATER RUNOFF FROM ROOFS AND PARKING LOTS, BUT CAN BE USED IN OTHER APPLICATIONS. IN AREAS WITH HIGH SEDIMENT LOADS, RUNOFF SHOULD PASS THROUGH STORMWATER PRE-TREATMENT MEASURES TO REMOVE COARSE SEDIMENT THAT CAN CLOG PORE SPACES. REFER TO THE STORMWATER MANAGEMENT REQUIREMENTS APPENDIX A: BMP FACT SHEETS FOR ADDITIONAL REQUIREMENTS.
8. SUBSURFACE INFILTRATION SYSTEMS ARE NOT APPROVED AS TREATMENT MEASURES FOR RUNOFF FROM INDUSTRIAL AREAS, AREAS SUBJECT TO HIGH (GREATER THAN 15,000 VEHICLES PER DAY) TRAFFIC LOADING, AUTOMOTIVE REPAIR SHOPS, CAR WASHES, FLEET STORAGE AREAS, NURSERIES, SITES THAT STORE CHEMICALS OR HAZARDOUS MATERIALS, OR OTHER LAND USES THAT POSE A HIGH THREAT TO WATER QUALITY.
9. SUBSURFACE INFILTRATION SYSTEMS SHOULD NOT BE USED IN AREAS OF KNOWN OR PRESUMED CONTAMINATED SOIL OR GROUNDWATER, AREAS WITH CURRENT OR HISTORICAL INDUSTRIAL USE, AREAS WITHIN 100 FEET OF CURRENT OR HISTORICAL UNDERGROUND STORAGE TANKS, FILLED FORMER BAY, MARSH OR CREEK AREAS, OR AREAS WITHIN 150 FEET OF A CURRENT OR HISTORICAL HIGHWAY. SEE SETBACK REQUIREMENTS TABLE ON **SI 1.2**.
10. SMALL SYSTEMS (TYPICALLY A FEW FEET IN WIDTH) ARE KNOWN AS DRY WELLS AND ARE RECOMMENDED FOR SMALL DRAINAGE AREAS WITH LOW POLLUTANT LOADINGS, SUCH AS ROOFTOPS LESS THAN 0.25 ACRES IN SIZE. LARGER SYSTEMS (TYPICALLY 10 TO 100 FEET IN WIDTH) ARE KNOWN AS INFILTRATION GALLERIES AND CAN BE USED TO RECEIVE RUNOFF FROM DRAINAGE AREAS TYPICALLY UP TO 5 ACRES IN SIZE.
11. THE DRAWINGS PROVIDED DO NOT COVER DESIGNS THAT UTILIZE PROPRIETARY STORAGE, DISTRIBUTION, AND/OR STRUCTURAL SYSTEMS OTHER THAN PREFABRICATED DRY WELL STRUCTURES, WHICH HAVE BEEN SHOWN IN A GENERIC WAY. REFER TO THE MANUFACTURER'S RECOMMENDATIONS FOR ALL PROPRIETARY SYSTEMS.

GENERAL UTILITY NOTES:

1. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS, OTHER GOVERNING UTILITY STANDARD, AND OTHER UTILITY PROVIDER REQUIREMENTS. SEE UTILITY CROSSING DESIGNER NOTES ON **GC 2.1**.
2. PROVIDE UTILITY TRENCH DAM, ANTI-SEEP COLLAR, OR EQUIVALENT TO PREVENT PREFERENTIAL FLOW OF WATER FROM INFILTRATIVE FACILITY INTO UTILITY TRENCH FROM CAUSING DAMAGE DOWNSTREAM. ENGINEER TO EVALUATE SITE CONDITIONS AND NEED FOR TRENCH DAM. REFER TO **GC2.12** FOR GUIDANCE ON UTILITY TRENCH DAM DESIGN.
3. PROPOSED UTILITY LINES TO BE LOCATED OUTSIDE OF FACILITY.

RELATED COMPONENTS		
UTILITY CROSSINGS:	GC 2.1	GC 2.12
OBSERVATION PORTS:	GC 3.1	GC 3.3
UTILITY CONFLICTS:	GC 4.1	GC 4.4
CLEANOUTS:		GC 5.2

NOTES		LARGE SYSTEMS PLAN SECTIONS		SMALL SYSTEMS PLAN SECTIONS	
SI 1.1	SI 1.2	SI 2.1	SI 2.2	SI 3.1	SI 3.2

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San Francisco Water Power Sewer

GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE: SEPTEMBER 2016
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REVISED:

SUBSURFACE INFILTRATION SYSTEMS

DESIGNER NOTES (1 OF 2)

DWG NO. SI 1.1

LAYOUT REQUIREMENTS:

REFER TO STORMWATER MANAGMENT REQUIRMENTS APPENDIX C: CRITERIA FOR INFILTRATION - BASED BMPS FOR MORE DETAILED INFORMATION ON SITING AND DESIGN REQUIREMENTS FOR INFILTRATION BASED BMPS.

1. STANDARD SETBACK REQUIREMENTS PER THE STORMWATER MANAGEMENT REQUIREMENTS:

SETBACK DISTANCE (FEET)	SETBACK FROM:
5	PROPERTY LINE
10	DOWNGRADIENT FROM ADJACENT FOUNDATIONS
100	UPGRADIENT FROM ADJACENT FOUNDATIONS
100	UPGRADIENT FROM GROUND SLOPES >15%
150	DRINKING WATER WELL

2. REFER TO APPENDIX C OF THE STORMWATER MANAGEMENT REQUIREMENTS FOR CONDITIONAL SETBACK REQUIREMENTS AND THE SFPUC ASSET PROTECTION STANDARDS FOR ADDITIONAL SETBACK REQUIREMENTS REGARDING WATER AND SEWER INFRASTRUCTURE.

3. MINIMUM 4-FOOT VERTICAL SEPARATION FROM BASE OF SUBSURFACE INFILTRATION SYSTEM TO BEDROCK IS REQUIRED.

4. VERTICAL SEPARATION TO GROUND WATER:
   - **BAYSIDE**: MINIMUM 4-FOOT VERTICAL SEPARATION FROM BASE OF SUBSURFACE INFILTRATION SYSTEM TO SEASONAL HIGH GROUNDWATER TABLE IS REQUIRED FOR ALL BAYSIDE GROUNDWATER BASINS.
   - **LOBOS & WESTSIDE BASINS**: MINIMUM 4-FOOT TO 10-FOOT VERTICAL SEPARATION FROM BASE OF SUBSURFACE INFILTRATION SYSTEM TO SEASONAL HIGH GROUNDWATER TABLE IS REQUIRED IN THE LOBOS AND WESTSIDE GROUNDWATER BASINS, DEPENDENT UPON SITE CHARACTERISTICS AND SFPUC APPROVAL.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ SUBSURFACE INFILTRATION SYSTEM WIDTH AND LENGTH
- ☐ DEPTH AND TYPE OF AGGREGATE STORAGE LAYER
- ☐ DEPTH AND TYPE OF FILTER SAND, IF REQUIRED
- ☐ ELEVATIONS AND CONTROL POINTS AT EVERY CORNER
- ☐ AGGREGATE STORAGE SPECIFICATIONS AND/OR DRY WELL TYPE AND DIMENSIONS
- ☐ ELEVATIONS OF EACH PIPE INLET AND OVERFLOW INVERT
- ☐ TYPE AND DESIGN OF SUBSURFACE INFILTRATION COMPONENTS (E.G. INLETS, OVERFLOWS, OBSERVATION WELLS)
- ☐ SETBACK DIMENSIONS TO BEDROCK, HIGH GROUNDWATER TABLE, PROPERTY LINES, FOUNDATIONS, WATER SUPPLY WELLS, SEWER MAINS, AND GROUND SLOPES OF 15% OR GREATER, AS APPLICABLE. SEE SFPUC ASSET PROTECTION STANDARDS.
- ☐ TYPE AND SIZE OF PRETREATMENT MEASURE, AS NESSESARY

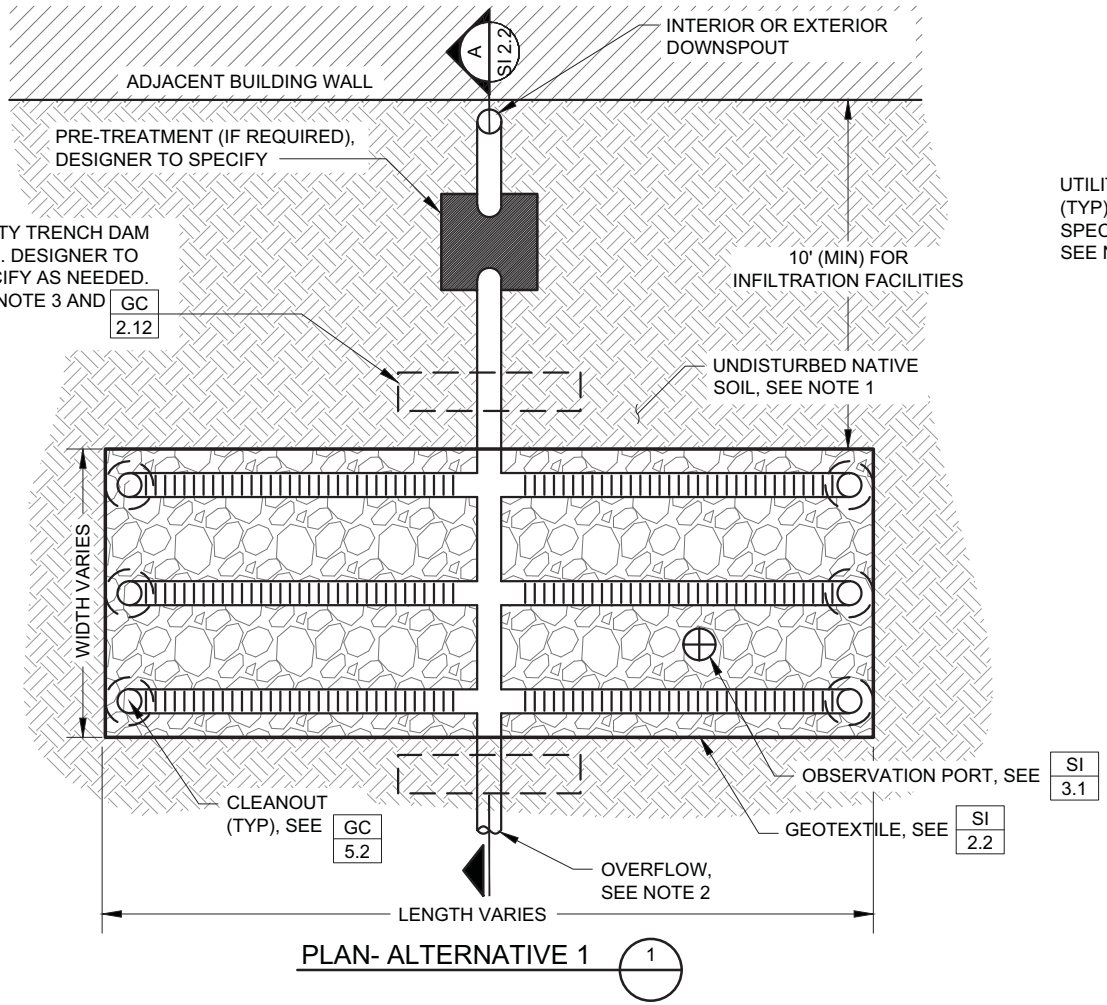
SOIL TYPE GUIDANCE:

HYDROLOGIC SOIL GROUP	SOIL TYPE	CORRESPONDING UNIFIED SOIL CLASSIFICATION	DESCRIPTION
A	SAND, LOAMY SAND, OR SANDY LOAM	GW - WELL-GRADED GRAVELS, SANDY GRAVELS GP - GAP-GRADED OR UNIFORM GRAVELS, SANDY GRAVELS GM - SILTY GRAVELS, SILTY SANDY GRAVELS SW - WELL-GRADED, GRAVELLY SANDS SP - GAP-GRADED OR UNIFORM SANDS, GRAVELLY SANDS	LOW RUNOFF POTENTIAL. SOILS HAVING HIGH INFILTRATION RATES EVEN WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF DEEP, WELL TO EXCESSIVELY DRAINED SANDS OR GRAVELS.
B	SILT LOAM OR LOAM	SM - SILTY SANDS, SILTY GRAVELLY SANDS MH - MICACEOUS SILTS, DIATOMACEOUS SILTS, VOLCANIC ASH	SOILS HAVING MODERATE INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF MODERATELY DEEP TO DEEP, MODERATELY WELL TO WELL-DRAINED SOILS WITH MODERATELY FINE TO MODERATELY COARSE TEXTURES.
C	SANDY CLAY LOAM	ML - SILTS, VERY FINE SANDS, SILTY AND CLAYEY FINE SANDS	SOILS HAVING SLOW INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF SOILS WITH A LAYER THAT IMPEDES DOWNWARD MOVEMENT OF WATER, OR SOILS WITH MODERATELY FINE TO FINE TEXTURES.
D	CLAY LOAM, SANDY CLAY, SILTY CLAY, OR CLAY	GC - CLAYEY GRAVELS, CLAYEY SANDY GRAVELS SC - CLAYEY SANDS, CLAYEY GRAVELLY SANDS CL - LOW PLASTICITY CLAYS, SANDY OR SILTY CLAYS OL - ORGANIC SILTS AND CLAYS OF LOW PLASTICITY CH - HIGHLY PLASTIC LAYS AND SANDY CLAYS OH - ORGANIC SILTS AND CLAYS OF HIGH PLASTICITY	HIGH RUNOFF POTENTIAL. SOILS HAVING VERY SLOW INFILTRATION RATES WHEN THOROUGHLY WETTED AND CONSISTING CHIEFLY OF CLAY SOILS WITH A HIGH SWELLING POTENTIAL, SOILS WITH A PERMANENT HIGH WATER TABLE, AND SHALLOW SOILS OVER NEARLY IMPERVIOUS MATERIAL.

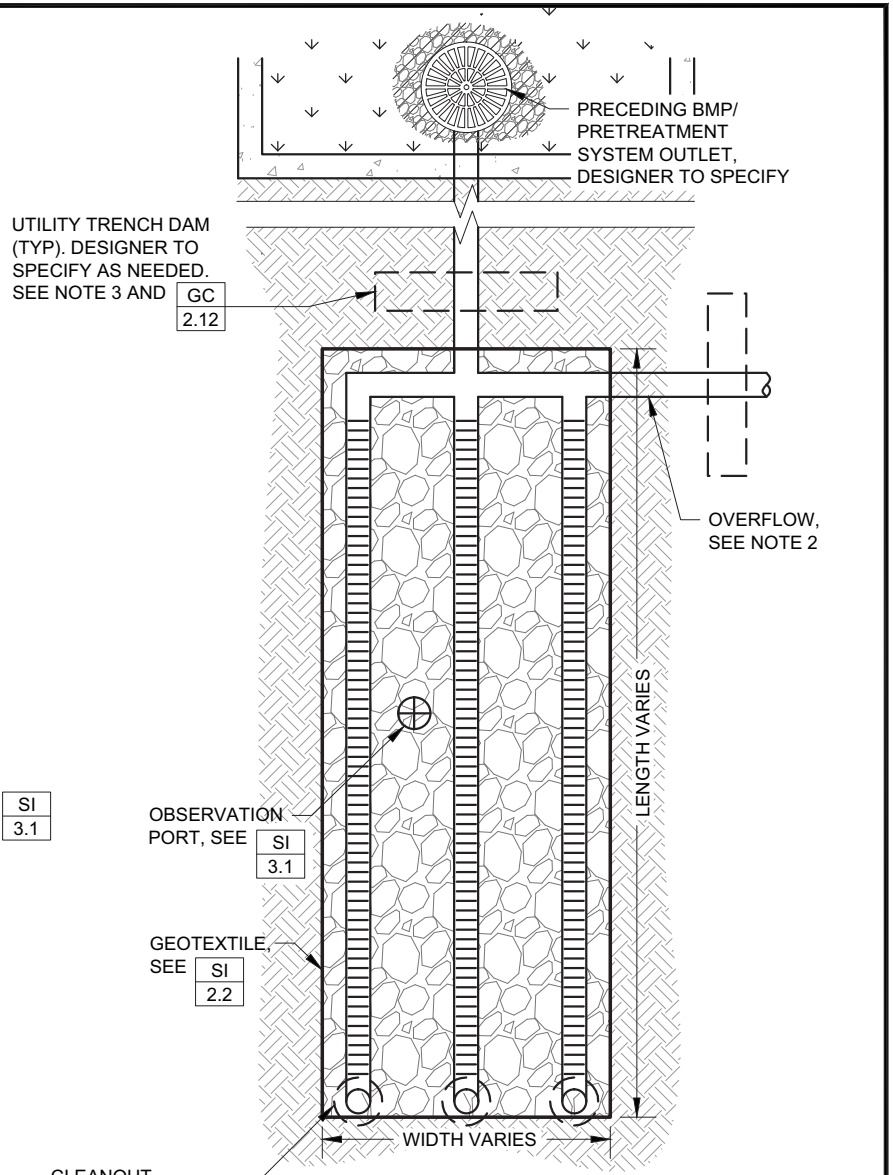
NOTES | LARGE SYSTEMS PLAN SECTIONS | SMALL SYSTEMS PLAN SECTIONS

NOTES		LARGE SYSTEMS PLAN SECTIONS		SMALL SYSTEMS PLAN SECTIONS	
SI 1.1	SI 1.2	SI 2.1	SI 2.2	SI 3.1	SI 3.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



PLAN- ALTERNATIVE 1 (1)



PLAN - ALTERNATIVE 2 (2)

CONSTRUCTION NOTES:

1. AVOID COMPACTION AND DISTURBANCE OF EXISTING SOIL WITHIN 5 FEET ADJACENT TO AND BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.
2. ROUTE OVERFLOW PIPE TO THE STORM SEWER OR TO ANOTHER BMP FOR FURTHER TREATMENT AS SHOWN ON THE DESIGN PLANS.
3. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.

NOTES		LARGE SYSTEMS		SMALL SYSTEMS	
		PLAN SECTIONS		PLAN SECTIONS	
SI 1.1	SI 1.2	SI 2.1	SI 2.2	SI 3.1	SI 3.2

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San Francisco Water Power Sewer

GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

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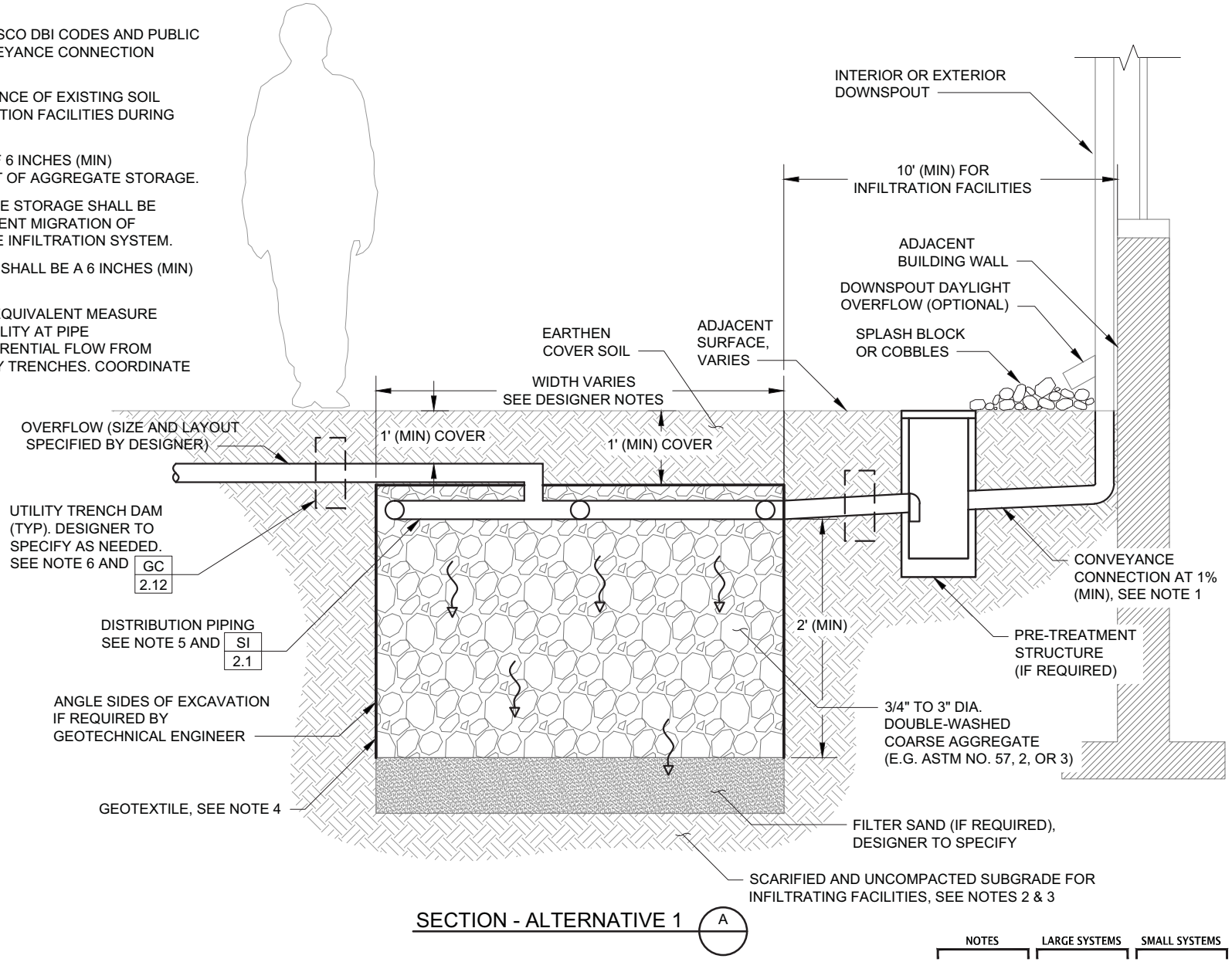
SUBSURFACE INFILTRATION SYSTEM

INFILTRATION GALLERY
LARGE SYSTEM - PLAN

DWG NO. SI 2.1

CONSTRUCTION NOTES:

1. REFER TO APPLICABLE SAN FRANCISCO DBI CODES AND PUBLIC WORKS REQUIREMENTS FOR CONVEYANCE CONNECTION REQUIREMENTS.
2. AVOID COMPACTION AND DISTURBANCE OF EXISTING SOIL ADJACENT TO AND BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.
3. SCARIFY SUBGRADE TO A DEPTH OF 6 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF AGGREGATE STORAGE.
4. SIDEWALLS AND TOP OF AGGREGATE STORAGE SHALL BE LINED WITH A GEOTEXTILE TO PREVENT MIGRATION OF ADJACENT SOILS INTO SUBSURFACE INFILTRATION SYSTEM.
5. SUBSURFACE DISTRIBUTION PIPING SHALL BE A 6 INCHES (MIN) IN DIAMETER.
6. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.



SECTION - ALTERNATIVE 1 (A)

NOTES		LARGE SYSTEMS		SMALL SYSTEMS	
		PLAN SECTIONS		PLAN SECTIONS	
SI 1.1	SI 1.2	SI 2.1	SI 2.2	SI 3.1	SI 3.2

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San Francisco Water Power Sewer

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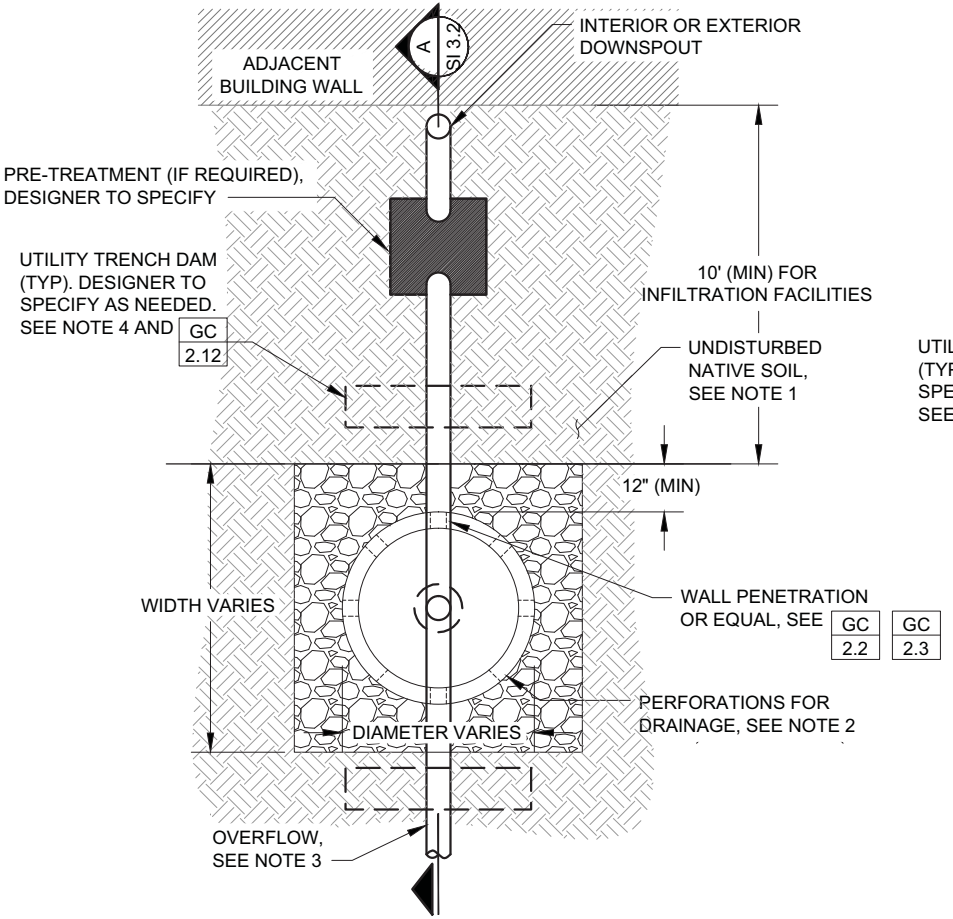
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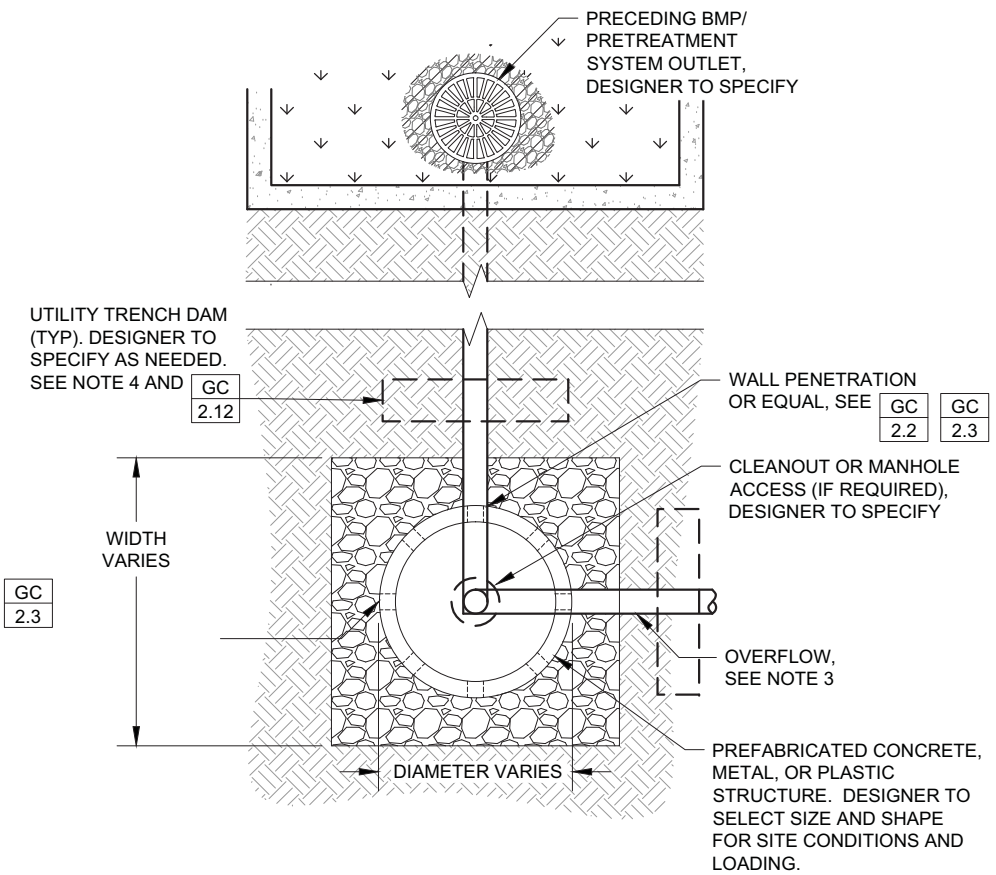
SUBSURFACE INFILTRATION SYSTEM

INFILTRATION GALLERY LARGE SYSTEM - SECTION

DWG NO. SI 2.2



PLAN- ALTERNATIVE 1 (1)



PLAN - ALTERNATIVE 2 (2)

CONSTRUCTION NOTES:

1. AVOID COMPACTION AND DISTURBANCE OF EXISTING SOIL WITHIN 5 FEET ADJACENT TO AND BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.
2. PREFABRICATED DRY WELLS SHALL HAVE SMALL DIAMETER PERFORATIONS TO PREVENT LATERAL MOVEMENT OF AGGREGATE INTO WELL AND SHALL BE SUFFICIENT IN NUMBER TO ALLOW FOR THE DRAINAGE OF THE STRUCTURE WITHIN 48 HOURS.
3. ROUTE OVERFLOW PIPE TO THE STORM SEWER OR TO ANOTHER BMP FOR FURTHER TREATMENT AS SHOWN ON THE DESIGN PLANS.
4. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.

NOTES		LARGE SYSTEMS		SMALL SYSTEMS	
		PLAN SECTIONS		PLAN SECTIONS	
SI 1.1	SI 1.2	SI 2.1	SI 2.2	SI 3.1	SI 3.2

San Francisco Water Power Sewer

GREEN INFRASTRUCTURE TYPICAL DETAILS

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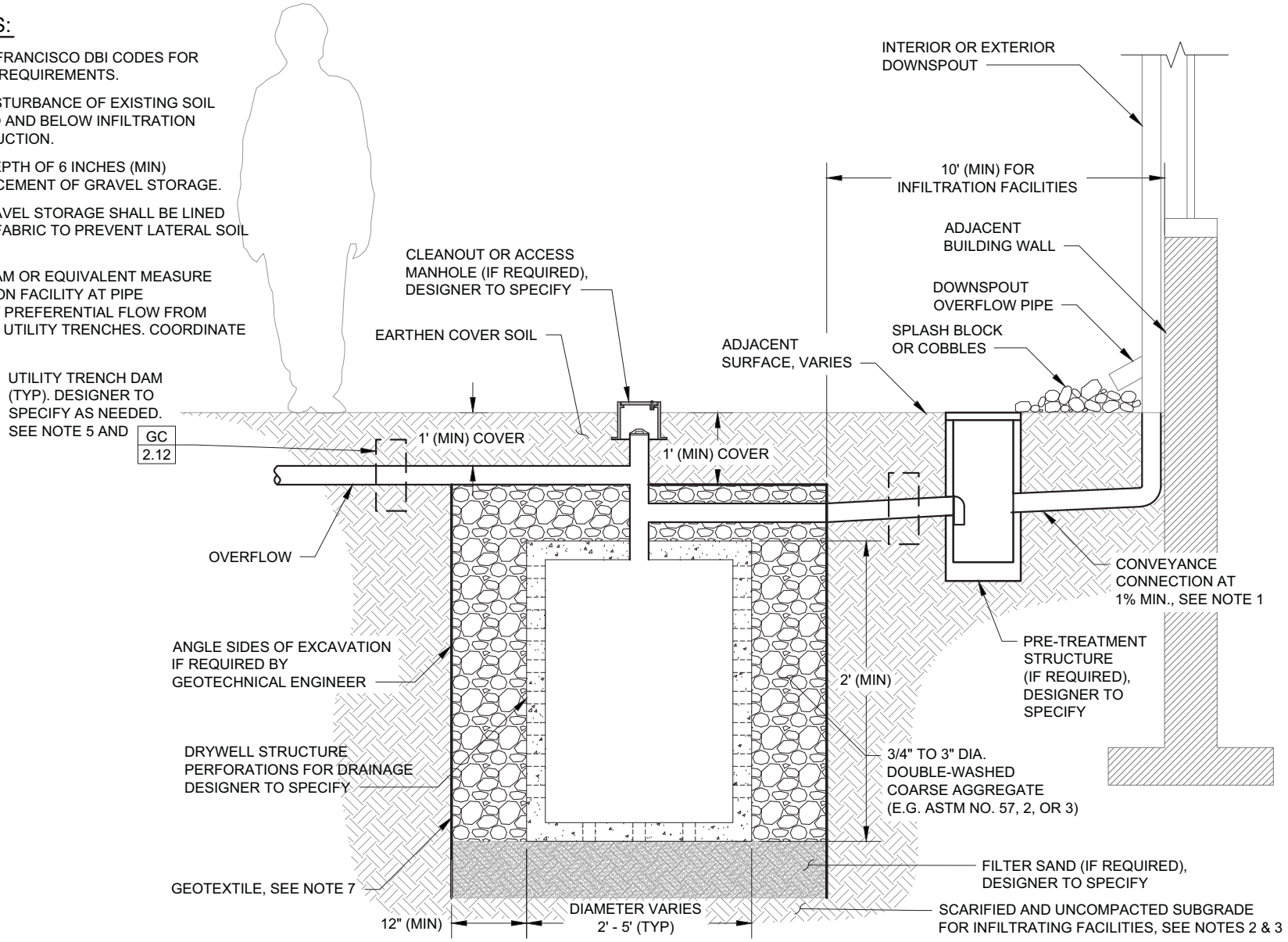
DRY WELL
SMALL SYSTEM - PLAN

DWG NO. SI 3.1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

CONSTRUCTION NOTES:

1. REFER TO APPLICABLE SAN FRANCISCO DBI CODES FOR CONVEYANCE CONNECTION REQUIREMENTS.
2. AVOID COMPACTION AND DISTURBANCE OF EXISTING SOIL WITHIN 5 FEET ADJACENT TO AND BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.
3. SCARIFY SUBGRADE TO A DEPTH OF 6 INCHES (MIN) IMMEDIATELY PRIOR TO PLACEMENT OF GRAVEL STORAGE.
4. SIDEWALLS AND TOP OF GRAVEL STORAGE SHALL BE LINED WITH A PERMEABLE FILTER FABRIC TO PREVENT LATERAL SOIL MOVEMENT.
5. PROVIDE UTILITY TRENCH DAM OR EQUIVALENT MEASURE OUTSIDE OF THE INFILTRATION FACILITY AT PIPE PENETRATIONS TO PREVENT PREFERENTIAL FLOW FROM INFILTRATION GALLERY INTO UTILITY TRENCHES. COORDINATE WITH ENGINEER.



SECTION - ALTERNATIVE 1 (A)

NOTES		LARGE SYSTEMS		SMALL SYSTEMS	
		PLAN SECTIONS		PLAN SECTIONS	
SI 1.1	SI 1.2	SI 2.1	SI 2.2	SI 3.1	SI 3.2

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San Francisco Water Power Sewer

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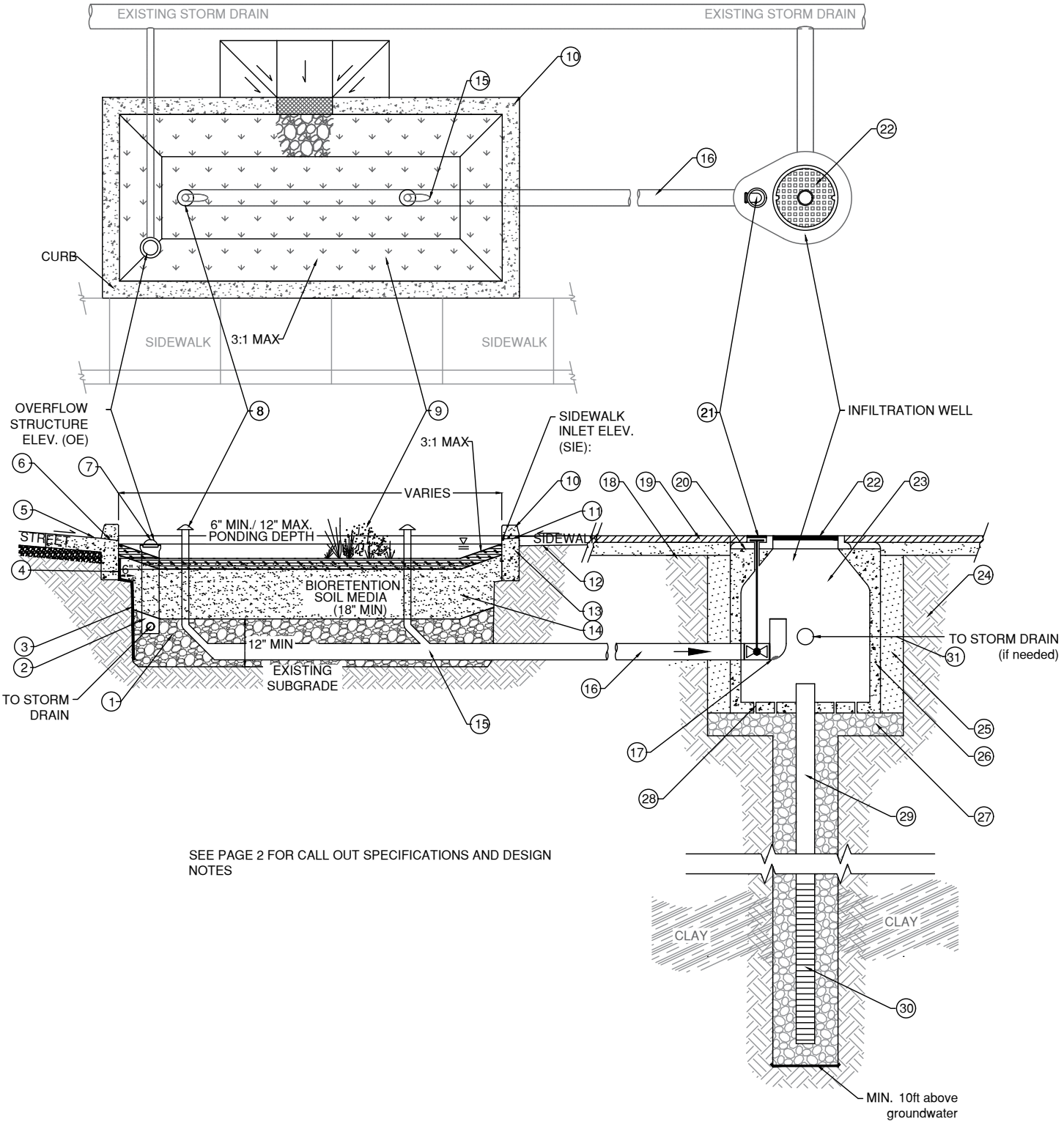
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SUBSURFACE INFILTRATION SYSTEMS

DRY WELL
SMALL SYSTEM - SECTION

DWG NO. SI 3.2



SEE PAGE 2 FOR CALL OUT SPECIFICATIONS AND DESIGN NOTES

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

DEVELOPED UNDER PROP. 84 GRANT

APPROVED BY:

VERSION: 08/31/2017

DRYWELL STORMWATER BMP

STANDARD PLAN NO. **SW-27**

USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION

SPECIFICATIONS

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

DESIGN NOTES

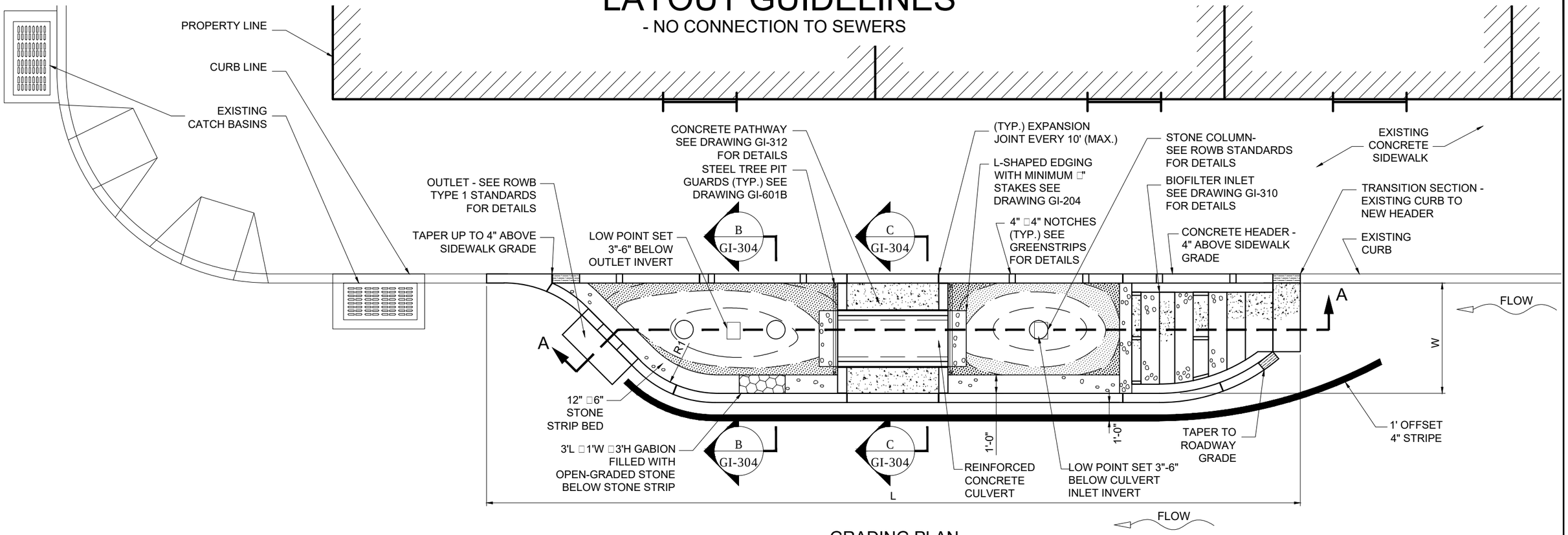
1. ADDITIONAL DESIGN GUIDANCE FOR BIOFILTRATION SYSTEM PROVIDED IN LIDI BIORETENTION TECHNICAL SPECIFICATIONS (BTS) DOCUMENT.
2. BOTTOM WIDTH - PROVIDE 2 FT MINIMUM FLAT BREGENALL
3. BOTTOM WITH A MAX 3:1 SLOPE FOR SURFACE FINISHING WITHIN BIOFILTRATION SYSTEM
4. IF CALTRANS CLASS 2 PERMEABLE IS NOT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

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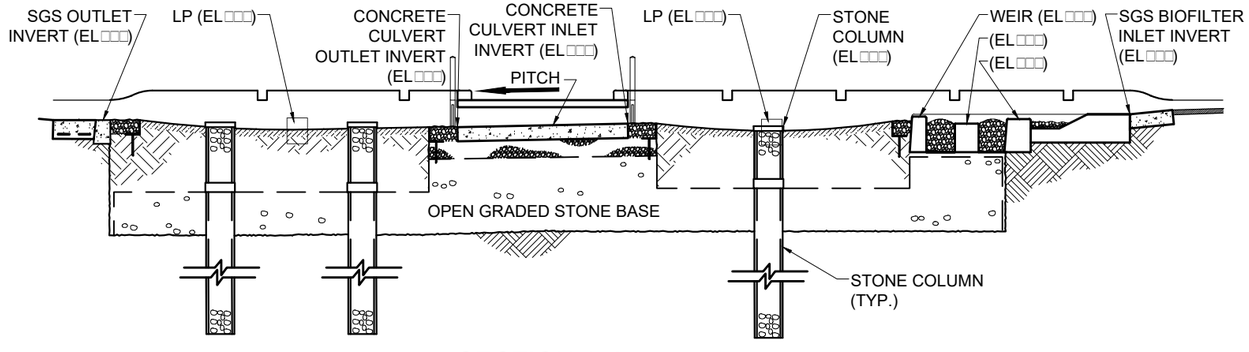
GI–303

R.O.W. STORMWATER GREENSTREET (ROWSGS) TYPE 1A-WITH STONE COLUMNS LAYOUT GUIDELINES

- NO CONNECTION TO SEWERS



GRADING PLAN



SECTION A-A

NOTES:

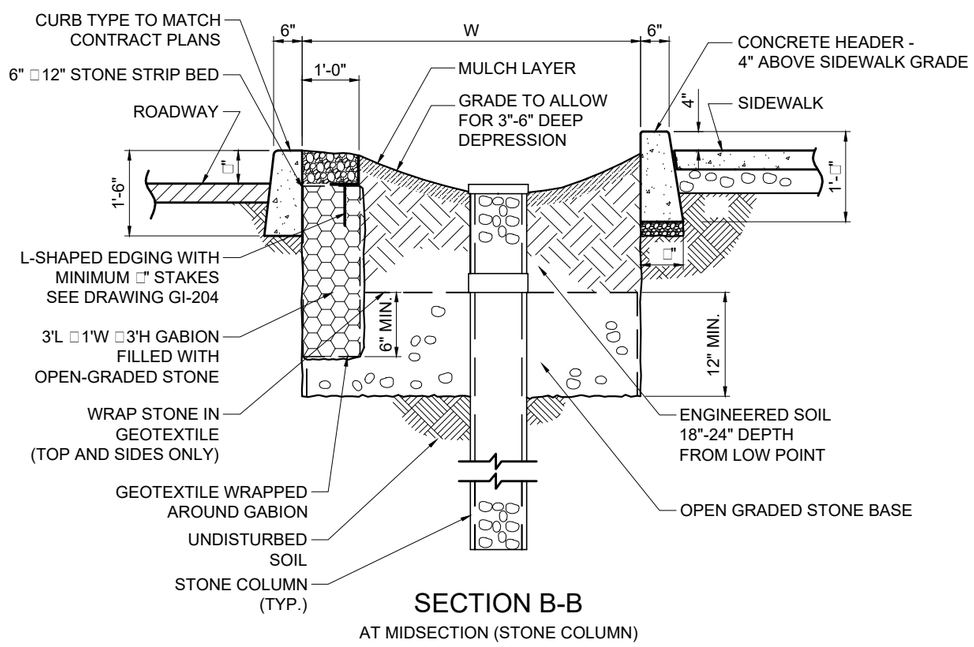
1. DEPTH OF SOIL AND STONE SHALL BE DIMENSIONED IN ACCORDANCE WITH STORMWATER GREENSTREET CALCULATIONS.
2. ENGINEERED SOIL DEPTH TO BE 18", AND 24" IF TREE IS PRESENT. STONE DEPTH VARIES. TOTAL DEPTH NOT TO EXCEED 60".
3. DEPTH AND MATERIALS MAY CHANGE DUE TO FIELD CONDITIONS UNDER THE DIRECTION OF THE ENGINEER.
4. IF DEEPER LOW POINT (LP) IS REQUIRED, OGI APPROVAL WILL BE REQUIRED.
5. STONE COLUMN AND/OR PEDESTRIAN PATHWAY WHEN REQUIRED.
6. TOP OF DOWNSTREAM STONE COLUMN(S) TO BE 1" LOWER THAN OUTLET INVERT (TYP.) TOP OF UPSTREAM STONE COLUMN(S) TO BE 1" LOWER THAN CONCRETE CULVERT INLET INVERT (TYP.).
7. □ WHERE (EL□□□) IS INDICATED, ELEVATION TO BE SHOWN IN CONTRACT PLANS.
8. HEADER NOTCHES ARE PLACED EQUALLY SPACED 4' TO □' APART.
9. □ 5' (MIN.) DISTANCE BETWEEN STONE COLUMNS□NUMBER OF STONE COLUMNS AS REQUIRED BY OGI.

GI–304

CITY OF NEW YORK
DEPARTMENT OF ENVIRONMENTAL PROTECTION
OFFICE OF GREEN INFRASTRUCTURE

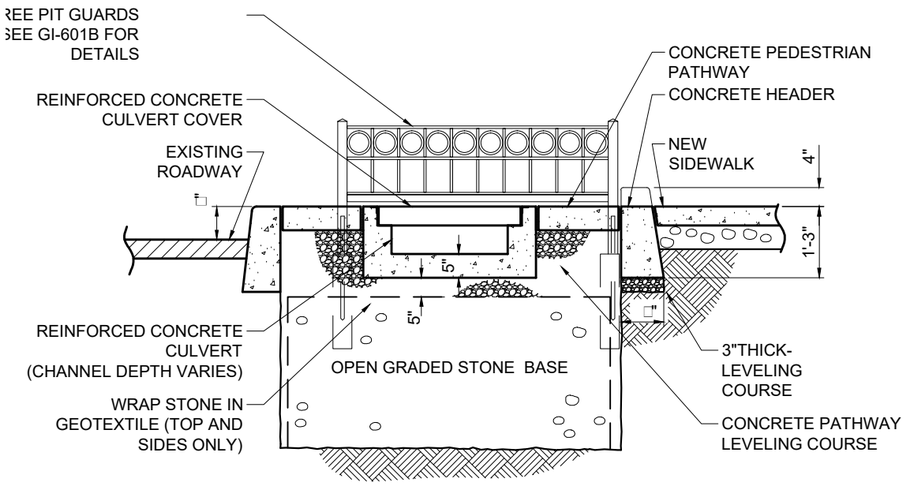
R.O.W. STORMWATER GREENSTREET (ROWSGS) TYPE 1A-WITH STONE COLUMNS LAYOUT GUIDELINES

- NO CONNECTION TO SEWERS



SECTION B-B

AT MIDSECTION (STONE COLUMN)



SECTION C-C

AT PEDESTRIAN PATHWAY

NOTES:

1. DEPTH OF SOIL AND STONE SHALL BE DIMENSIONED IN ACCORDANCE WITH STORMWATER GREENSTREET CALCULATIONS.
2. IMPERVIOUS ROW AREA IS CALCULATED IN TDA ANALYSIS SPREADSHEET.
3. ENGINEERED SOIL DEPTH TO BE 18", AND 24" IF TREE IS PRESENT. STONE DEPTH VARIES. TOTAL DEPTH NOT TO EXCEED 60".
4. DEPTH AND MATERIALS MAY CHANGE DUE TO FIELD CONDITIONS UNDER THE DIRECTION OF THE ENGINEER.
5. IF DEEPER LOW POINT (LP) IS REQUIRED, OGI APPROVAL WILL BE REQUIRED.
6. STONE COLUMN AND/OR PEDESTRIAN PATHWAY WHEN REQUIRED.

□. TOP OF DOWNSTREAM STONE COLUMN(S) TO BE 1" LOWER THAN OUTLET INVERT (TYP.) TOP OF UPSTREAM STONE COLUMN(S) TO BE 1" LOWER THAN CONCRETE CULVERT INLET INVERT (TYP.)

8. WHERE (EL□□□) IS INDICATED. ELEVATION TO BE SHOWN IN CONTRACT PLANS.

□. PEDESTRIAN PATHWAY CULVERT COVER TO BE CONCRETE WHEN ELEVATION AT SIDEWALK CURB IS HIGHER THAN ELEVATION AT ROADWAY CURB□OTHERWISE, CULVERT COVER TO BE METAL GRATED WITH PATHWAY SLOPING TOWARDS GRATING ON EITHER SIDE.

GENERAL COMPONENTS

PURPOSE:

IMPERMEABLE LINERS IN GREEN INFRASTRUCTURE CAN BE USED TO RESTRICT MOVEMENT OF WATER INTO UNDERLYING AND/OR ADJACENT SOILS AND/OR AGGREGATES TO PROTECT SENSITIVE INFRASTRUCTURE (E.G., IMPERMEABLE ROADWAY BASE, FOUNDATIONS, UTILITIES), MITIGATE RISK OF GEOLOGIC HAZARDS (E.G., STEEP SLOPES, CONTAMINATED SOILS), OR OTHER SITE-SPECIFIC CONDITIONS)

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. THE DESIGNER AND/OR GEOTECHNICAL ENGINEER SHOULD ASSESS THE RISK OF WATER LEAKAGE FROM THE PLANTER AND DETERMINE THE LINER EXTENTS AND LINER CONNECTION REQUIREMENTS (E.G., WATER TIGHT, SOIL TIGHT), DEPENDING ON DEGREE OF PROTECTION NECESSARY TO PROTECT ADJACENT INFRASTRUCTURE.
3. CONSIDER PLACING GEOTEXTILE ON PREPARED SUBGRADE PRIOR TO PLACEMENT OF LINER TO PROTECT LINER FROM DAMAGE DURING INSTALLATION.
4. DEPENDING ON ANTICIPATED FACILITY MAINTENANCE, IT MAY BE PRUDENT TO INCLUDE A GEOTEXTILE OVER THE LINER TO PROVIDE AN ADDITIONAL BARRIER BETWEEN LINER AND MAINTENANCE EQUIPMENT OR TO PROTECT AGAINST AGGRESSIVE PUNCTURES DURING PLACEMENT AND COMPACTION.
5. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

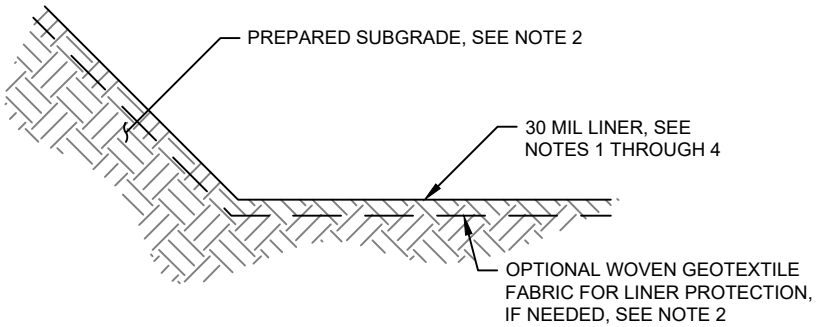
DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ LINER TYPE AND EXTENTS (E.G., FULL LINER, PARTIAL LINER)
- ☐ LINER ANCHOR TYPE (E.G., WATER TIGHT, SOIL TIGHT)
- ☐ LINER JOINT WELDING/SEALING REQUIREMENTS
- ☐ OTHER CRITICAL PROJECT-SPECIFIC PLACEMENT REQUIREMENTS

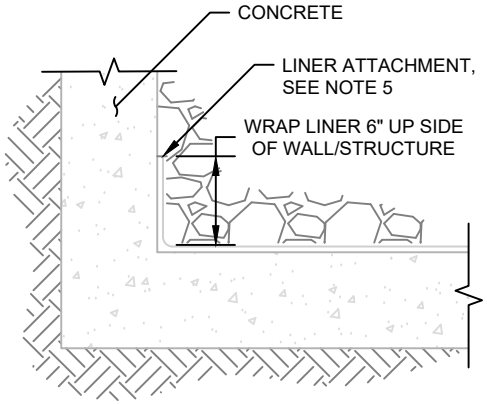
NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES COMPONENTS

GC 1.1	GC 1.2



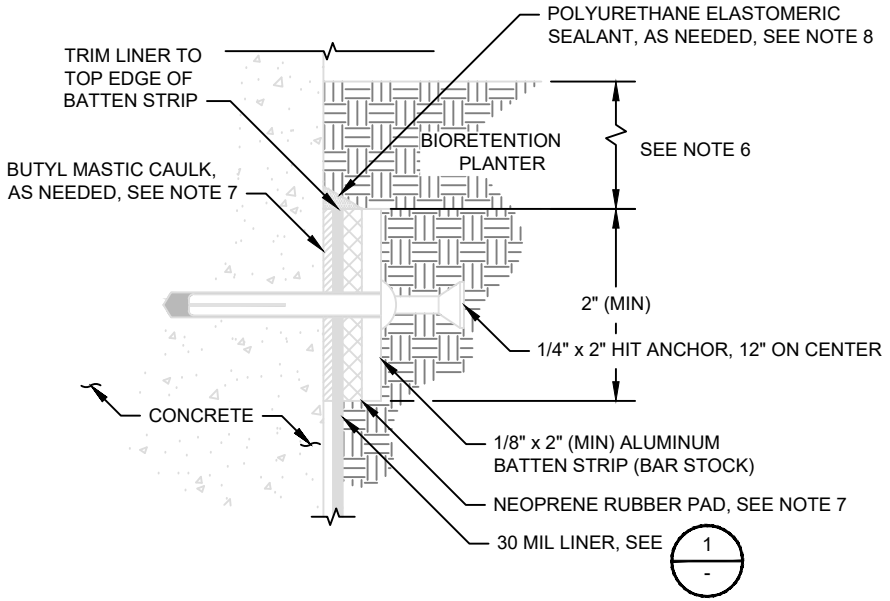
IMPERMEABLE LINER 1



SOIL TIGHT LINER ATTACHMENT AT WALL/STRUCTURE 2

CONSTRUCTION NOTES:

1. WATERPROOFING AND/OR LINER SYSTEM TO BE DESIGNED AND INSTALLED BY WATERPROOFING PROFESSIONAL. POTENTIAL LINER MATERIALS TO BE CONSIDERED INCLUDE: HDPE (HIGH DENSITY POLYETHYLENE), CPSE (CHLOROSULFONATED POLYETHYLENE), OR LLDPE (LINEAR LOW DENSITY POLYETHYLENE).
2. LINER SHALL LAY FLUSH WITH GROUND WITH NO AIR VOIDS BELOW THE LINER PRIOR TO BACKFILLING MATERIAL ABOVE THE LINER AND REMOVE ALL SHARP ROCKS AND DEBRIS. IF SUBGRADE SOIL CONTAINS ANGULAR ROCKS/DEBRIS, INSTALL WOVEN GEOTEXTILE FABRIC OVER SUBGRADE TO PROTECT LINER FROM PUNCTURE. CONTOUR THE SUBGRADE AS NEEDED TO ENSURE LINER LAYS FLUSH WITH GROUND.
3. OVERLAP LINER PER MANUFACTURER'S RECOMMENDATIONS.
4. ALL SEAMS SHALL BE WELDED PER MANUFACTURER'S RECOMMENDATIONS UNLESS OTHERWISE SPECIFIED.
5. SECURE LINER CONTINUOUSLY WITH DOUBLE-SIDED TAPE ALONG LINER EDGE AND SINGLE SIDED TAPE ALONG THE TOP EDGE OF LINER TO HOLD LINER IN PLACE DURING BACKFILLING.
6. TOP OF LINER TO BE AT LEAST 3 INCHES BELOW FINISHED GRADE OF BIOTREATMENT SOIL MIX EXCEPT WHEN ADJACENT TO BUILDING WALL. WHEN ADJACENT TO BUILDING WALL, LINER OR EQUAL WATER PROOFING SHALL EXTEND TO TOP OF FREEBOARD ELEVATION.
7. APPLY BATTEN STRIP, AND NEOPRENE RUBBER PAD CONTINUOUSLY ALONG TOP EDGE OF LINER. FOR WATER-TIGHT APPLICATIONS, ALSO APPLY BUTYL MASTIC CAULK.
8. FOR WATER-TIGHT APPLICATIONS, APPLY BEAD OF POLYURETHANE ELASTOMERIC SEALANT CONTINUOUSLY ALONG TOP EDGE OF BATTEN STRIP ASSEMBLY.



WATER TIGHT LINER ATTACHMENT AT WALL/STRUCTURE 3

NOTES COMPONENTS

GC 1.1	GC 1.2

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 1.2

DATE: OCTOBER 2024
VERSION: 1.0
REVISED:

GENERAL COMPONENTS

LINERS

LINERS AND ATTACHMENTS

DWG NO. GC 1.2

PURPOSE:

WHEN SITING GREEN INFRASTRUCTURE (GI) FACILITIES, THE DESIGNER SHOULD LOCATE AND ASSESS ALL KNOWN UTILITY CROSSINGS AND CONFLICTS AND ADJUST THE DESIGN TO AVOID AS MANY EXISTING UTILITIES AS POSSIBLE. THE CRITICALITY OF UTILITY CONFLICTS IN TERMS OF THEIR POTENTIAL IMPACT TO THE PROJECT'S DESIGN PERFORMANCE, COST, AND SCHEDULE SHOULD BE CAREFULLY EVALUATED DURING THE PLANNING PHASE.

THE PURPOSE OF THE FOLLOWING TYPICAL UTILITY CROSSING DETAILS IS TO ALERT THE DESIGNERS TO COMMON UTILITY CROSSINGS THAT OCCUR ON GI PROJECTS WITHIN THE PUBLIC RIGHT-OF-WAY AND PROVIDE GENERAL GUIDANCE ON THE PROTECTION OF THESE UTILITIES. THEY ARE PROVIDED AS TYPICAL APPLICATIONS AND DO NOT REPRESENT APPROVED MUNICIPAL UTILITY STANDARDS AND SPECIFICATIONS. IN ADDITION TO THESE TYPICAL DETAILS, DESIGNERS MUST FOLLOW ALL APPLICABLE LOCAL AND FEDERAL REGULATIONS ASSOCIATED WITH THEIR PROJECT.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS AND UTILITY REQUIREMENTS AND OBTAIN APPROVAL FROM ALL RELEVANT UTILITY PROVIDERS PRIOR TO CONSTRUCTION. COORDINATION AND APPROVAL FROM THE FOLLOWING UTILITY PROVIDERS MAY BE NECESSARY, BUT NOT EXCLUSIVELY:
   - DOMESTIC/RECYCLED/FIRE WATER
   - SANITARY/STORM/SEWER
   - PACIFIC GAS ELECTRIC (PGE) OR MUNICIPALITY FOR ELECTRIC/GAS/UTILITY POLES
   - TRAFFIC SIGNAL/STREET SIGNS/PARKING METERS/BUS STOPS AND CATENARY POLES.
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT MUNICIPAL PROTECTION STANDARDS. IN THE ABSENCE OF THESE STANDARDS, THE DESIGNER SHALL REFER TO THE SCVURPPP GSI HANDBOOK FOR ADDITIONAL GUIDANCE AND COORDINATE DIRECTLY WITH RELEVANT UTILITY PROVIDERS FOR REQUIREMENTS.
3. UTILITY CONFLICTS SHALL BE MITIGATED PER MUNICIPAL STANDARDS AND OTHER UTILITY PROVIDER REQUIREMENTS. ENGINEER TO EVALUATE CONDITIONS AND NEED TO INCLUDE MEASURES TO ENSURE WATER TIGHT UTILITY PENETRATIONS THROUGH PLANTER WALL, AS NEEDED AND TO PREVENT PREFERENTIAL FLOW INTO UTILITY TRENCHES (E.G., WATER STOP, TRENCH BLOCK, OR TRENCH COLLAR). (REFER TO **GC 2.9 - 2.12**)
4. THE DESIGNER MUST DETERMINE THE TYPE OF PROTECTION MEASURE(S) REQUIRED BASED ON THE SITE-SPECIFIC CONDITIONS, UTILITY REQUIREMENTS, AND THE FUNCTION THE PROTECTION MEASURE MUST PERFORM. THE FOLLOWING ARE BRIEF DESCRIPTIONS OF THE PROTECTION MEASURES INCLUDED IN THESE DETAILS:
   a. SOIL OR ENGINEERED FILL WITH OVERLYING IMPERMEABLE LINER: PROTECTS UTILITY FROM DAMAGE DURING FUTURE TRENCHING, EXCAVATION, AND LANDSCAPE ACTIVITIES. THE LINER PREVENTS PREFERENTIAL FLOW OF WATER INTO THE UTILITY TRENCH. THESE METHODS ARE GENERALLY ONLY ACCEPTABLE WHEN THE FACILITY DOES NOT INCLUDE AN UNDERDRAIN OR WHEN THE LINER CAN BE LOCATED BELOW THE INVERT OF THE UNDERDRAIN.
   b. SLEEVE/CASING: BY HOUSING THE UTILITY PIPE WITHIN A LARGER CARRIER PIPE OR APPROVED SPLIT SLEEVE PRODUCT, THE UTILITY PIPE CAN BE REPLACED IF NEEDED IN THE FUTURE WITHOUT SIGNIFICANT IMPACT TO THE OVERLYING INFRASTRUCTURE. THE SLEEVE ALSO PROTECTS THE PIPE FROM IMPACT DURING CONSTRUCTION AND FUTURE TRENCHING, EXCAVATION, AND LANDSCAPE ACTIVITIES. ADDITIONALLY, SLEEVES CAN BE USED TO SEAL THE UTILITY FROM THE INFILTRATED STORMWATER AND/OR PROTECT THE INFILTRATION FACILITY FROM SEWER LATERAL LEAKAGES. SEE THE UTILITY SLEEVE GUIDANCE.
   c. UTILITY TRENCH DAM: WHERE UTILITY TRENCHES CROSS UNDER INFILTRATIVE FACILITIES, SUBSURFACE WATER MAY PREFERENTIALLY FLOW THROUGH THE TRENCH AND CAUSE DAMAGE TO DOWNSTREAM INFRASTRUCTURE. RISKS INCLUDE BACKFILL EROSION, CREATION OF VOIDS, THE DEGRADATION OF OVERLYING FILL/PAVEMENT, AND SUBSURFACE WATER BEING DIRECTED TO BUILDING FOUNDATIONS OR BASEMENTS. UTILITY TRENCH DAMS PLACED OUTSIDE OF THE INFILTRATION FACILITY FOOTPRINT PREVENT WATER FROM TRAVELING FURTHER ALONG THE UTILITY TRENCH.
   d. INSULATING WRAP: PROVIDES IMPACT AND WATER PROTECTION FOR EXISTING SHALLOW UTILITY SERVICE LINES THAT ARE REMAINING IN PLACE WITHIN INFILTRATION FACILITIES.
6. FOR PERMEABLE PAVEMENT FACILITIES, UTILITY CROSSINGS SHOULD BE BELOW THE BOTTOM OF THE STRUCTURAL PAVEMENT SECTION, WHENEVER POSSIBLE. IF UTILITIES ENCROACH INTO THIS SECTION, THE ENGINEER SHALL CONFIRM THAT THE STRUCTURAL INTEGRITY OF THE PAVEMENT CAN BE MAINTAINED OVER THE UTILITY.
7. THE AREA OF SUBBASE COVERED BY SUBSURFACE CHECK DAMS, IMPERMEABLE LINERS, COMPACTED ENGINEERED FILL, CONCRETE PADS AND OTHER UTILITY INFRASTRUCTURE SHOULD BE EXCLUDED FROM HYDROLOGIC PERFORMANCE CALCULATIONS WHEN THE AREA IS SIGNIFICANT (GREATER THAN 10 PERCENT) RELATIVE TO THE INFILTRATIVE AREA.
8. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES		BIORETENTION			PERVIOUS PAVEMENT			WALL PENETRATIONS			TRENCH DAM
GC 2.1	GC 2.2	GC 2.3	GC 2.4	GC 2.5	GC 2.6	GC 2.7	GC 2.8	GC 2.9	GC 2.10	GC 2.11	GC 2.12

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.1

DATE: OCTOBER 2024
VERSION: 1.0
REVISED:

GENERAL COMPONENTS

UTILITY CROSSINGS

DESIGNER NOTES (1 OF 2)

DWG NO. GC 2.1

UTILITY SLEEVE NOTES AND GUIDANCE:

THE DESIGNER MUST SPECIFY THE TYPE OF SLEEVE METHOD AND MATERIALS THAT SHALL BE USED FOR ALL APPLICABLE NEW AND EXISTING UTILITIES TO REMAIN IN PLACE WITHIN THE FOOTPRINT OF INFILTRATION FACILITIES. DEPENDING ON THE SPECIFIC SITE CONDITIONS AND GOVERNING UTILITY STANDARDS, EXISTING UTILITIES TO REMAIN IN PLACE SHALL BE SLEEVED THE ENTIRE LENGTH WITHIN THE INFILTRATION FACILITY USING ONE OF THE FOLLOWING METHODS OR AN APPROVED EQUAL:

a. PLASTIC PIPE, 1 - 2 SIZES LARGER THAN UTILITY PIPE, CUT IN HALF, PLACED AROUND UTILITY PIPE, SEALED ALONG JOINTS WITH ADHESIVE, AND CLAMPED TOGETHER WITH STAINLESS STEEL BANDS/HOSE CLAMPS. PIPE SUPPORTS (E.G. CLOSED CELL FOAM BLOCKING) WITHIN THE SLEEVE PER UTILITY PROVIDER'S REQUIREMENTS.

b. GEORGE FISCHER "CONTAIN-IT" PIPE CONTAINMENT SYSTEM PRODUCT, PART NO. 8326-040AA OR 8326-060AA OR EQUAL, INSTALLED PER MANUFACTURER'S RECOMMENDATIONS.

c. STAINLESS STEEL SPLIT SLEEVE PRODUCT INSTALLED AROUND THE EXISTING PIPE AND POSITIONED IN THE FORM TO CENTER THE UTILITY PIPE. AFTER INSTALLATION, THE MANUFACTURER'S RECOMMENDED MATERIAL IS USED TO SEAL THE ANNULAR SPACE BETWEEN THE SPLIT SLEEVE AND PIPE. USE PIPE SEAL AND INSULATOR INC., WS SPLIT SEALWALL SLEEVE, OR EQUAL.

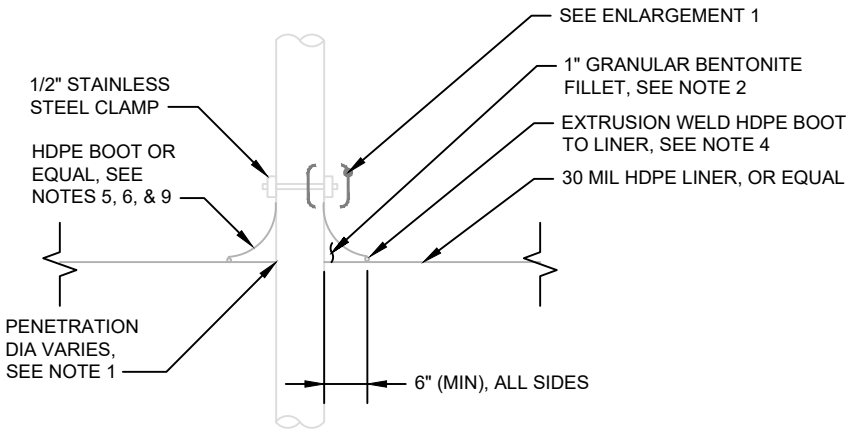
EXISTING UTILITY COORDINATION NOTES:

1. THE DESIGNER SHALL LOCATE ALL EXISTING UTILITIES WITHIN THE PROJECT AREA TO THE MOST PRACTICAL EXTENT POSSIBLE UTILIZING SITE SURVEYS, AS-BUILT PLANS, SITE INVESTIGATIONS, POTHOLING, UTILITY AGENCY DATA, ETC. AND PRESENT THIS INFORMATION AND SOURCE (I.E. AS-BUILT VS. ASSUMED LOCATION) CLEARLY ON THE DESIGN DRAWINGS. THE ASSUMED LOCATION OF EXISTING UTILITIES SHALL BE PROVIDED IN THE SAME COORDINATE SYSTEM AS THE REST OF THE DESIGN DRAWINGS. DESIGN DRAWINGS SHALL ALSO INCLUDE CONTACT INFORMATION FOR ANY UTILITIES AFFECTED BY THE PROJECT.
2. IF AN EXISTING UTILITY HAS THE POTENTIAL TO IMPACT THE PROJECT DESIGN AND/OR THE PERFORMANCE OF THE GI FACILITY, THE EXACT LOCATION, DEPTH, AND CONDITION OF THIS UTILITY SHOULD BE FIELD VERIFIED DURING THE DESIGN PHASE (VIA POTHOLING OR OTHER APPROVED METHOD) TO PREVENT COSTLY REDESIGNS AND/OR PROJECT DELAYS DURING CONSTRUCTION.
3. THE CONTRACTOR SHALL VERIFY THE LOCATIONS AND DEPTH OF EXISTING UTILITIES AT THE START OF CONSTRUCTION PER THE PROJECT SPECIFICATIONS. ANY DISCREPANCIES BETWEEN THE EXISTING UTILITIES SHOWN IN THE DESIGN DRAWINGS AND THE ACTUAL FIELD CONDITIONS SHOULD BE COMMUNICATED TO THE ENGINEER IMMEDIATELY.
4. THE CHECK DAM SPACING AND HEIGHT SPECIFIED ON THE DESIGN PLANS MUST BE MAINTAINED. IF THE CHECK DAM PROTECTING THE EXISTING UTILITY WILL IMPACT THE CHECK DAM SPACING SPECIFIED ON THE PLANS, THE ENGINEER MUST EVALUATE ITS IMPACT ON THE HYDROLOGIC PERFORMANCE AND APPROVE THE VARIANCE. SEE **PC 2.1** AND **PC 2.2** FOR FURTHER DETAILS.

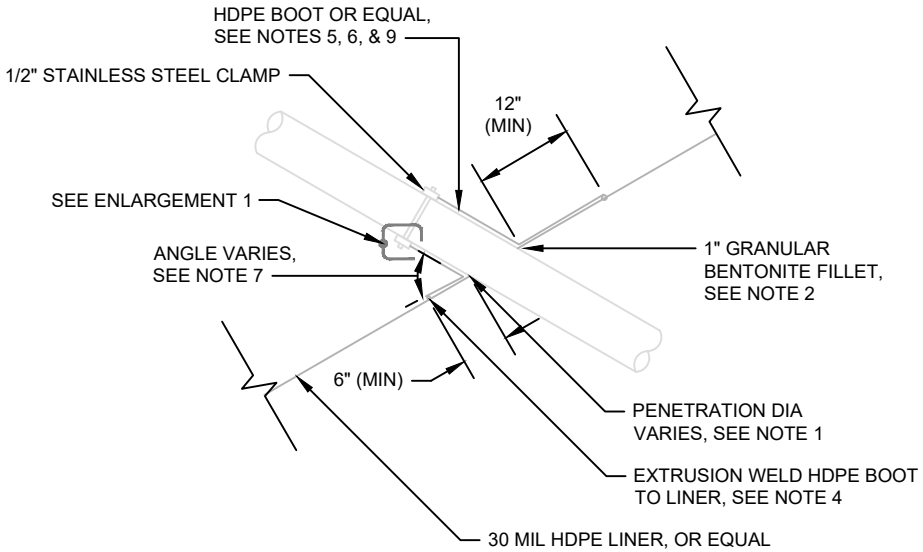
DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ LINER EMBEDMENT DEPTH INTO SUBGRADE SOILS
- ☐ PIPE AND SLEEVE MATERIALS AND DIAMETER FOR ALL WALL PENETRATIONS
- ☐ WALL PENETRATION TYPE (E.G., GROUTED, COMPRESSION, BOOT) SEE **GC 2.9 - 2.11**.
- ☐ GEOTEXTILE FABRICS AND/OR LINER MATERIALS
- ☐ ENGINEERED BACKFILL MATERIAL
- ☐ DIMENSIONS OF ALL PROTECTION MEASURES
- ☐ MINIMUM SETBACKS TO ADJACENT INFRASTRUCTURE, PAVEMENT BASES, SURFACES
- ☐ MINIMUM PIPE COVER AS REQUIRED BY UTILITY PROVIDER

NOT FOR CONSTRUCTION - REFER TO USER GUIDE



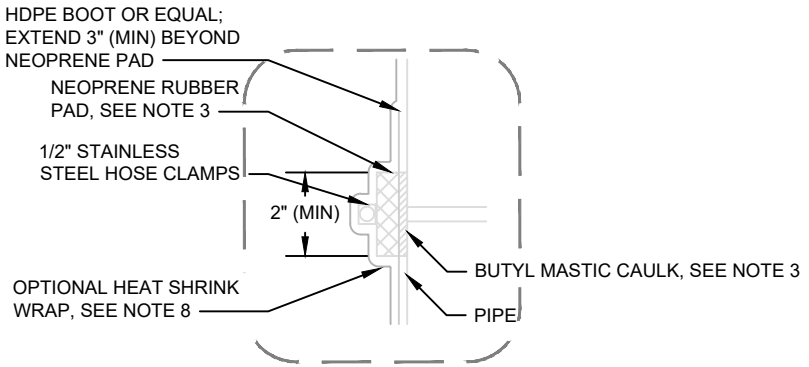
TYPICAL LINER PENETRATION - PERPENDICULAR (1)



TYPICAL LINER PENETRATION - ANGLED (2)

CONSTRUCTION NOTES:

1. CUT OPENING IN LINER FOR PIPE TO WITHIN 1/2" OF PIPE OUTSIDE DIAMETER.
2. FILL ANNULAR SPACE WITH 1" MINIMUM GRANULAR BENTONITE FILLET AS SHOWN.
3. APPLY BUTYL MASTIC CAULK AND NEOPRENE RUBBER PAD CONTINUOUSLY AROUND PIPE.
4. PROVIDE CONTINUOUS EXTRUSION WELD AT PIPE BOOT/LINER INTERFACE.
5. FORM BOOT WITH SUFFICIENT MATERIAL TO PREVENT OVERSTRESSING DURING BACKFILLING, BUT WITHOUT FOLDS OR WRINKLES.
6. CONSTRUCT BOOT FROM SAME MATERIAL AS THE LINER.
7. ANGLE SHOULD NOT BE LESS THAN 30°. IF ANGLE IS LESS THAN 30° ADD SOIL AROUND THE PIPE TO INCREASE THE ANGLE AND PREVENT STRESSING AND CRACKING.
8. SEAL CLAMP AND END OF BOOT WITH HEAT SHRINK WRAP. EXTEND HEAT SHRINK WRAP ONE PIPE DIAMETER (MINIMUM) BEYOND CLAMP.
9. CONTRACTOR MAY USE PREFABRICATED PIPE BOOTS IN LIEU OF FIELD-FABRICATED BOOTS. CONNECT PREFABRICATED BOOT TO LINER AND PIPE PER MANUFACTURER'S RECOMMENDATIONS.



ENLARGEMENT 1

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES		BIORETENTION			PERVIOUS PAVEMENT			WALL PENETRATIONS			TRENCH DAM
GC 2.1	GC 2.2	GC 2.3	GC 2.4	GC 2.5	GC 2.6	GC 2.7	GC 2.8	GC 2.9	GC 2.10	GC 2.11	GC 2.12

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.9

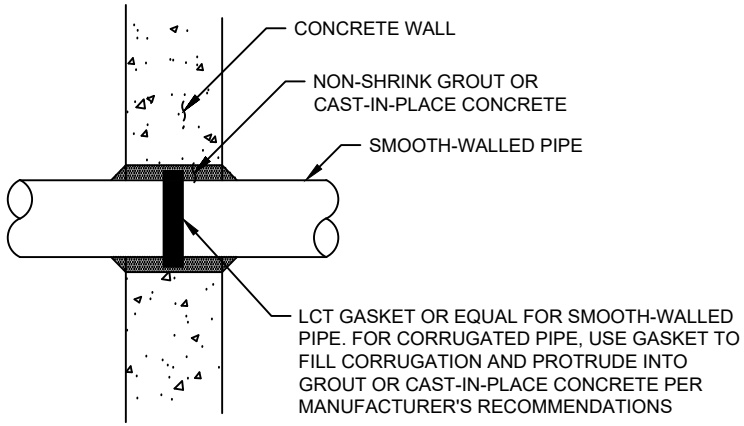
DATE: OCTOBER 2024
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GENERAL COMPONENTS

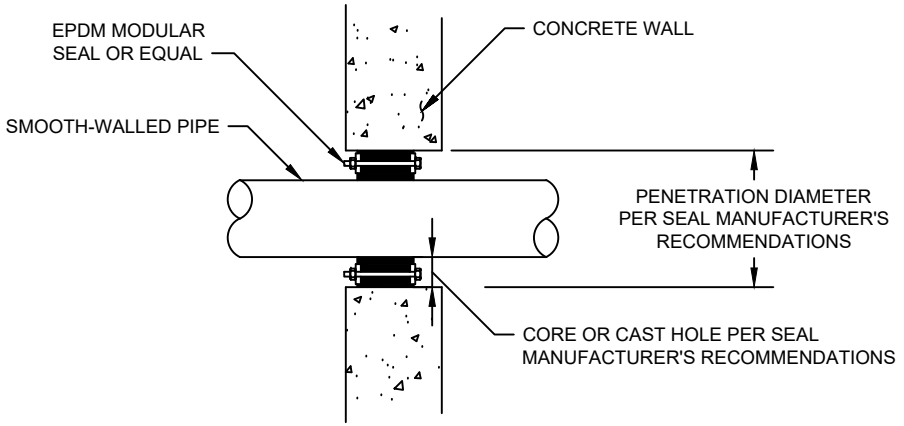
UTILITY CROSSINGS

LINER PENETRATIONS

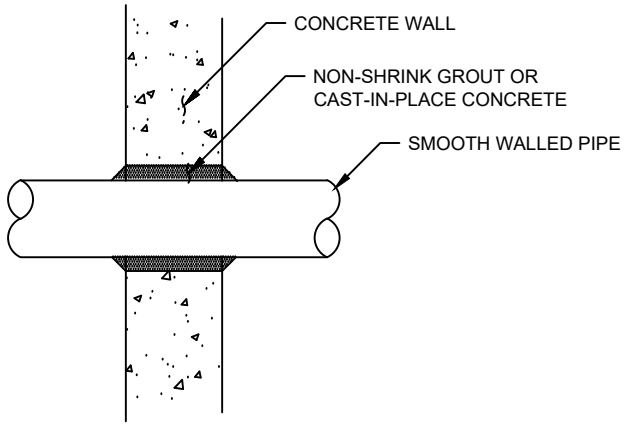
DWG NO. GC 2.9



TYPICAL WATERTIGHT WALL PENETRATION - ALTERNATE 1 (1)



TYPICAL WATERTIGHT WALL PENETRATION - ALTERNATE 2 (2)



TYPICAL SOIL TIGHT WALL PENETRATION (3)

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.10

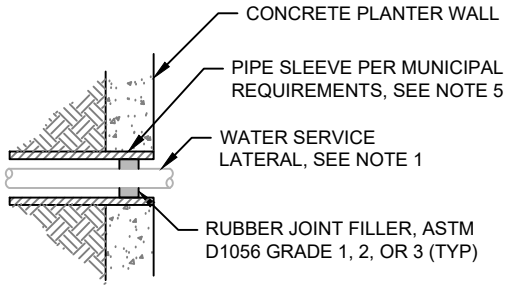
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VERSION: 1.0
REVISED:

GENERAL COMPONENTS

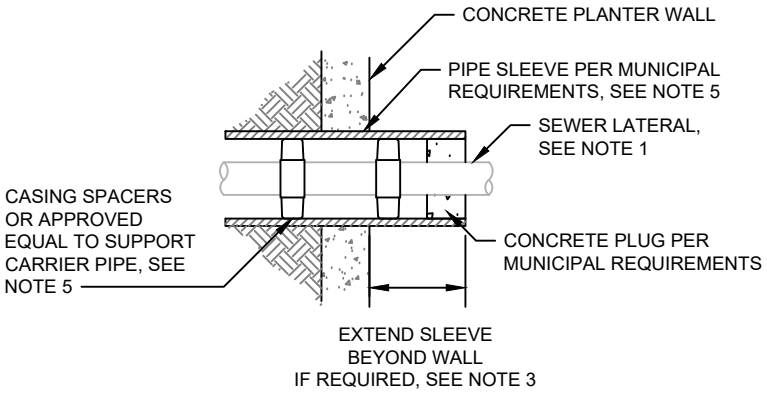
UTILITY CROSSINGS

WALL PENETRATIONS (1 OF 2)

DWG NO. GC 2.10



WALL PENETRATION FOR WATER LATERALS 1



WALL PENETRATION FOR SEWER LATERALS 2

CONSTRUCTION NOTES:

1. IN CASES WHERE SHALLOW EXISTING UTILITIES, SUCH AS STREET LIGHT CONDUIT, HAVE BEEN APPROVED TO REMAIN IN PLACE PER THE UTILITY PROVIDER, AND SLEEVING FROM ONE END IS NOT FEASIBLE, THE EXISTING UTILITIES SHALL BE CAREFULLY WRAPPED WITH AN INSULATION MATERIAL (MIN. 1" THICK) AND A WATERTIGHT TAPE UNTIL THE WALLS ARE FORMED AROUND THE PIPE CROSSINGS. ONCE THE WALLS ARE SET, THE INSULATION WRAP SHALL BE REMOVED AND THE WALL PENETRATIONS SEALED.
2. DETECTABLE UTILITY MARKING TAPE SHALL BE PLACED OVER ALL UTILITIES WITHIN THE FOOTPRINT OF BIORETENTION FACILITIES. REFER TO THE TAPE MANUFACTURER'S RECOMMENDATIONS FOR MAXIMUM TAPE BURIAL DEPTH.
3. IF SEWER LATERAL IS BELOW BOTTOM OF BIORETENTION FACILITY AND WALL PENETRATION IS NOT NECESSARY, THE MUNICIPALITY MAY REQUIRE THE SLEEVE AROUND NEW LATERAL PIPE TO BE EXTENDED BEYOND THE OUTSIDE OF THE PLANTER ON THE SIDEWALK SIDE. SEE DESIGN DRAWINGS FOR FURTHER DIRECTION.
4. ALL OTHER REPLACED OR NEW UTILITY SERVICES, SUCH AS GAS, TELECOM, ELECTRICAL, AND IRRIGATION RUNNING THROUGH A BIORETENTION FACILITY SHALL BE SLEEVED AND WALL PENETRATIONS SHALL BE DESIGNED TO MEET UTILITY PROVIDER'S REQUIREMENTS.
5. PIPE SLEEVE DESIGN AND MATERIALS, CONFORMING TO MUNICIPAL STANDARDS, SHALL BE SPECIFIED ON THE DESIGN DRAWINGS.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 2.11

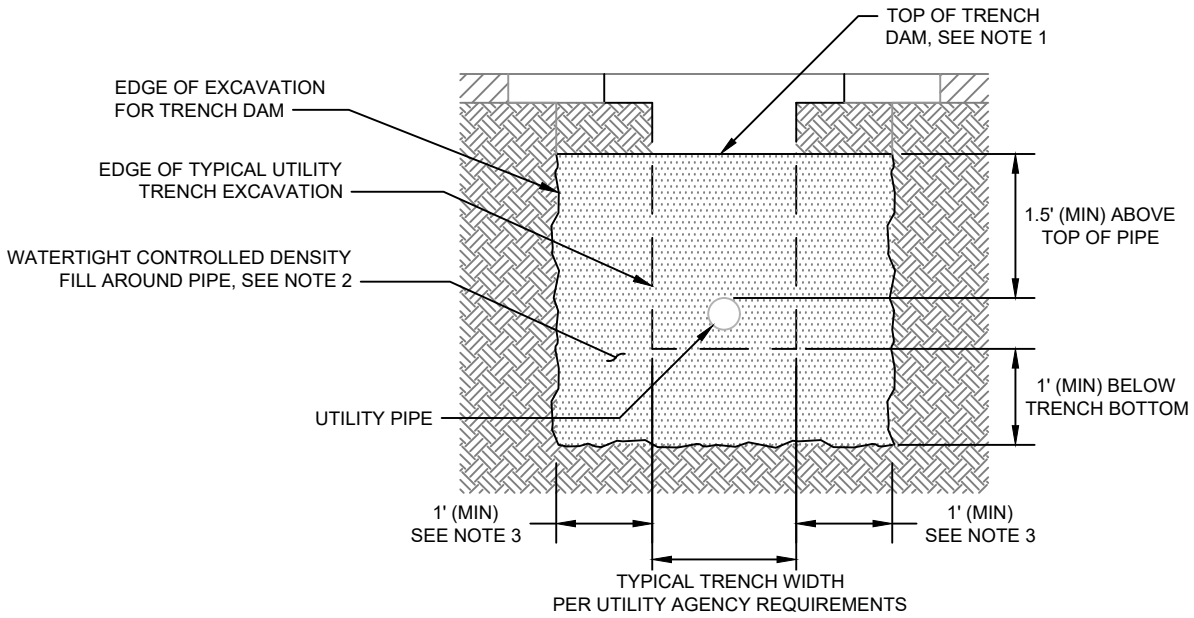
DATE: OCTOBER 2024
VERSION: 1.0
REVISED:

GENERAL COMPONENTS

UTILITY CROSSINGS

WALL PENETRATIONS (2 OF 2)

DWG NO. GC 2.11



UTILITY TRENCH DAM 1

CONSTRUCTION NOTES:

1. REFER TO DESIGN PLANS FOR TRENCH DAM LOCATIONS.
2. CONTROLLED DENSITY FILL SHALL BE 100 - 150 PSI STRENGTH WITH A WATER CONDUCTIVITY OF 1.0 X 10^{-6} CM/SEC (MAX).
3. TRENCH DAM SHALL EXTEND BEYOND THE EXISTING UTILITY TRENCH INTO THE NATIVE SOIL PER THE MINIMUM DIMENSIONS SHOWN. THE TRENCH DAM SHALL HAVE A MINIMUM THICKNESS OF 1' (MEASURED PARALLEL TO THE UTILITY PIPE LENGTH).

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

PURPOSE:

WHEN SITING GREEN INFRASTRUCTURE (GI) FACILITIES, THE DESIGNER SHOULD LOCATE AND ASSESS ALL KNOWN UTILITY CROSSINGS AND CONFLICTS AND ADJUST THE DESIGN TO AVOID AS MANY EXISTING UTILITIES, LIGHTS, POLES, SIGNS AND OTHER INFRASTRUCTURE AS POSSIBLE. THE CRITICALITY OF INFRASTRUCTURE CONFLICTS IN TERMS OF THEIR POTENTIAL IMPACT TO THE GI PROJECT'S DESIGN PERFORMANCE, COST, AND SCHEDULE SHOULD BE CAREFULLY EVALUATED DURING THE PLANNING PHASE.

THE PURPOSE OF THE FOLLOWING TYPICAL UTILITY CONFLICT DETAILS IS TO ALERT THE DESIGNERS TO COMMON UTILITY CONFLICTS THAT OCCUR ON GI PROJECTS WITHIN THE PUBLIC RIGHT-OF-WAY AND PROVIDE GENERAL GUIDANCE ON THE PROTECTION AND/OR RELOCATION OF THESE UTILITIES IN RELATION TO THE GI FACILITY. THEY ARE PROVIDED AS TYPICAL APPLICATIONS AND DO NOT REPRESENT APPROVED CITY UTILITY STANDARDS AND SPECIFICATIONS.

DESIGNER NOTES AND GUIDELINES:

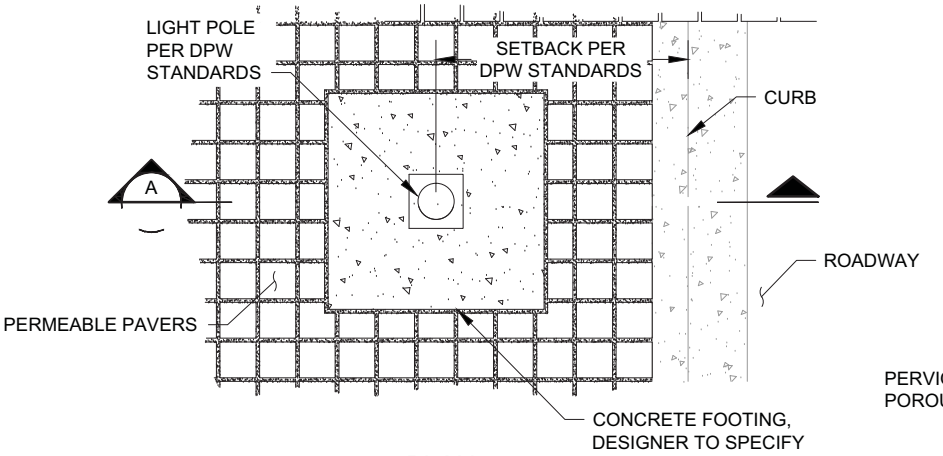
1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS AND UTILITY REQUIREMENTS AND OBTAIN APPROVAL FROM ALL RELEVANT UTILITY PROVIDERS PRIOR TO CONSTRUCTION. COORDINATION AND APPROVAL FROM THE FOLLOWING UTILITY PROVIDERS MAY BE NECESSARY, BUT NOT EXCLUSIVELY:
   - SFPUC CITY DISTRIBUTION DIVISION (CDD) FOR DOMESTIC/RECYCLED/FIRE WATER
   - SFPUC WASTEWATER ENTERPRISE (WWE) FOR SANITARY/STORM/SEWER
   - PACIFIC GAS ELECTRIC (PGE) FOR ELECTRIC/GAS/UTILITY POLES
   - SAN FRANCISCO PUBLIC WORKS FOR TRAFFIC SIGNAL/LIGHT POLE
   - SFMTA FOR STREET SIGNS/PARKING METERS/BUS STOP, CATENARY POLES
2. MINIMUM UTILITY SETBACKS AND PROTECTION MEASURES MUST CONFORM TO CURRENT SFPUC ASSET PROTECTION STANDARDS.
3. THE AREA OF SUBBASE COVERED BY THE INFRASTRUCTURE FOOTINGS, COMPACTED ENGINEERED FILL, CONCRETE PADS AND OTHER UTILITY INFRASTRUCTURE SHOULD BE EXCLUDED FROM HYDROLOGIC PERFORMANCE CALCULATIONS WHEN THE AREA IS SIGNIFICANT (GREATER THAN 10 PERCENT) RELATIVE TO THE INFILTRATIVE AREA.
4. DESIGNER TO SPECIFY CONCRETE FOOTING DIMENSIONS AND REINFORCEMENT FOR ALL VERTICAL INFRASTRUCTURE.
5. SEE SAN FRANCISCO PUBLIC WORKS TRAFFIC LIGHT STANDARDS FOR REQUIRED SETBACKS FROM CURBS, GUARD POSTS REQUIREMENTS, AND FOOTING DESIGN STANDARDS.
6. ALL STREET SIGN PLACEMENTS SHALL BE APPROVED BY SFMTA PRIOR TO INSTALLATION.
7. ALL PARKING METER INSTALLATIONS OR RELOCATION DESIGNS SHALL CONFORM TO SFMTA STANDARDS.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

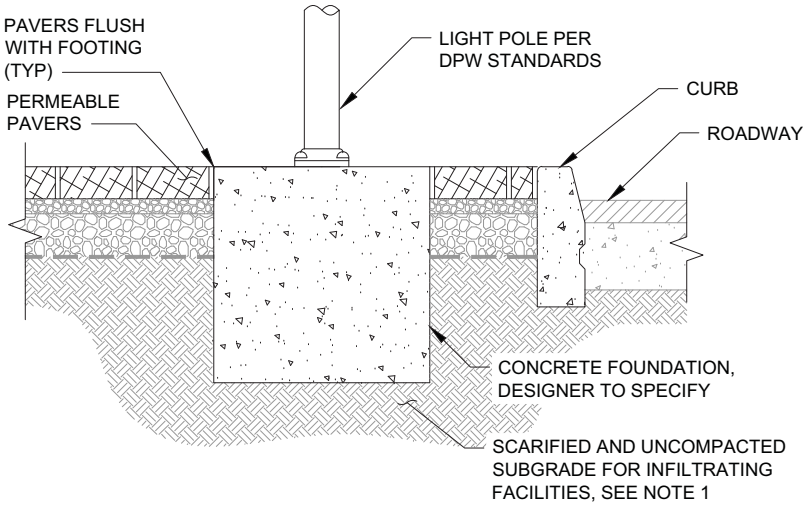
- ☐ STREET LIGHT, SIGN, AND UTILITY POLE FOUNDATION DIMENSIONS, REINFORCEMENT, AND SPECIFICATIONS
- ☐ GEOTEXTILE FABRICS AND/OR LINER MATERIALS
- ☐ ENGINEERED BACKFILL MATERIAL
- ☐ DIMENSIONS OF ALL PROTECTION MEASURES
- ☐ MINIMUM SETBACKS TO ADJACENT INFRASTRUCTURE, PAVEMENT BASES, SURFACES

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES	COMPONENTS		
GC 3.1	GC 3.2	GC 3.3	GC 3.4

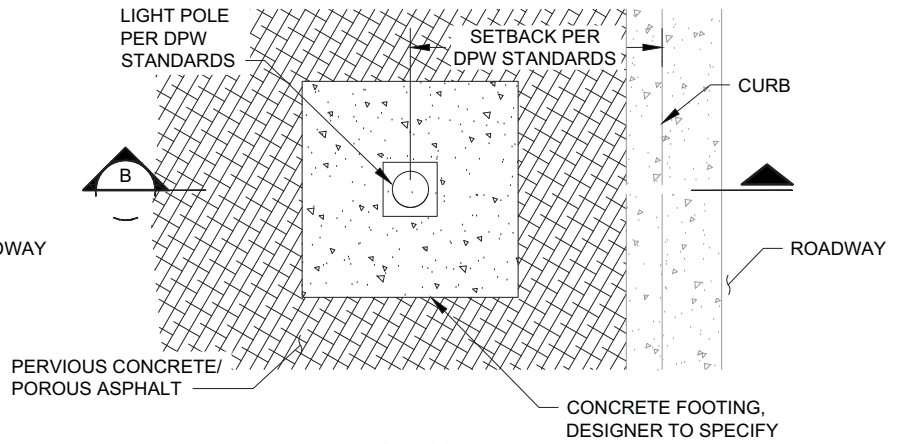


PLAN

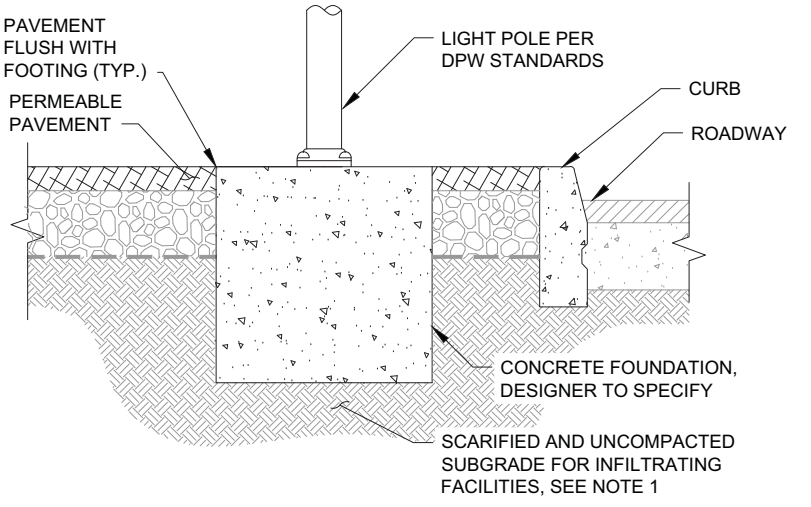


SECTION A

UTILITY POLE AT PERMEABLE PAVEMENT 1



PLAN



SECTION B

UTILITY POLE AT PERVIOUS CONCRETE/POROUS ASPHALT 2

CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW PERMEABLE PAVEMENT DURING CONSTRUCTION.

NOTES	COMPONENTS		
GC 3.1	GC 3.2	GC 3.3	GC 3.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

San Francisco Water Power Sewer

GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

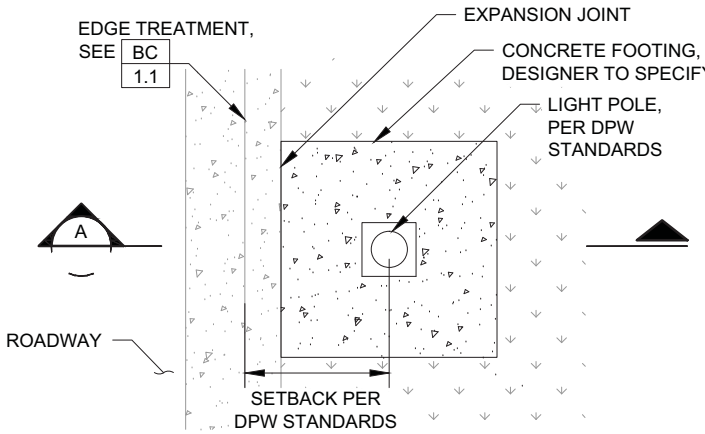
DATE SEPTEMBER 2016
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GENERAL COMPONENTS

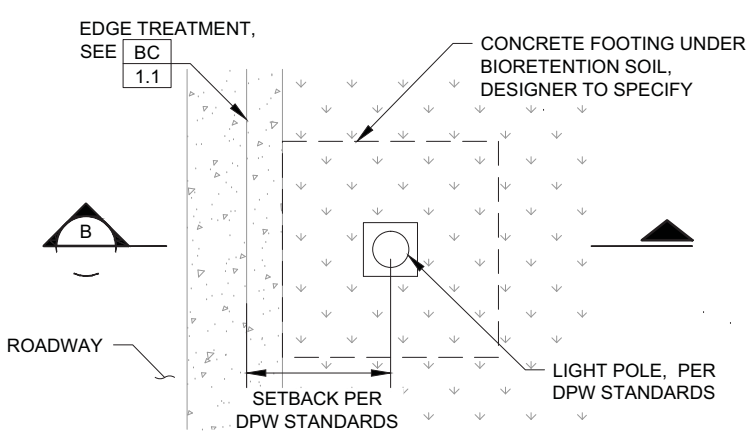
UTILITY CONFLICTS

STREET/TRAFFIC LIGHT POLES (1 OF 2)

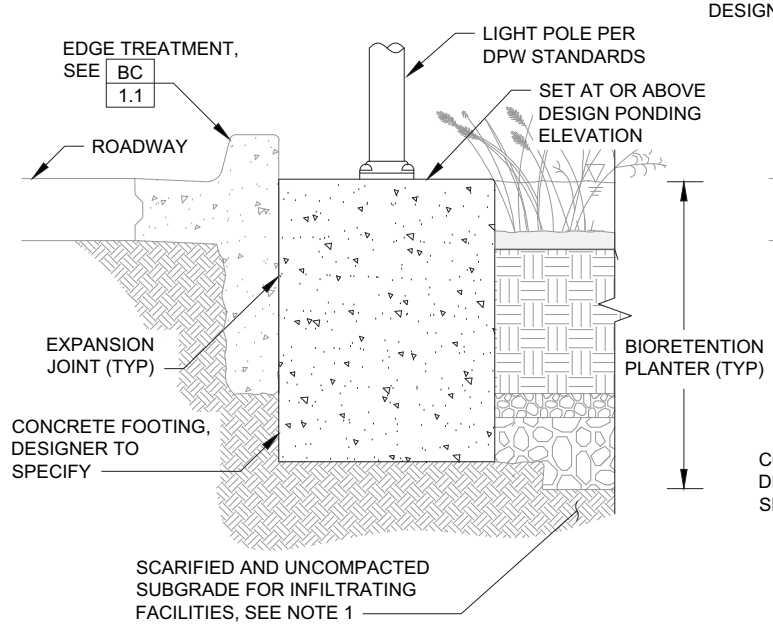
DWG NO. GC 3.2



PLAN

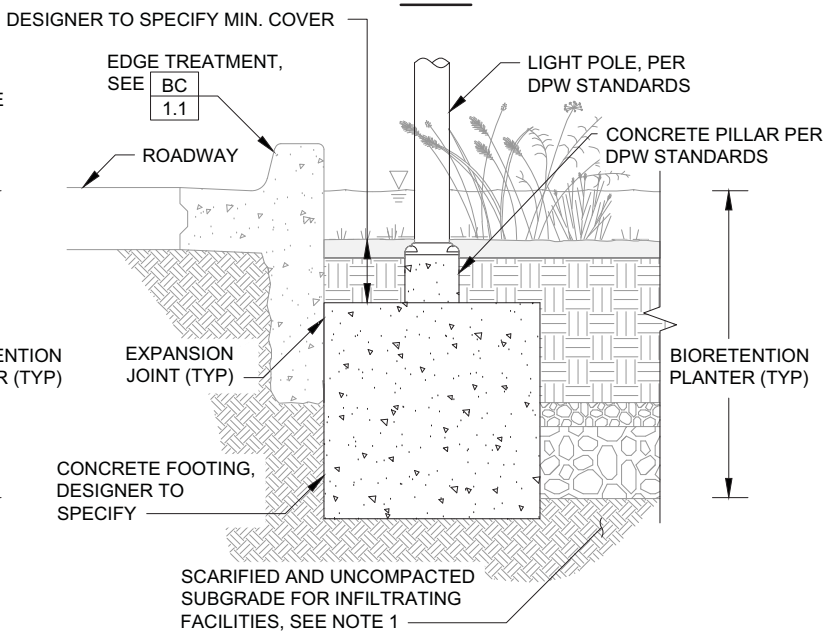


PLAN



SECTION A

UTILITY POLE AT PLANTER 1



SECTION B

UTILITY POLE AT PLANTER 2

CONSTRUCTION NOTES:

1. AVOID COMPACTION OF EXISTING SUBGRADE BELOW INFILTRATION FACILITIES DURING CONSTRUCTION.

NOTES	COMPONENTS		
GC 3.1	GC 3.2	GC 3.3	GC 3.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

San Francisco Water Power Sewer

GREEN INFRASTRUCTURE TYPICAL DETAILS

SAN FRANCISCO PUBLIC UTILITIES COMMISSION

DATE SEPTEMBER 2016

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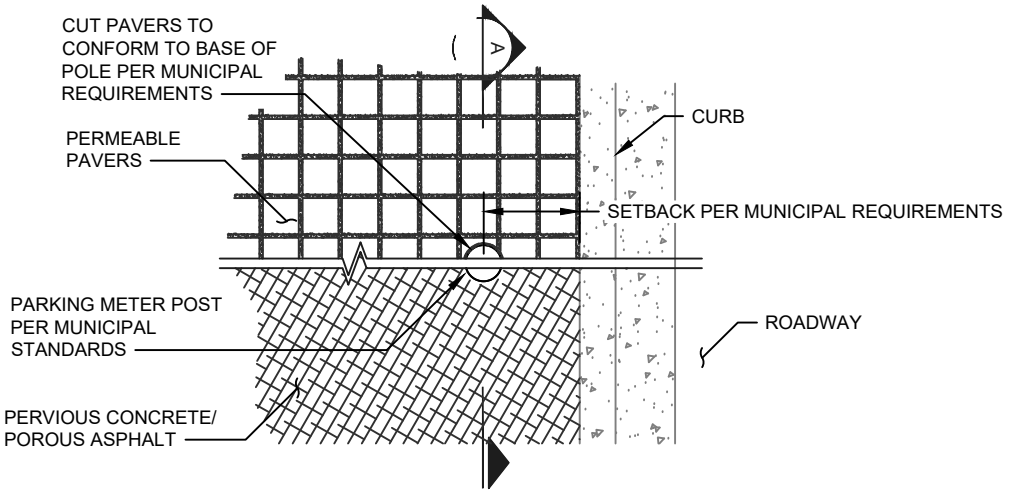
REVISED

GENERAL COMPONENTS

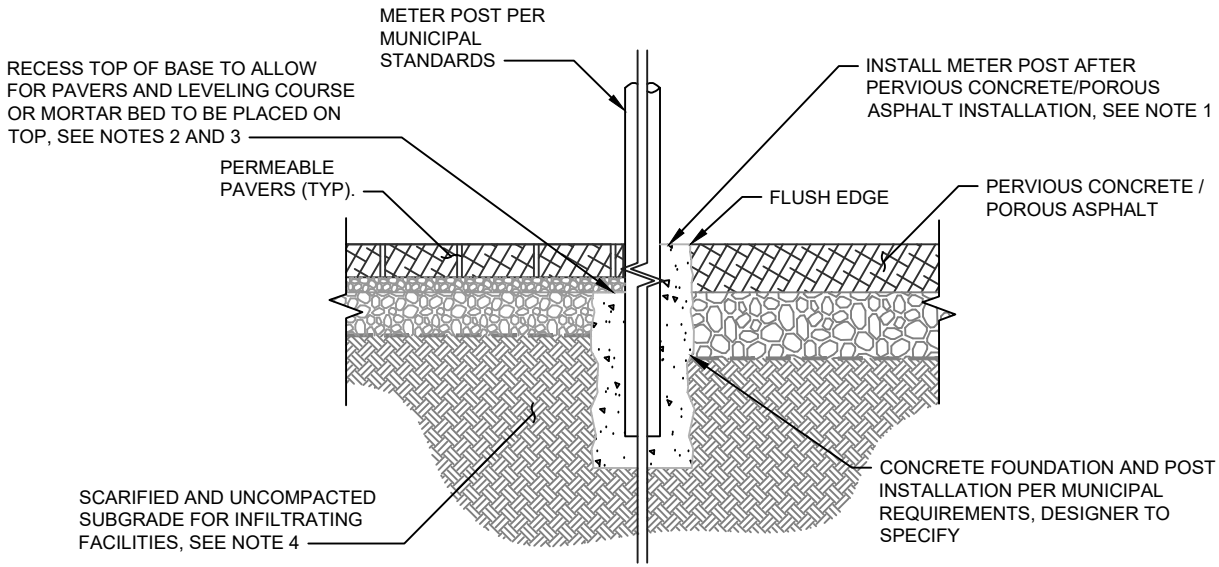
UTILITY CONFLICTS

STREET/TRAFFIC LIGHT POLES (2 OF 2)

DWG NO. GC 3.3



PLAN



SECTION A

PARKING METER AT PERVIOUS PAVEMENT (1)

CONSTRUCTION NOTES:

1. DUE TO THE ADDED COMPLEXITY OF INSTALLING PERVIOUS CONCRETE AND POROUS ASPHALT AROUND NUMEROUS POLES/POSTS, IT IS RECOMMENDED POST HOLES BE DRILLED OUT AFTER THE PERVIOUS CONCRETE/POROUS ASPHALT HAS CURED. IF POLES ARE INSTALLED PRIOR TO THE PLACEMENT OF PERVIOUS CONCRETE/POROUS ASPHALT, THE CONTRACTOR SHALL COORDINATE WITH THE DESIGNER ON HOW THE PERVIOUS CONCRETE/POROUS ASPHALT SHALL BE INSTALLED AROUND AND/OR OVER THE POLE BASES.
2. WHERE METER POLES ARE SHOWN WITHIN A PERMEABLE PAVER AREA, THE BASES OF THE POLES SHALL BE INSTALLED BEFORE THE PAVER INSTALLATION. THE DESIGNER MAY SPECIFY THAT THE TOP OF THE BASES BE SET (OR CUT DOWN) AT A DEPTH THAT ALLOWS THE PAVERS AND LEVELING COURSE TO COVER THE TOP OF THE BASE AND REMAIN FLUSH WITH THE SURROUNDING PAVEMENT.
3. INSTALL PERVIOUS PAVEMENT OVER TOP OF FOOTING PER PROJECT SPECIFICATIONS AND MANUFACTURER'S RECOMMENDATIONS.
4. AVOID OVER-COMPACTION OF EXISTING SUBGRADE BELOW PERVIOUS PAVEMENT DURING CONSTRUCTION.

NOTES	COMPONENTS		
GC 3.1	GC 3.2	GC 3.3	GC 3.4

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 3.4

DATE: OCTOBER 2024
VERSION: 1.0
REVISED:

GENERAL COMPONENTS

UTILITY CONFLICTS

PARKING METERS

DWG NO. GC 3.4

PURPOSE:

OBSERVATION PORTS ALLOW FOR MEASUREMENT OF DRAWDOWN THROUGH A FACILITY (WHEN WATER LEVEL MEASUREMENTS ARE NOT OBSERVABLE AT THE SURFACE). THESE PORTS CAN ALSO BE USED FOR LONG-TERM MONITORING WITH A PRESSURE TRANSDUCER. FOR SYSTEMS INCLUDING UNDERDRAINS, CLEANOUTS MAY SERVE AS THE FACILITY OBSERVATION PORT PROVIDED LONG-TERM MONITORING IS NOT REQUIRED FOR THE FACILITY.

DESIGNER NOTES & GUIDELINES:

1. THE DESIGNER MUST ADAPT DRAWINGS TO ADDRESS SITE-SPECIFIC CONDITIONS.
2. OBSERVATION PORTS WITHIN A BIORETENTION FACILITY ARE NOT REQUIRED TO INCLUDE A SEPARATE LOCKING COVER ASSEMBLY. HOWEVER, DESIGNERS SHOULD CONSIDER REQUIRING A LOCKING OBSERVATION PORT CAP OR PLUG IF THE RISK OF TAMPERING IS CONSIDERED TO BE HIGH.
3. WHENEVER FEASIBLE, OBSERVATION PORTS SHOULD BE LOCATED OUTSIDE OF THE TRAVELED WAY. IF SITE CONSTRAINTS NECESSITATE INSTALLATION OF OBSERVATION PORTS IN AN AREA SUBJECT TO VEHICULAR TRAFFIC OR OTHER LOADING, OBSERVATION PORT COVER ASSEMBLIES AND MANHOLES MUST BE DESIGNED TO WITHSTAND ANTICIPATED LOADING (E.G., H-20).
4. OBSERVATION PORTS SHOULD INCLUDE A 12 INCH WATERTIGHT SUMP TO ACCOMMODATE CONTINUOUS WATER LEVEL MEASUREMENT WITH A PRESSURE TRANSDUCER.
5. FOR ADDITIONAL DESIGN PARAMETERS, DESIGN CONSIDERATIONS, AND SIZING GUIDANCE, REFER TO THE SCVURPPP C.3 STORMWATER HANDBOOK, CHAPTERS 5 AND 6.

DESIGNER CHECKLIST (MUST SPECIFY, AS APPLICABLE):

- ☐ OBSERVATION PORT MATERIAL, DIAMETER, AND DEPTH
- ☐ OBSERVATION PORT COVER ASSEMBLY/MANHOLE TYPE AND SIZE (IF APPLICABLE)
- ☐ CONTROL ELEVATIONS FOR OBSERVATION PORT RIMS
- ☐ TYPE OF MONITORING EQUIPMENT TO BE INSTALLED (IF APPLICABLE)

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

NOTES	COMPONENTS	
GC 4.1	GC 4.2	GC 4.3

Santa Clara Valley *Urban Runoff* Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

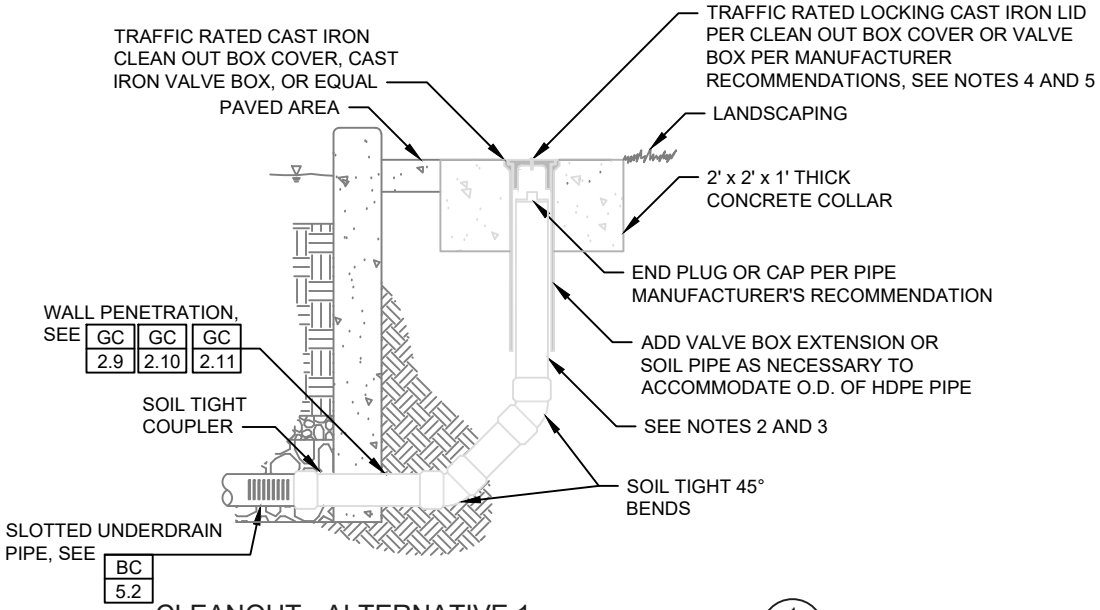
DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTIILTIES COMMISSION GC 4.1

DATE: OCTOBER 2024
VERSION: 2.0
REVISED:

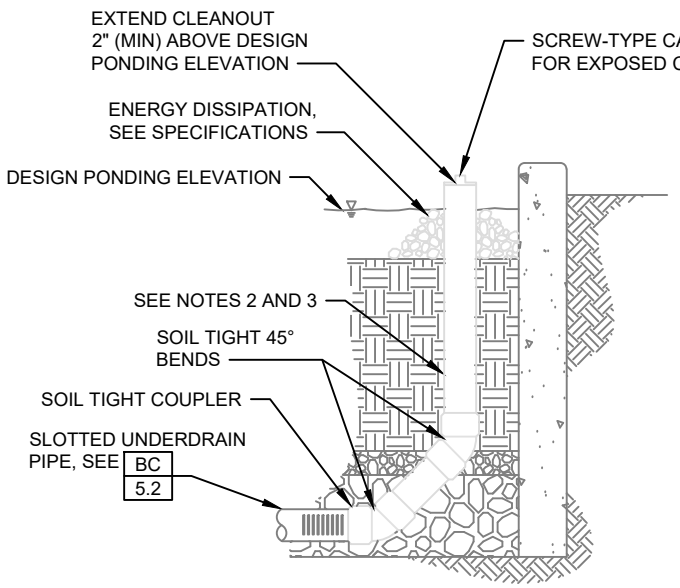
GENERAL COMPONENTS

OBSERVATION PORT DESIGNER NOTES

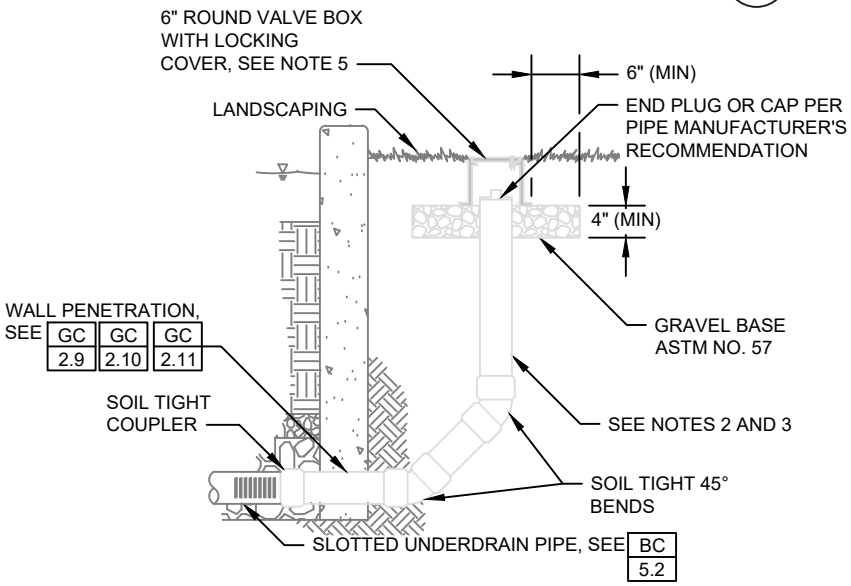
DWG NO. GC 4.1



CLEANOUT - ALTERNATIVE 1 (1)



CLEANOUT - ALTERNATIVE 2 (2)



CLEANOUT - ALTERNATIVE 3 (PARCEL ONLY) (3)

CONSTRUCTION NOTES:

1. ALL MATERIAL AND WORKMANSHIP FOR CLEANOUTS SHALL CONFORM TO MUNICIPAL STANDARD SPECIFICATIONS AND APPLICABLE CODES.
2. CLEANOUT PIPE AND FITTINGS SHALL BE OF THE SAME SIZE AND MATERIAL AS UNDERDRAIN PIPE.
3. COVER SHALL BE TRAFFIC RATED WITH TAMPER RESISTANT LOCKING MECHANISM. COVER SHALL INCLUDE CASTING OF "CO" OR EQUAL.
4. CLEANOUT COVERS AND LIDS MUST COMPLY WITH MUNICIPAL STANDARD ACCESSIBILITY REQUIREMENTS.
5. CLEANOUT SHALL BE INSTALLED TO ALLOW FOR MAINTENANCE ACCESS TO ALL PIPES.
6. ALL FITTINGS SHALL BE SOIL TIGHT.

NOT FOR CONSTRUCTION - REFER TO USER GUIDE

Santa Clara Valley Urban Runoff Pollution Prevention Program

GREEN INFRASTRUCTURE TYPICAL DETAILS

DETAIL ADAPTED FROM SAN FRANCISCO PUBLIC UTILITIES COMMISSION GC 5.1

DATE: OCTOBER 2024
VERSION: 1.0
REVISED:

GENERAL COMPONENTS
CLEANOUTS

DWG NO. GC 5.1

1.1.1 Fencing



Description

Fencing used for area protection includes short, rigid fencing that can be placed around a stormwater management practice (SMP) to provide a visual and tactile alert for pedestrians.

Specifications

- Top of fencing must be a minimum of 18-inches above the surrounding grade.
- Fencing must include vertical pickets with a maximum spacing of 4-inches.

Additional Considerations/Options

There are a variety of materials that can be used for fencing such as wrought iron, aluminum, or other materials. It can also be of a variety of colors, shapes, and patterns and can add a decorative appearance to an SMP.

Additional Considerations

Not applicable.

Applicability

May use where area protection is required around an SMP in the sidewalk area including stormwater planters and stormwater trees or on sidewalk side of stormwater bump-outs.

Submittal Requirements

In all cases, submit details of proposed fencing including manufacturer, product number, materials, painting specifications, fastener details, and proposed post anchoring for review and approval.

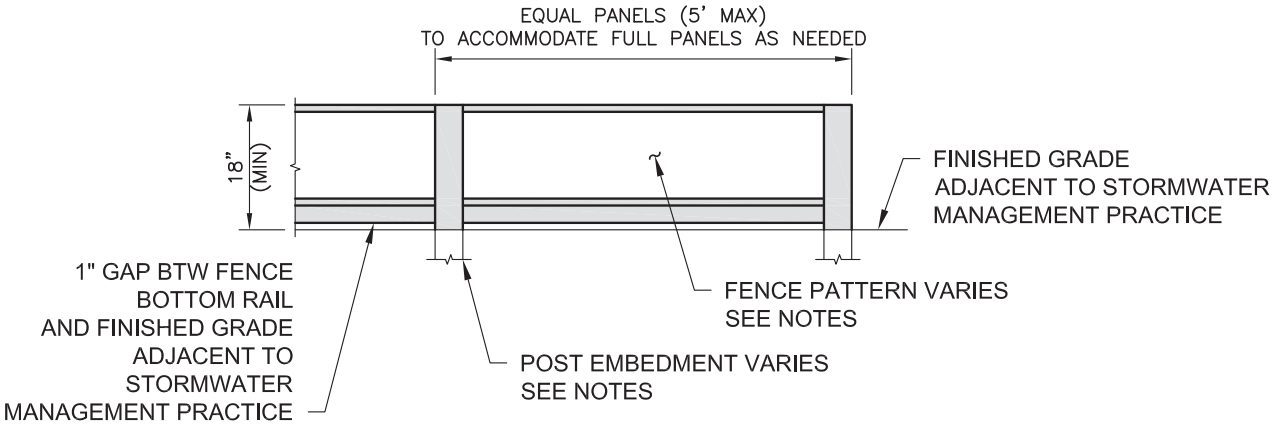
References

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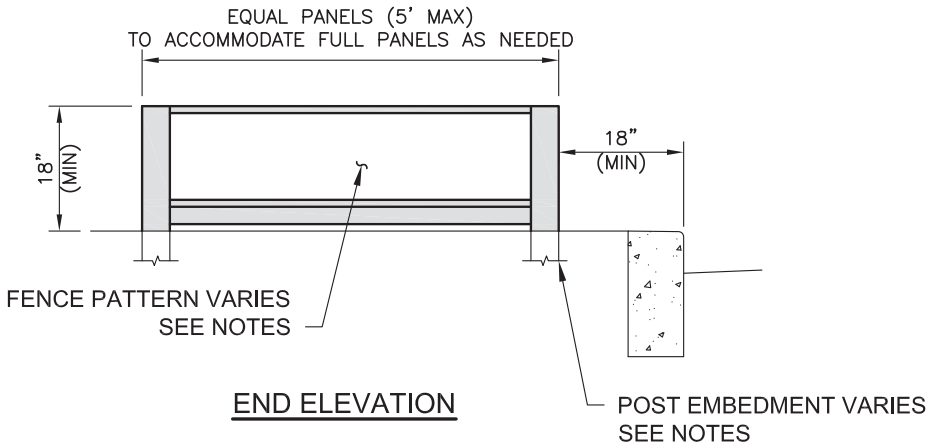
Attachments

- Fencing detail

AP



FRONT ELEVATION



END ELEVATION

NOTES:

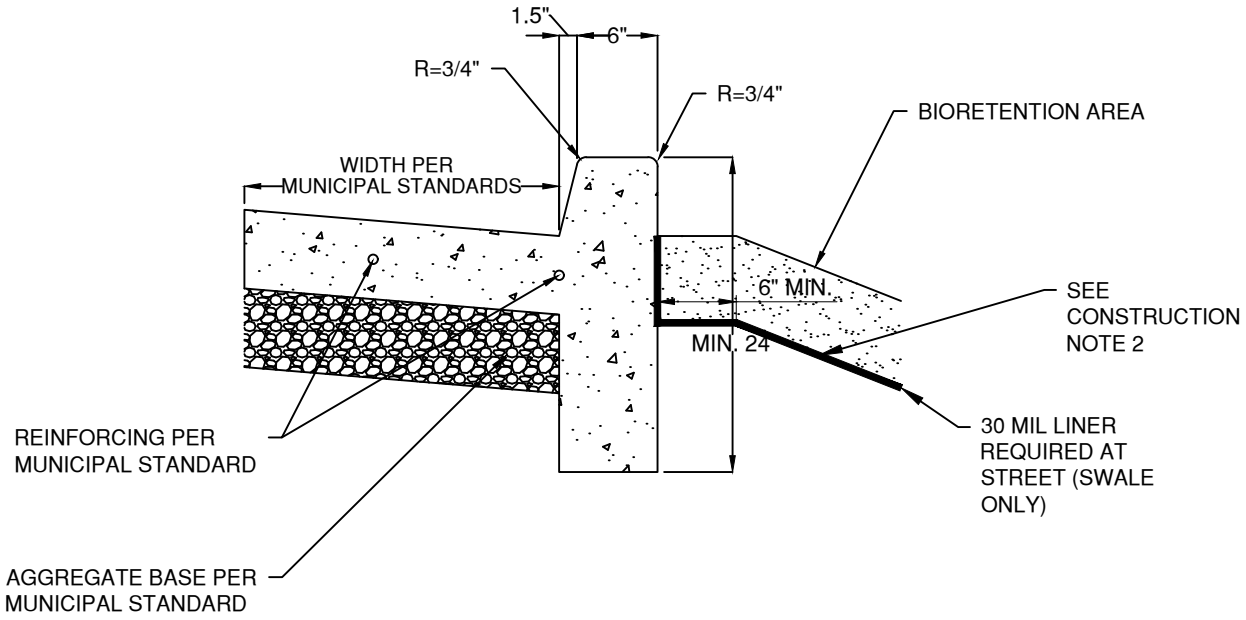
1. SPECIFIC FENCE PATTERN, POST/RAIL DIMENSIONS, MATERIALS, COLOR, JOINTS, AND OTHER FENCE DETAILS SHALL BE SPECIFIED BY DESIGNER FOR REVIEW AND APPROVAL BY PWD.

2. POSTS MAY BE EMBEDDED IN SIDEWALK SURROUNDING STORMWATER MANAGEMENT PRACTICE (SMP) OR WITHIN THE PLANTING MEDIA OF THE SMP. SPECIFIC EMBEDDMENT OF POST SHALL BE DESIGNED FOR SPECIFIC SITE CONDITIONS.

Green Streets

2014

FENCING



DESIGN NOTES

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

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

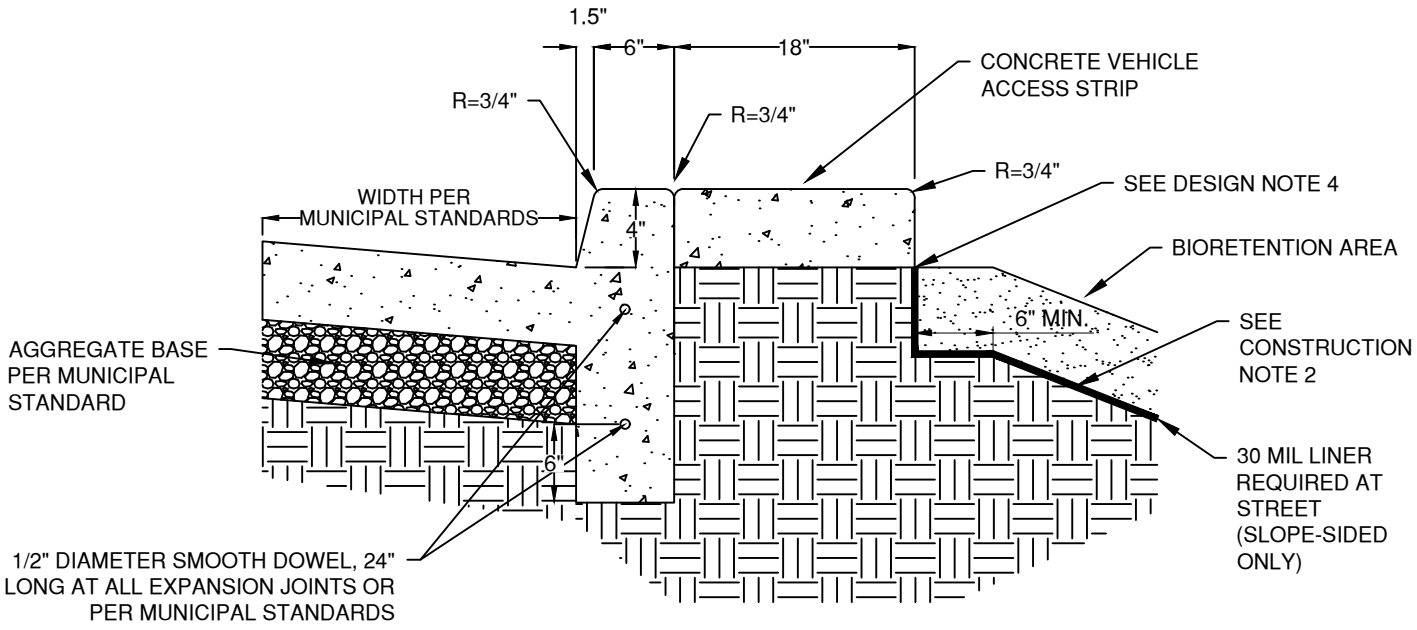
3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.

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

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

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

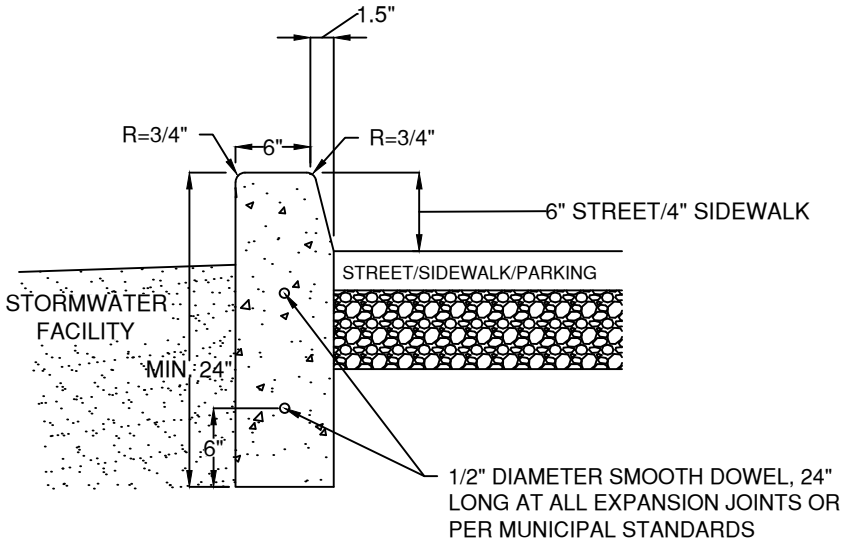


DESIGN NOTES

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

CONSTRUCTION NOTES

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



DESIGN NOTES

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

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

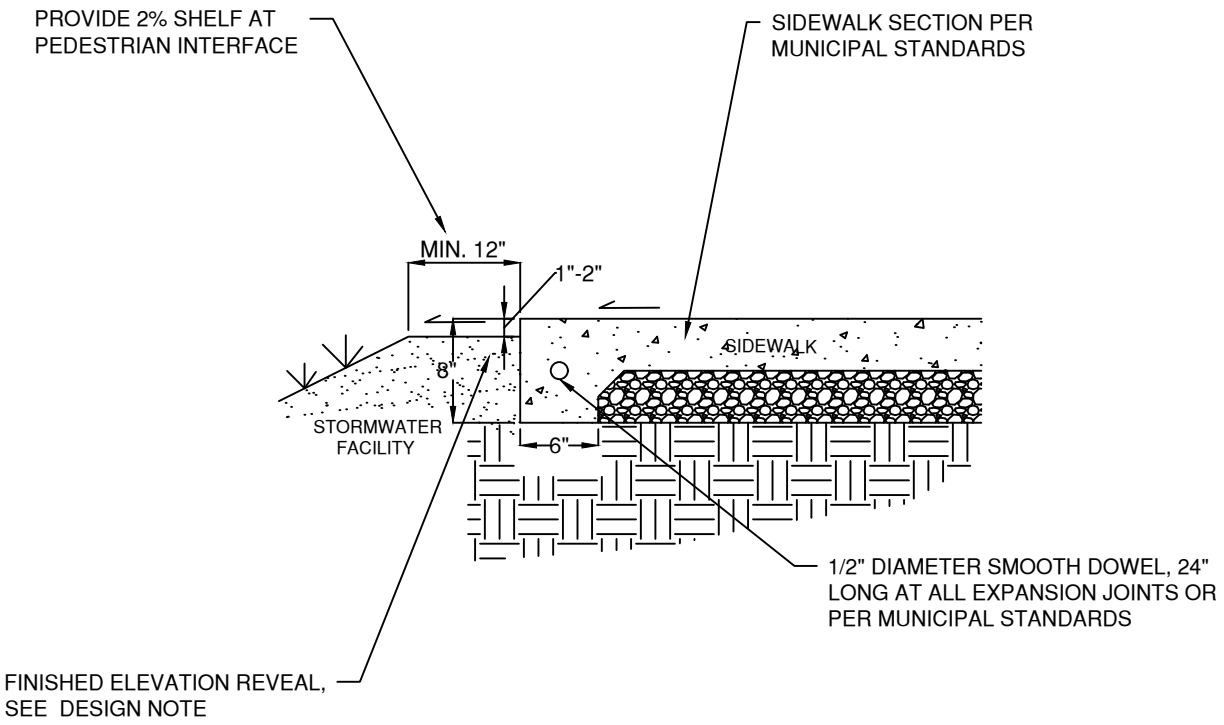
3. CONCRETE AND EXPANSION JOINTS SHALL MEET THE REQUIREMENTS OF THE MUNICIPALITY.

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

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

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



DESIGN NOTES

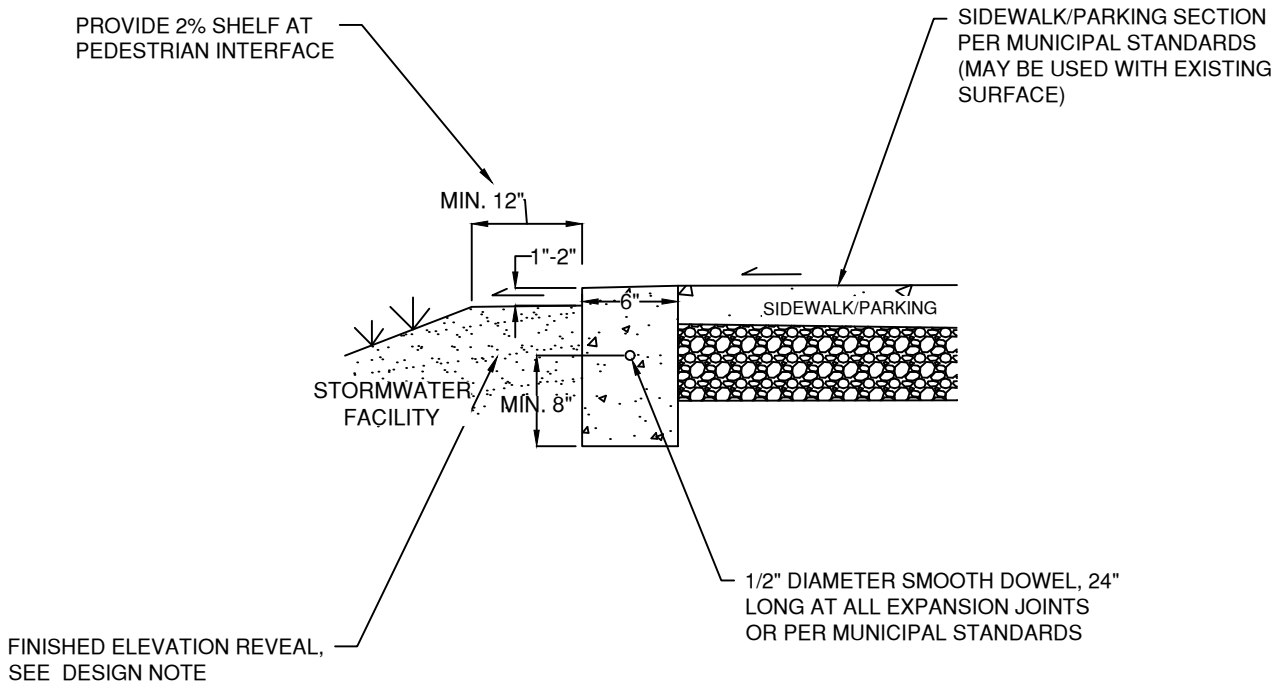
1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER FACILITY EDGE SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.

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

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

CONSTRUCTION NOTES

1. FINISH ALL EXPOSED CONCRETE SURFACES.

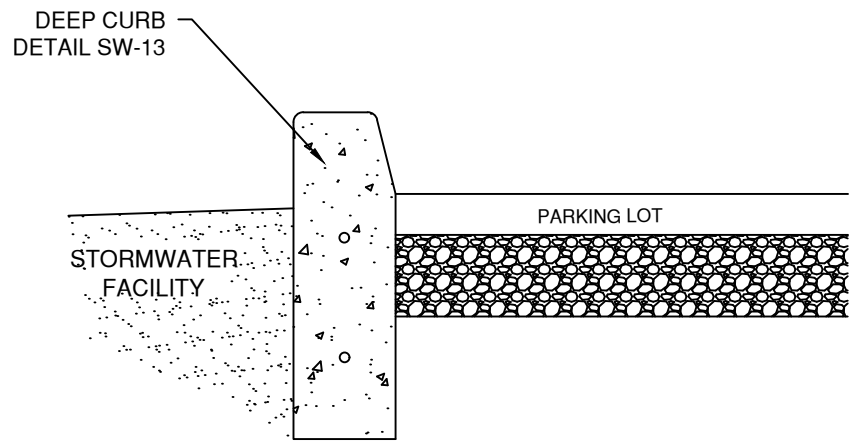


DESIGN NOTES

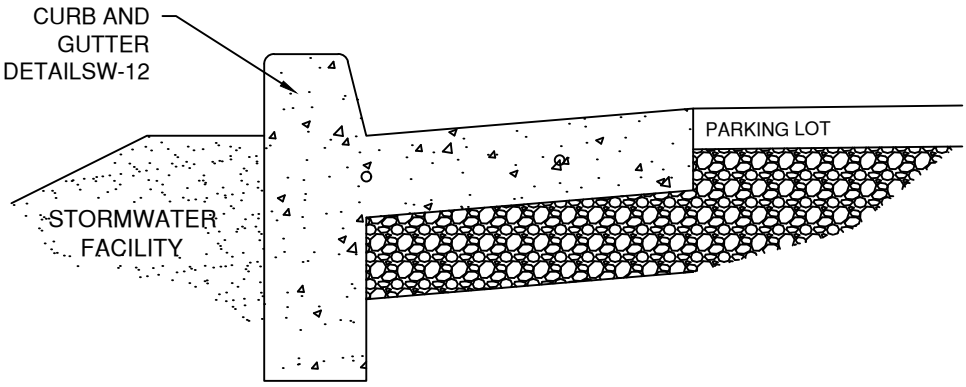
1. SPECIAL DESIGN CONSIDERATION OR STRUCTURAL REVIEW MAY BE REQUIRED FOR LONGER FACILITY EDGE SPANS. STEEL REINFORCEMENT OR ADDITIONAL CONCRETE CHECK DAMS MAY BE NEEDED FOR STABILITY.
2. EDGE CONDITION WILL VARY FOR PROJECTS. CURB DETAILS MAY BE MODIFIED BY CIVIL AND GEOTECHNICAL ENGINEERS SUBJECT TO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

CONSTRUCTION NOTES

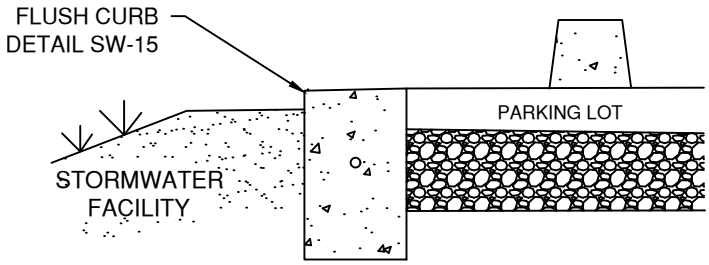
1. FINISH ALL EXPOSED CONCRETE SURFACES.



DEEP CURB



CURB AND GUTTER



FLUSH EDGE/WHEEL STOPS

DESIGN NOTES

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

LOW IMPACT DEVELOPMENT STORMWATER MANAGEMENT STANDARD DETAILS

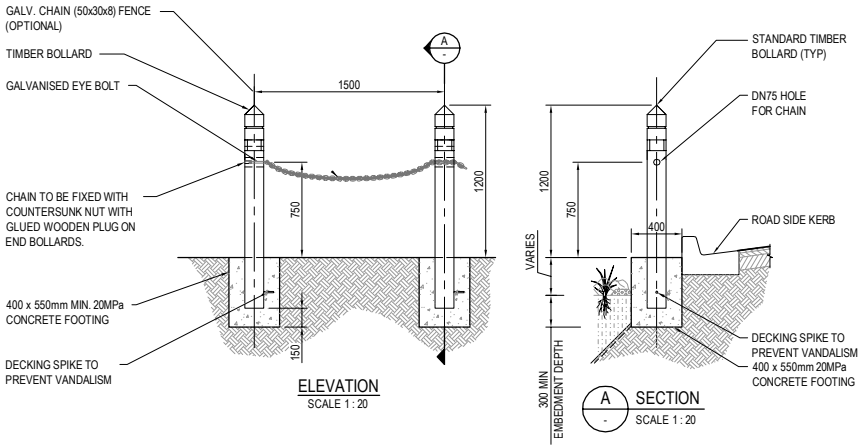
CASQA / central coast LIDI DEVELOPED UNDER PROP. 84 GRANT	APPROVED BY: VERSION: 08/31/2017	PARKING LOT EDGE OPTIONS USE WITH STANDARD SPECIFICATIONS FOR PUBLIC WORK CONSTRUCTION	STANDARD PLAN NO. SW-16 SHEET 1 OF 1



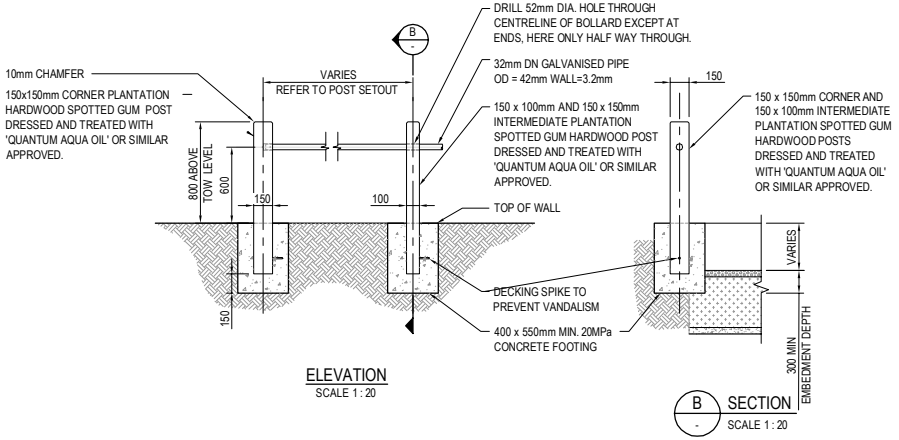
IMAGE
NTS



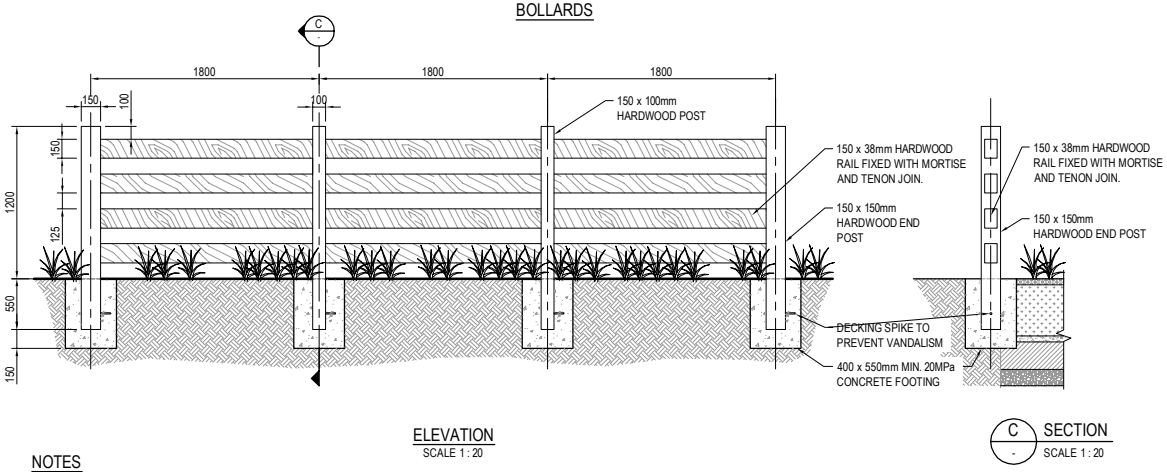
IMAGE
NTS



BOLLARDS



GALVANISED RAIL FENCE



1.2m HIGH TIMBER FENCE

NOTES

1. THE STANDARD DETAILS SHOWN ON THIS DRAWING ARE TYPICAL ONLY. THESE DETAILS MAY NEED TO BE RECONFIGURED TO SUIT SITE SPECIFIC CONDITIONS.



IMAGE
NTS

0 0.2 0.4 0.6 0.8 1.0m
SCALE 1:20 AT ORIGINAL SIZE

FOR ISSUE

rev	description	app'd	date
0	FOR ISSUE	SG	4/7/13

MORELAND CITY COUNCIL
WSUD MELBOURNE STANDARDS
RAINGARDEN
FENCING

Moreland City Council

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scale	1:20	for A4	
job no.	31-30117		
date	JULY 2013	rev no.	0

approved (PD) S. GRAHAM SK007

Chapter 3

Design Specifications

This Chapter provides typical design specifications and guidance for GSI measures discussed in Part 1 of this Handbook.

SCVURPPP has reviewed typical design specifications for Green Stormwater Infrastructure (GSI) measures from combined and separate storm sewer systems in the United States and has compiled applicable specifications for member agencies to reference, revise, and/or adopt as appropriate, for their GSI Plans and projects. The specifications provided are **TYPICAL** specifications rather than standard specifications and should be modified to match municipal codes and project conditions. These construction specifications are in addition to the design detail notes that are included with the design details referenced in Chapter 2.

To access PDFs of the specific design specifications or design guidance noted in the tables below you must first be viewing the electronic file of Part 2 that includes the Attachments. The table in Section 3-1 contains a list of design specifications and their contents. Click on the content category title to be directed to the first page of those specifications. The table in Section 3-2 contains design guidance that provides additional text and guidance for design details. Click on the design guidance category to be directed to the first page of that guidance.

3.1 Design Specifications

San Francisco Public Utilities Commission (2016)	***Word File Available***
Section 33 47 27 – Bioretention	Yes
Section 32 12 43 – Porous Asphalt Concrete	Yes
Section 32 13 43 – Pervious Concrete	Yes
Section 32 14 43 – Permeable/Porous Unit Pavers	Yes
Central Coast Low Impact Development Initiative (2013)	
Bioretention Technical Specifications	
BASMAA	
Biotreatment Soil Specifications	

3.2 Design Guidance

Caltrans (2016)
Pervious Pavement Design Guidance

Section 33 47 27 – Bioretention

DESIGNER NOTE: Green text corresponds to notes to the designer. Remove prior to use.

DESIGNER NOTE: Replace "Engineer/Landscape Architect" with person in responsible charge for the project (e.g., Owner, Engineer, Landscape Architect).

PART 1 GENERAL

1.01 SUMMARY

A. This section includes:

1. Bioretention Soil Mix
2. Aggregate Storage
3. Mulch [To be completed by designer.]
4. Streambed Gravel [To be completed by designer.]

B. Related Sections:

1. Section 01 57 29 – Temporary Protection of Green Infrastructure Facilities

DESIGNER NOTE: The designer should list any additional specification sections which relate to the bioretention work (i.e., clean outs and underdrains, overflow structures, planting, temporary erosion control, utilities, irrigation, earthwork, other appurtenances, etc.).

1.02 STANDARDS AND CODES

A. Reference Standards: This section incorporates by reference the latest versions of the following documents. These references are a part of this section as specified and modified.

Reference	Title
Caltrans	Standard Specifications
San Francisco DPW	Engineering Standard Specifications
ASTM	Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, PA, 1997 or latest edition.

1.03 DEFINITIONS

A. Bioretention Soil Mix (BSM): A soil mix that has been specially blended and tested for use in bioretention facilities with the intent to meet the following objectives:

1. Infiltrate runoff at a minimum rate of 5 inches per hour throughout the life of the facility, and
2. By nature of its components be capable of the removal of certain suspended and dissolved stormwater pollutants, and
3. Have sufficient moisture retention and other agronomic properties to support healthy vegetation.

1.04 REFERENCES

DESIGNER NOTE: Designer to provide references to all project specific documents (e.g., geotechnical report).

1.05 SUBMITTALS

A. Pre-Installation Submittals: The Contractor shall submit to the Engineer/Landscape Architect the following a minimum of 20 calendar days (or as directed by the Engineer/Landscape Architect) prior to the construction of bioretention facilities:

1. BSM Submittals

a. Two one (1) gallon samples of the BSM.

b. Source certificates for all BSM materials.

c. Sieve analysis of BSM per ASTM D422 performed within two (2) months of product delivery to site

d. Certification from the soil supplier or an accredited testing agency that the BSM, including sand and compost components, conforms to all industry or technical society reference standards specified in Sections 2.01.A, 2.01.B, and 2.01C.

e. A description of the equipment and methods used to mix the sand and compost to produce BSM.

f. Organic content test results of the BSM, performed in accordance with Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, “Loss-On-Ignition Organic Matter Method.”

g. Permeability test results for BSM per ASTM D2434 (Modified). See SFPUC Modified ASTM D2434 Procedures for required modifications to test.

DESIGNER NOTE: On larger projects, it may be appropriate to require that the above testing be performed on samples taken at the supplier’s yard from the stockpile to be used for the project; see designer note in Section 1.06.C.2.

2. Sand Submittals

a. Sieve analysis of sand per ASTM D422 performed within two (2) months of product delivery to site.

DESIGNER NOTE: Consider revising acceptable age of sieve tests depending on scale of project. On a larger project it may be appropriate to require testing on samples taken at the supplier’s yard from the stockpile to be used for the project.

3. Compost Submittals

a. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in Section 2.01.C, and performed within two (2) months of product delivery to site.

b. Sieve analysis of compost per TMECC 02.02-B performed within two (2) months of product delivery to site.

4. Other Submittals

a. Cut sheets of any media or soil admixes to enhance moisture retention properties, if used.

b. Testing agency qualifications as specified in Section 1.06.B.

DESIGNER NOTE: Designer should include relevant submittal requirements for mulch and streambed gravel (e.g., sieve analysis), to ensure quality of delivered products.

1.06 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect bioretention materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered after installation, nor shall it constitute final acceptance.

B. Testing Agency Qualification:

1. General: Agencies that perform testing on bioretention materials, including permeability testing, shall be accredited by STA, ASTM, AASHTO, or other designated recognized standards organization. All certifications shall be current. Testing agency shall be capable of performing all tests to the designated and recognized standards specified and shall provide test results with an accompanying Manufacturer's Certificate of Compliance. The following information shall be provided for all testing laboratories used:

a. Name of lab(s) and contact person(s)

b. Address(es) and phone number(s)

c. Email address(es)

d. Qualifications of laboratory and personnel including the date of current certification by STA, ASTM, AASHTO, or approved equal.

2. Compost: Laboratory that performs testing shall be independent, enrolled in the US Composting Council's (USCC) Compost Analysis Proficiency (CAP) program, and perform testing in accordance with USCC Test Method for The Examination of Composting and Compost (TMECC). The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741, 631-737-4931, www.compostingcouncil.org.

C. Responsibilities of Contractor

1. Submittals: Some of the tests required for this specification are unique, and BSM shall be considered a long-lead-time item. Under no circumstance shall failure to comply with all specification requirements be an excuse for a delay or for expedient substitution of unacceptable material(s). The requirements of Division 0 apply in their entirety.

Pre-Placement Conference: A mandatory pre-placement conference will take place, including at a minimum the Engineer/Landscape Architect, the Resident Engineer, the Owner/Client Representative, Installer, and general Contractor, to review schedule, products, soil testing, permeability testing, and installation. The Contractor shall notify the Engineer/Landscape Architect a minimum of 2 working days prior to conference.

DESIGNER NOTE: Pre-placement conference is mandatory for all projects within the public right-of-way, or on other public property, and is strongly recommended for privately-owned parcel projects.

2. Testing: All testing specified herein is the responsibility of the Contractor and shall be conducted by an independent testing agency, retained by the Contractor. The Owner reserves the right to conduct additional testing on all materials submitted, delivered, or in-place to ensure compliance with Specifications.

DESIGNER NOTE: Batch-specific test results and certifications shall be required for projects installing more than 500 cubic yards of BSM.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect the BSM and mulch from contamination and all sources of additional moisture at supplier site, during transport, and at the project site, until incorporated into the Work.

B. The Contractor is required to coordinate delivery of BSM and aggregates with bioretention facility excavation and soil installation. A written schedule shall be submitted for review as part of the submittal package. BSM should not be stockpiled onsite for any length of time. In no case shall BSM be stockpiled onsite for more than 24 hours without prior written approval by the Engineer/Landscape Architect. If stockpiling onsite for any length of time, BSM stockpiles shall meet the following requirements:

1. Locate stockpiles away from drainage courses, inlets, sewer cleanout vents, and concentrated stormwater flows

2. Place stockpiles on geotextile fabric

3. Cover stockpiles with plastic or comparable material

4. Contain stockpiles (and prevent contamination from adjacent stockpiles) with temporary perimeter barrier (e.g., sand bags, wattles, silt fence)

PART 2 PRODUCTS

2.01 BIORETENTION SOIL MIX (BSM)

A. General: BSM shall be a well-blended mixture of sand and compost, shall have sufficient moisture retention to support healthy plant growth, and shall meet the following criteria:

1. Mixture proportions: 30 to 40 percent Compost by volume and 60 to 70 percent Sand by volume

DESIGNER NOTE: Up to 15 percent of the sand fraction may be replaced with other media or soil admixtures (e.g., scoria, coconut coir, perlite, expanded shale, gypsum, vermiculite, pumice, biochar, etc.) to enhance moisture retention capacity of soil, provided admixtures are low in fines (less than 5 percent passing the 200 sieve) and do not break down under normal handling and use. No topsoil, peat, silts, or clays are permitted to be used as admixtures. Admixtures shall be free of sediments and other materials deleterious to plant growth.

2. Organic matter content: 4 to 8 percent as determined by TMECC 05.07-A, Loss on Ignition Method.

3. Extraneous materials: BSM shall be free of all roots, plants, weeds, sod, stones, clods, pockets of coarse sand, construction debris, or other extraneous materials harmful to plant growth.

4. Permeability/Saturated Hydraulic Conductivity: 10 inches per hour (minimum) tested in accordance with ASTM D2434 (Modified). See SFPUC Modified ASTM D2434 Procedures for required modifications to test.

DESIGNER NOTE: 10-inch-per-hour minimum rate assumes a design rate of 5 inches per hour and a correction factor of 2 to account for reduction in performance from initially measured rates.

5. Acceptance of BSM quality and performance may be based on samples taken from stockpiles at supplier's yard, submitted test results, and/or onsite and laboratory testing of installed material at the discretion of the Engineer/Landscape Architect. The point of acceptance will be determined in the field by the Engineer/Landscape Architect.

DESIGNER NOTE: Designer to consider non-compost based BSM specification if facility is serviced by an underdrain and if it is draining to phosphorus sensitive water body.

B. Sand: Sand in the BSM shall conform to the requirements for Sand, Type [specify type from table below] specified herein, unless otherwise approved by the Engineer/Landscape Architect.

DESIGNER NOTE: Designer to specify sand type based on project specific requirements. If bioretention facilities will be subjected to heavy sediment loads (e.g., arterial runoff), consider specifying Sand, Type B (low fines sand)

in an effort to reduce clogging risk (pending local availability). Additionally, projects anticipating heavy sediment loads should incorporate pre-settling measures at the upstream end of the facility to allow for more efficient maintenance of facilities.

1. Sand shall be free of wood, waste, coating, or any other deleterious material.

2. Sand material shall meet the following specifications for gradation.

Sieve Size[1]	Percent Passing by Weight	
	Type A[2]	Type B (low fines)[3]
3/8 inch	100	100
No. 4	90 to 100	90 to 100
No. 8	70 to 100	70 to 100
No. 16	40 to 95	40 to 85
No. 30	15 to 70	15 to 60
No. 50	5 to 55	8 to 15
No. 100	0 to 15	0 to 4
No. 200	0 to 5	0 to 2

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Sand conforming to ASTM C33 for Fine Aggregate satisfies the requirements of this specification for Sand, Type A.

[3] Type B (low fines) sand gradation pending local availability.

3. Coefficient of Uniformity: $C_u = \frac{D_{60}}{D_{10}}$: 4 or less for Sand, Type B.

4. Effective Particle Size (D_{10}): 0.3 to 0.5 mm for Sand, Type B.

5. All aggregate passing the No. 200 sieve shall be non-plastic.

6. Acceptance of grading and quality of the sand may be based on samples taken from stockpiles at supplier's yard or a submitted gradation report at the discretion of the Engineer/Landscape Architect. The point of acceptance will be determined in the field by the Engineer/Landscape Architect.

C. Compost: Compost in the BSM shall be well decomposed, stable, weed free organic matter sourced from waste materials including yard debris, wood wastes or other organic materials, not including biosolids or manure feedstock. Compost shall conform to California Code of Regulations Title 14, Division 7, Chapter 3.1 requirements, be certified through the USCC Seal of Testing Assurance (STA) Program, and meeting the criteria specified herein.

1. Feedstock: Feedstock materials shall be specified and include one or more of the following: landscape/yard trimmings, grass clippings, food scraps, and agricultural crop residues. Feedstock shall not include biosolids or manure.

2. Organic Matter Content: 35 to 75 percent by dry weight tested in accordance with TMECC 05.07-A (Loss on Ignition Organic Matter Method).

3. Carbon to Nitrogen Ratio: C:N between 15:1 and 25:1 when tested in accordance with TMECC 05.02-A.

4. Maturity/Stability: shall have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell, containing recognizable grass or leaves, or is hot (120°F) upon delivery or rewetting is not acceptable. In addition any one of the following is required to indicate stability:

a. Specific Oxygen Uptake Rate (SOUR): 1.5 milligrams O_2 per gram biodegradable volatile solids per hour (maximum) per TMECC 05.08-A.

b. Carbon Dioxide Evolution Rate: 8 milligrams CO_2 per gram volatile solids per day per TMECC 05.08-B.

c. Dewar Self Heating Test: 20°C temperature rise (maximum) per TMECC 05.08-D (Class IV or V).

d. Solvita®: Index value greater than 6 per TMECC 05.08-E.

5. Toxicity: Seed Germination: greater than 80 percent of control AND Vigor: greater than 80 percent of control per TMECC 05.05-A.

6. Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.

a. Total Nitrogen: 0.9 percent (minimum).

b. Boron: Total shall be < 80 ppm

7. Salinity/Electrical Conductivity: less than 6.0 deciSiemen per meter (dS/m or mmhos/cm) per TMECC 04.10-A (1:5 Slurry Method, Mass Basis).

8. pH: 6.5 to 8 per TMECC 04.11-A (1:5 Slurry pH).

9. Gradation: Compost for BSM shall meet the following size gradation per TMECC 02.02-B (test shall be run on dry compost sample):

Sieve Size	Percent Passing by Weight	
	Min	***Max***
1 inch	99	100
1/2 inch	90	100
1/4 inch	40	90
No. 200	1	10

10. Bulk density: 500 to 1,100 dry pounds per cubic yard.

11. Moisture content: 30 to 55 percent of dry solids.

12. Inerts: compost shall be relatively free of inert ingredients, including glass, plastic and paper, less than 1 percent by weight or volume per TMECC 03.08A.

13. Weed seed/pathogen destruction: provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach minimum 55°C for 15 days with at least 5 turnings during that period.

14. Select Pathogens

a. Salmonella: less than 3 Most Probable Number per 4 grams of total solids, dry weight per TMECC 07.02.

b. Coliform Bacteria: fecal coliform less than 1,000 Most Probable Number per gram of total solids, dry weight per TMECC 07.01.

15. Trace Contaminants Metals (lead, mercury, etc.): Product must meet US EPA, 40 CFR 503 regulations.

D. Soil Admixtures: [Specify admixtures, if used]

2.02 AGGREGATE STORAGE

DESIGNER NOTE: Aggregate storage layer requirements are dependent on location of project (i.e., MS4 areas vs. combined sewer areas), site specific conditions (e.g., native soil infiltration rates, storage volume needs of project). The designer should update this specification based on the aggregate storage materials required for the project.

DESIGNER NOTE: Aggregate storage is optional in combined sewer areas for facilities without underdrains. BSM depth may also be increased for additional storage capacity (in lieu of an aggregate storage layer), provided the facility is within a combined sewer area and not serviced by an underdrain.

A. Aggregate Storage shall consist of hard, durable, and clean, sand, gravel, or mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove fines, organic matter, extraneous debris, or objectionable materials. Recycled materials are not permitted. The material shall be obtained only from a source(s) approved by the Engineer/Landscape Architect. Written requests for source approval shall be submitted to the Engineer/Landscape Architect not less than ten (10) working days prior to the intended use of the Material. Should the proposed source be one that the Engineer/Landscape Architect has no history of Material performance with, the Engineer/Landscape Architect reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract.

B. Aggregate storage shall meet the following specifications for grading and quality.

1. Aggregate gradation testing in accordance with ASTM C136 at least once per 500 cubic yards.

Sieve[1]	Percent Passing by Weight		
	Choking Course ASTM No. 9 (Modified)[3]	**Reservoir Course ASTM No. 7 (Modified)[4]**	**Caltrans Class 2 Permeable Aggregate (MS4 Areas Only)**
1 inch	–	–	100
3/4 inch	–	100	90 to 100
1/2 inch	100	90 to 100	–
3/8 inch	100	40 to 70	40 to 100
No. 4	85 to 100	0 to 15	25 to 40
No. 8	10 to 40	0 to 5	18 to 33
No. 16	0 to 10	–	–
No. 30	–	–	5 to 15
No. 50	–	–	0 to 7
No. 200[2]	0 to 2	0 to 2	0 to 3

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Gradation modified from ASTM for portion passing the No. 200 sieve.

[3] Materials likely to meet this specification are available locally as Graniterock 1/4” premium screenings (Wilson 1/4" x #10 Premium Screenings).

[4] Materials likely to meet this specification are available locally as Graniterock 1/2” premium screenings (Wilson 1/2" x #4 Roofing Aggregate).

2. Crushed Particles: 90 percent (minimum) fractured faces tested in accordance with California Test 205. Do not use rounded river gravel.

3. L.A. Abrasion: 40 percent (maximum) tested in accordance with ASTM C 131.

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying coarser graded materials or reduction in permeability relative to the underlying material. Refer to the SFPUC Aggregate Filter Criteria Guidance document for information on selecting appropriate alternate materials.

DESIGNER NOTE: Designer should verify that underdrain slot dimensions for project are compatible with aggregate gradation specified. Refer to the SFPUC Aggregate Filter Criteria Guidance document for information on selecting appropriate underdrain materials.

2.03 MULCH

DESIGNER NOTE: This section intentionally left blank. Designer to specify mulch requirements for bioretention facilities. Mulch may be wood, compost, or rock mulch. Mulch shall be free of dyes, recycled dimensional lumber, and bark. Materials selected shall be sufficiently permeable to allow water to pass through at a rate equal to or greater than the underlying BSM. Typical mulch recommended for this application includes tree trimming mulch per Caltrans Standard Specification Section 20-7.02D(6)(a) and (e), or other comparable material (e.g., arbor mulch).

2.04 STREAMBED GRAVEL

DESIGNER NOTE: This section intentionally left blank. Designer to specify gravel requirements, including gradation, for bioretention facilities. Streambed Gravel shall be sized to provide energy dissipation and to minimize erosion at facility inlets and outlets. The following text is a sample/template specification for cobbles within a bioretention facility:

Streambed Cobbles shall be clean, naturally occurring water rounded gravel material. Streambed Cobbles shall have a well-graded distribution of cobble sizes and conform to the following gradation [Designer to specify]:

Streambed Cobbles	
Approximate Size[1]	**Percent Passing by Weight**

[1] Approximate size can be determined by taking the average dimension of the three axes of the rock, Length, Width, and Thickness, by use of the following calculation: (Length + Width + Thickness)/3 = Approximate Size Length is the longest axis, width is the second longest axis, and thickness is the shortest axis.

The grading of the cobbles shall be determined by the Engineer/Landscape Architect by visual inspection of the load before it is dumped into place, or, if so ordered by the Engineer/Landscape Architect, by dumping individual loads on a flat surface and sorting and measuring the individual rocks contained in the load. Cobbles must be washed before placement.

PART 3 EXECUTION

3.01 GENERAL

A. Prevent runoff from adjacent pervious and impervious surfaces from entering the bioretention facility (e.g., sand bag inlet curb cuts, stabilize adjacent areas, flow diversion) until authorization is given by the Engineer/Landscape Architect. Refer to SFPUC Specification Section 01 57 29 Temporary Protection of Green Infrastructure Facilities.

B. Exclude equipment from bioretention facilities. No equipment shall operate within the facility once bioretention facility excavation has begun, including during and after excavation, backfilling, mulching, or planting.

C. Prevent foreign materials and substances, such as silt laden run-off, construction debris, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid from entering or being stored in the facility at any point during construction.

3.02 GRADING

A. The Contractor shall not start bioretention facility grading until all areas draining to the facility are stabilized and authorization has been given by the Engineer/Landscape Architect.

B. Construct bioretention facility subgrade to +/- 3/4 inch of the grades and slopes specified on the Plans.

C. Excavation within 6 inches of final native soil grade shall not be permitted if facility soils have standing water, or have been subjected to more than 1/2 inch of precipitation within the previous 48 hours.

3.03 SUBGRADE PREPARATION AND PROTECTION

A. Protect the bioretention excavation from over compaction and/or contamination.

1. Areas which have been over compacted by equipment or vehicle traffic or by other means and which need to be ripped, over excavated, receive additional scarification, or other restorative means shall be done at the Contractor's expense and at the direction of the Engineer/Landscape Architect.

2. Excavated areas contaminated by sediment laden runoff prior to placement of BSM or Aggregate Storage material shall be remediated at the Contractor's expense by removing the contaminated soil (top 3 inches minimum) and replacing with a suitable material, as determined by the Engineer/Landscape Architect.

B. Remove all trash, debris, construction waste, cement dust and/or slurry, or any other materials that may impede infiltration into prepared subgrade.

C. The subgrade shall be inspected and accepted by the Engineer/Landscape Architect prior to placement of any materials or final subgrade scarification.

D. Scarify the surface of the subgrade to a minimum depth of 3 inches immediately prior to placement of BSM or aggregate storage material. Acceptable methods of scarification include use of excavator bucket teeth or a rototiller to loosen the surface of the subgrade.

E. Place aggregate storage material, where shown on drawings with conveyor belt or with an excavator or loader from a height no higher than 6 feet unless otherwise approved by the Engineer/Landscape Architect (i.e., do not dump material directly from truck into cell).

F. Aggregate Storage areas contaminated by sediment-laden runoff prior to placement of BSM shall be remediated at the Contractor's expense by removing the contaminated aggregate storage material (top 3 inches minimum or as directed by the Engineer/Landscape Architect) and replacing with clean aggregate storage material per Section 2.03, to the lines and grades on the Plans.

G. Aggregate Storage material shall be inspected and accepted for placement and finish grade by the Engineer/Landscape Architect prior to the installation of BSM. Any material that does not conform to this Specification shall be removed and replaced with acceptable material or remediated to the satisfaction of the Engineer/Landscape Architect, at the Contractor's expense.

3.04 BIORETENTION SOIL MIX PLACEMENT

A. The Contractor shall not place BSM until the Engineer/Landscape Architect has reviewed and confirmed the following:

1. BSM delivery ticket(s): Delivery tickets shall show that the full delivered amount of BSM matches the product type, volume and manufacturer named in the submittals. Each delivered batch of BSM shall be accompanied by a certification letter from the supplier verifying that the material meets specifications and is supplied from the approved BSM stockpile.

2. Visual match with submitted samples: Delivered product will be compared to the submitted 1-gallon sample, to verify that it matches the submitted sample. The Engineer/Landscape Architect may inspect any loads of BSM on delivery and stop placement if the soil does not appear to match the submittals; and require sampling and testing of the delivered soil to determine if the soil meets the requirements of Section 2.01 before authorizing soil placement.

3. Inspection of the aggregate storage layer, underdrain, cleanout, and overflow structure installation, where included on the plans.

DESIGNER NOTE: On larger projects, it may be appropriate to require that the testing specified in Section 2.01 be performed on samples taken at the supplier's yard from the stockpile to be used for the project; see designer note in Section 1.06.C.2.

B. BSM placement, grading and consolidation shall not occur when the BSM is excessively wet, or has been subjected to more than 1/2 inch of precipitation within 48 hours prior to placement. Excessively wet is defined as being at or above 22 percent soil moisture by a General Tools & Instruments DSMM500

Precision Digital Soil Moisture Meter with Probe (or equivalent). A minimum of three readings with the soil moisture probe will be used to determine the average percent soil moisture reading per each truck load. There should be no visible free water in the material.

C. The Contractor shall place BSM loosely with a conveyor belt or with an excavator or loader from a height no higher than 6 feet, unless otherwise approved by the Engineer/Landscape Architect (i.e., do not dump material directly from truck into cell). Soil shall be placed upon a prepared subgrade in accordance with these Specifications and in conformity with the lines, grades, depth, and typical cross-section shown in the Drawings or as established by the Engineer/Landscape Architect.

D. Excessively dry BSM may be lightly and uniformly moistened, as necessary, to facilitate placement and workability.

E. Compact BSM using non-mechanical compaction methods (e.g., boot packing, hand tamping, or water consolidation) to 83 percent (+/- 2 percent) of the maximum dry density per modified Proctor test (ASTM D1557), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6938. Moisture content determination shall be conducted on a soil sample taken at the location of the nuclear gage reading per ASTM D2216.

DESIGNER NOTE: BSM compaction target density will be updated as more data from installed projects becomes available on the optimal compaction to minimize settlement while maintaining the infiltration capacity of the media. Designers are encouraged to report field density measurements, observed infiltration rates (if available), and anecdotal field observations (e.g., soil appears well draining, settlement observed minimal).

F. Grade BSM to a smooth, uniform surface plane with loose, uniformly fine texture. Rake, remove ridges, and fill depressions to meet finish grades.

G. Final soil depth shall be measured and verified only after the soil has been compacted. If after consolidation, the soil is not within +/- 3/4 inch of the grades and slopes specified on the Plans, add material to bring it up to final grade and raked.

H. The BSM shall be inspected and accepted for placement and finish grade by the Engineer/Landscape Architect prior to the installation of planting and mulch. Any BSM that does not conform to this Specification shall be remediated to the satisfaction of the Engineer/Landscape Architect, or removed and replaced with acceptable BSM, at the Contractor's expense.

3.05 PLANTING AND MULCHING

A. Bioretention facilities shall be planted and mulched as shown on the Plans.

B. Bioretention facilities shall not be planted or mulched when soils are excessively wet as defined in Section 3.04.

C. Bioretention facility areas contaminated by sediment laden runoff prior to planting or placement of mulch shall be remediated at the Contractor's expense by removing the contaminated BSM (top 3 inches minimum) and replacing with BSM per Section 2.01, to the lines and grades on the Plans.

D. All mulch shall be inspected and accepted by the Engineer/Landscape Architect to ensure appropriate depth and material prior to facility commissioning (e.g., unblocking of inlets).

DESIGNER NOTE: Planting and mulching requirements shall be determined by the designer and included or referenced herein.

3.06 FLOOD TESTING

A. Inlets shall be constructed per the Plans and free from all obstructions prior to commencing flow testing.

B. Testing shall be conducted at the conclusion of the 90-day plant grow-in period. Protection and flow diversion measures installed to comply with Section 01 57 29 Temp Protection of GI Facilities shall be removed in their entirety prior to commencing flow testing.

C. Underdrains shall be plugged at the outlet structure to minimize water consumption during testing.

D. Prior to testing, broom sweep gutter and other impervious surfaces within the test area to remove sediments and other objectionable materials.

E. The Engineer/Landscape Architect shall be present during the demonstration. The Contractor shall notify the Engineer/Landscape Architect a minimum of 2 working days prior to testing.

F. The Contractor shall water test each facility to demonstrate that all inlet curb openings are capturing and diverting all water in the gutter to the facility, outlet structures are engaging at the elevation specified, and the designed ponding depth is achieved. Testing shall include application of water from a hydrant or water truck per Section 00 73 73, Article 3.04 (Requirements for Using Water For Construction), at a minimum rate of 10 gallons per minute, into the gutter a minimum of 15 feet upstream of the inlet curb opening being tested. Each inlet shall be tested individually. If erosion occurs during testing, restore soils, plants, and other affected materials.

DESIGNER NOTE: Designer should update test flow rate for inlets to reflect project-specific design, as needed.

G. Engineer/Landscape Architect will identify deficiencies and required corrections, including but not limited to relocating misplaced plants, adjusting streambed gravel, adjusting mulch, adjusting inlets, splash aprons, and forebays, removing and replacing inlets, and removing debris.

H. Once adjustments are made, the Contractor shall re-test to confirm all test water flows into the facility from the gutter and correct any remaining deficiencies identified by Engineer/Landscape Architect.

l. Inlets, outlets, and other bioretention facility appurtenances shall not be accepted until testing and any required correction and retesting is complete and accepted by the Engineer/Landscape Architect.

DESIGNER NOTE: The Owner may, at any time, conduct additional testing on all materials submitted, delivered, or in-place, to ensure compliance with the Specifications. Testing may include permeability testing per ASTM D2434 (Modified), density testing per ASTM D6938, etc., if the Engineer/Landscape Architect suspects the facility does not conform to these specifications (e.g., as evidenced by lower than anticipated infiltration capacity).

DESIGNER NOTE: Designer should consider adding a similar requirement to the Concrete Paving and Sanitary Sewerage Utilities sections of the Specifications, as needed.

END OF SECTION

DIVISION 32 – EXTERIOR IMPROVEMENTS

Section 32 12 43 – Porous Asphalt Concrete

DESIGNER NOTE: The specifications below are based on the best available information. Designer should modify the specifications to satisfy project-specific constraints.

DESIGNER NOTE: Green text corresponds to notes to the designer.

PART 1 GENERAL

1.01 SUMMARY

A. This section includes:

1. Porous Asphalt Pavement

2. Pavement Base

3. Geotextile for Soil Separation

B. Related Sections:

DESIGNER NOTE: The designer should list any additional specification sections which relate to the porous asphalt work (i.e., traffic control, temporary erosion control, utilities, earthwork, etc.)

1.02 STANDARDS AND CODES

A. Reference Standards: This section incorporates by reference the latest revisions of the following documents. These references are a part of this section as specified and modified.

Reference	Title
Caltrans	Standard Specifications (published by State of California Business, Transportation, and Housing Agency, Department of Transportation)
San Francisco DPW	Engineering Standard Specifications
AASHTO	Standards of the American Association of State Highway and Transportation Officials, 1998 or latest edition
ASTM	Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, PA, 1997 or latest edition.
NAPA IS 115	Design, Construction, and Maintenance of Open-Graded Asphalt Friction Courses
NAPA IS 131	Porous Asphalt Pavements for Stormwater Management, Design, Construction, and Maintenance.

1. Caltrans Standard Specifications: Any references to Caltrans Standard Specifications invoke technical specifications in Section 39 for material, construction, and quality control and quality assurance only. Caltrans contractual requirements, general specifications, and measurement and payment do not apply.

2. Caltrans Standard Specifications Term Equivalencies

Terms Equivalencies	
Term or Clause in Caltrans Standard Specifications	**Term or Clause in These Specifications**
The Department	The Owner
OGFC	Porous Asphalt

1.03 REFERENCES

DESIGNER NOTE: Designer to provide references to related industry manuals and guidance and all project specific documents (e.g., geotechnical report).

1.04 SUBMITTALS

A. Bid Submittals: The Contractor shall submit to the Owner the following as part of the bid proposal:

1. Project experience and personnel qualification examples as specified in Section 1.05.B for the contractor and personnel assigned to this project.

DESIGNER NOTE: The designer should incorporate by reference these requirements in Division 00 of the Specifications.

B. Pre-Installation Submittals: Submittals shall conform to the requirements of Caltrans Standard Specifications including:

1. Proposed job mix formula per Section 1.05.B of this Specification.

2. Proposed QC plan per Section 39-1.04A (General Requirements for Contractor Quality Control) and Section 39-2.02A (Quality control plan requirements for the "Standard Construction Process"). The QC Plan shall satisfactorily test the porous asphalt for compliance with Section 39-2.02B (Quality Control for Standard Construction Process) of the Caltrans Standard Specifications, with the following modifications and additions:

a. Aggregate durability index shall be tested in accordance with Caltrans Test Method 229 at least one time per each 750 tons of porous asphalt.

b. Aggregate cleanliness value shall be tested in accordance with Caltrans Test Method 227 at least one time per each 750 tons of porous asphalt.

c. Air voids shall be tested for by determining the bulk specific gravity in accordance with ASTM D6752 or AASHTO T275, the maximum theoretical specific gravity with AASHTO T209, and the voids by test ASTM D3203.

d. Draindown shall be tested in accordance with ASTM D6390.

e. Retained tensile strength shall be tested in accordance with AASHTO 283.

f. Three (3) surface infiltration tests per ASTM C1701 shall be conducted per 10,000 square feet of porous asphalt, in place and one (1) additional test per 5,000 square feet of porous asphalt, or fraction thereof, in place. Document and record the results of each field infiltration test with a designated test number. Include infiltration rate, date pavement was placed, date test was taken, and location on the site (via stationing or other means) where test was performed in each test record. If minimum required field infiltration rate is not achieved at any location as defined in this Section, re-test for field infiltration rate at a new location for each failed field infiltration test. Coordinate location with Owner's Representative.

The QC plan shall be consistent with the Caltrans Quality Control Quality Assurance Manual for Asphalt Concrete Production and Placement (latest version).

In addition to the Caltrans submittal requirements, the Contractor shall submit the following:

3. Source certificates, gradations, R-values, LA abrasion, and cleanness values of aggregates for base and reservoir course materials performed within one (1) month of product delivery to site.

4. Product data sheets for geotextiles.

5. Testing agency qualifications as specified in Section 1.05.A.

1.05 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect asphalt materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered later, nor shall it constitute final acceptance.

DESIGNER NOTE: This specification does not include a test panel/mockup due to the difficulty of installation and because physical properties of the material are known from the plant test. Consider whether project design objectives warrant the cost of a test panel/mockup.

1. Contractor and Personnel Qualifications

DESIGNER NOTE: The designer should adjust the required qualifications for the contractor and personnel based on the availability of qualified bidders and project size, complexity, and risk.

a. Contractor qualification: The Contractor shall provide documentation showing one of the following for the general contractor or paving subcontractor:

1) One (1) example owner-accepted porous asphalt project, similar (or greater) in extent to the proposed project, completed in the last one (1) year with reference.

OR

2) Three (3) example owner-accepted open graded friction course projects completed in the last one (1) year with references.

Documentation shall include name and address of project, and contact information for project owner.

b. Personnel qualification: The Contractor or paving subcontractor shall provide a qualified foreman with experience installing porous asphalt and documentation showing with following:

1) One (1) example owner-accepted porous asphalt project, similar (or greater) in extent to the proposed project, completed in the last one (1) year with reference.

Documentation shall include name and address of project, and contact information for project owner.

The qualified foreman shall be onsite for the duration of asphalt work including preparation, placement, testing, and completion.

c. Testing agency qualification: Agencies that perform testing on porous asphalt materials shall meet the requirements of Caltrans Standard Specification Section 39-1.03A or be accredited by the AASHTO Accreditation Program (AAP) for the scope and standard being evaluated.

d. Plant qualification: Batch or continuous mixing plants used for porous asphalt shall meet the requirements of Caltrans Standard Specification Section 39-1.08A.

B. Authorized Job Mix Formula (JMF): The mix design process shall conform to Caltrans Specification Section 39-1.03 except as noted below.

1. The final paragraph under Section 39-1.03A is deleted and replaced with the following:

a. Submit a complete JMF submittal including identification of asphalt binder percentage in form CEM-3511 Contractor Job Mix Formula Proposal. Determine the optimum asphalt binder content using California Test 368 in a lab that meets the requirements of 1.05.A. of these specifications.

The products used in the JMF shall meet the requirements in Section 2.01 of this Specification.

The JMF shall meet the quality characteristics defined in Section 39-2.02B (Quality Control for Standard Construction Process) with the modified and additional quality characteristics listed in the table below.

Quality Characteristics	Test Method	Requirement
Aggregate Durability Index	CT 229	DI >= 35
Aggregate Cleanness Value	CT 227	CV >= 75
Air Void Content by Corelok (%)[1]	ASTM D6752 (with AASHTO T209 and ASTM D3203)	16–20%
Air Void Content by Paraffin Wax (%)[1]	AASHTO T275 (with AASHTO T209 and ASTM D3203)	18–22%
Draindown (% of total weight)	ASTM D6390	<= 3%
Retained Tensile Strength (%)	AASHTO 283	>= 80%
Infiltration Rate (Average Inches per Hour)	ASTM C1701	See Note 2.

[1] Either method of determining air void content is acceptable.

[2] The finish surface shall yield an infiltration rate that is consistent with the following: The average infiltration rate from three (3) infiltration tests conducted per ASTM C1701 shall be greater than 100 inches per hour with no single test less than 50 inches per hour. Water shall infiltrate rapidly and uniformly through the surface without formation of large puddles when applied at a rate of 5 gallons per minute (gpm).

2. Once verified and accepted by the Engineer, the JMF meeting the criteria above shall become the Authorized JMF. Acceptance of the JMF shall be per Caltrans Standard Specification Section 39-1.03G, except that verification of the JMF by the City of San Francisco shall be considered equivalent to verification of the JMF by Caltrans. Any adjustments or renewals of the JMF shall be per Caltrans Standard Specifications Section 39-1.03 (Hot Mix Asphalt Mix Design Requirements). Submit a letter from the asphalt supplier with the recommended temperature ranges for mixing, laying, breakdown rolling, and finished rolling, as well as the recommended maximum temperature of the finished mat before placement of subsequent lifts.

C. Responsibilities of Contractor

1. General: Conform to the requirements set forth in Section 39-1.04 (Contractor Quality Control) and Section 39-2.02 (Standard Construction Process Contractor Quality Control) of the Caltrans Standard Specifications.

2. Pre-Placement Conference: A mandatory pre-placement conference will take place, including at a minimum the Engineer, the Owner, the general Contractor, and paving subcontractor, to review preparation, placement, testing procedures, and responsibilities.

3. Quality Control: Contractor quality control inspection and testing of porous asphalt shall be conducted in accordance with the approved QC plan.

4. Load Slip: Provide a load slip certified by a licensed weightmaster showing combined mixture weight for each load of porous asphalt transported to the location.

5. Infiltration Rate Testing: Perform surface infiltration tests per ASTM C1701 as described below.

a. Three (3) test locations per 10,000 square feet of porous asphalt in place.

b. One (1) additional test location per 5,000 square feet of porous asphalt, or fraction thereof, in place.

DESIGNER NOTE: Designer to specify the number and location(s) of required post-construction infiltration tests.

6. Required Inspections: Notify the Engineer at least 5 business days prior placement of porous asphalt.

7. Failed Tests: Each test shall meet the acceptance criteria as defined in this section. For any single quality characteristic except smoothness, if two consecutive quality control test results do not comply with the action limits or specifications:

a. Stop production.

b. Notify the Engineer.

c. Take corrective action.

d. Demonstrate compliance with the specifications before resuming production and placement.

DESIGNER NOTE: The following table is a Sample Contractor Quality Control Sampling and Testing Plan; it is provided to illustrate the type and frequency of testing that may be required The Contractor will need to develop a similar table as part of their QC plan. Frequency and standard for all tests should be project specific.

Sample Contractor Quality Control Sampling and Testing Plan						
Quality Characteristic	**Test Standard**	**Frequency**	**Sample Location**	**Contractor Responsibility**	**Attribute or Tolerance**	
Plant Operations						
Aggregate Gradation	CT 202	1/750 tons	Plant	Plant Inspector	1/2"	TV ± 6
					3/8"	TV ± 6
					No. 4	TV ± 7
					No. 8	TV ± 5
					No. 30	TV ± 4
					No. 200	TV ± 2
Asphalt Binder Content	CT 382	Daily	Plant	Plant Inspector	Design ± 0.5%	
Percent of crushed particles coarse aggregate (%, min) One fractured face Two fractured faces Fine aggregate (%, min) (Passing no. 4 sieve and retained on no. 8 sieve.) One fractured face	CT 205	1/project	Plant	Plant Inspector	 90 75 90	
Los Angeles Rattler (%, max) Loss at 100 rev. Loss at 500 rev.	CT 211	1/project	Plant	Plant Inspector	 12 40	
Aggregate Durability Index	CT 229	1/750 tons	Plant	Plant Inspector	DI > 35	
Aggregate Cleanness Value	CT 227	1/750 tons	Plant	Plant Inspector	CV > 75	
Asphalt Temp.	Recorded	Continuous	Plant	Plant Inspector	120–190	
Plant Mix Temperature	Recorded	Continuous	Plant	Plant Inspector	165 Maximum	
Aggregate moisture content	CT 226	2/day	Plant	Plant Inspector	For adjusting the plant controller at the HMA plant	
Flat and elongated particles (%, max by weight @ 5:1)	CT 235	1/project	Plant	Plant Inspector	Report Only	

Sample Contractor Quality Control Sampling and Testing Plan					
Quality Characteristic	**Test Standard**	**Frequency**	**Sample Location**	**Contractor Responsibility**	**Attribute or Tolerance**
Street Operations					
Subgrade Preparation	Visual	Daily	Jobsite	Field Inspector	Smooth and Clean
Asphalt Paver & Hopper	Visual and Measure	Daily	Jobsite	Field Inspector	Manufacturer Standards
Compaction Equipment	Visual and Measure	Daily	Jobsite	Field Inspector	Manufacturer Standards
Compaction Process	Visual	Continuous	Jobsite	Field Inspector	Per Specifications
Pavement Temp. at Breakdown	Temperature Equipment	Hourly	Mat Behind Paver	Field Inspector	Per Specifications
Asphalt Binder Content	CT 382	Daily	Mat Behind Paver	Field Inspector/Tester	Design ± 0.5%
HMA Moisture Content (%, max)	CT 226	Daily	Mat Behind Paver	Field Inspector/Tester	1.0
Lift Thickness	Measured	Hourly	Mat Behind Paver	Field Inspector	Per Specifications
Pavement Temp. at Finish	Temperature Equipment	Daily	At Finish Roller	Field Inspector	Per Specifications
Air Void Content by Paraffin Wax (%)	AASHTO T275 (with AASHTO T209 and ASTM D3203)	Daily	Cores of Finished Surface	Field Inspector	16–20%
Tensile Strength	AASHTO 283	Daily	Cores of Finished Surface	Engineer	>= 80%
Long./Transverse Joints	Visual	Continuous	Pavement Joints	Field Inspector	Industry Standards
Smoothness	10 ft straightedge	Hourly	Finished Surface	Field Inspector	Per Specifications

Sample Contractor Quality Control Sampling and Testing Plan					
Quality Characteristic	**Test Standard**	**Frequency**	**Sample Location**	**Contractor Responsibility**	**Attribute or Tolerance**
Street Operations (continued)					
Infiltration Rate (average Inches per hour)	ASTM C1701	Three (3) test locations per 10,000 square feet of pervious asphalt, in place One (1) additional test location per 5,000 square feet of pervious asphalt, or fraction thereof, in place	Finished Surface	Field Inspector	Each Test: 50”/hr min Daily Avg.: 100”/hr min
Pavement Transitions	Visual	Daily	AC Transitions	Field Inspector	Per Specifications

D. Acceptance: Acceptance of porous asphalt shall be determined based on the criteria defined in Section 39-2.03A (Acceptance) of the Caltrans Standard Specifications, with the following modifications and additions:

1. Source aggregate will not be subject to acceptance testing once is has been approved as part of the JMF, unless samples are requested by the Engineer.

2. Air Voids: Air voids shall be tested for by determining the bulk specific gravity in accordance with ASTM D6752 or AASHTO T275, the maximum theoretical specific gravity with AASHTO T209, and the voids by test ASTM D3203.

3. Retained Tensile Strength: Retained tensile strength shall be tested in accordance with AASHTO 283.

Test results for air voids, draindown, and retained tensile strength shall be consistent with the characteristics of the approved JMF.

4. Infiltration Testing

a. Infiltration Rate Testing: The average of all surface infiltration tests shall be greater than 200 inches per hour with no single test less than 100 inches per hour.

DESIGNER NOTE: The designer should adjust infiltration rates to reflect project specific conditions such as anticipated sediment loading based on pavement use (e.g., vehicular, pedestrian) and design run-on from adjacent surfaces. The recommended criteria are as follows:

- For porous asphalt that will accept run-on from adjacent impervious and/or pervious surfaces OR pavement that will be subject to vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 200 inches per hour with no single test less than 100 inches per hour
- For porous asphalt not subject to run-on OR vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 100 inches per hour with no single test less than 50 inches per hour

b. Infiltration Visual Testing: Visual flood testing of the surface shall be conducted by application of clean water at the rate of at least 5 gpm over the surface, using a hose or other distribution devise. Water used for the test shall be clean, free of suspended solids and deleterious liquids and will be provided at no extra cost to the Owner. All applied water shall infiltrate directly without large puddle formation or surface runoff, and shall be observed by the

Engineer. The Engineer shall mark areas where large puddles form in the field. Areas with slow infiltration shall not exceed 10 percent of the total surface.

DESIGNER NOTE: Smoothness specification should be revised as needed to reflect project design objectives (e.g., smoothness specifications from Section 212 of the City Streets and Highways specifications).

5. Smoothness: Porous asphalt smoothness shall be checked with a 10-foot straightedge. Vertical measurement shall be taken between the pavement's determined plane and straight edge in a direction perpendicular and parallel to the centerline. The finished pavement shall be uniform to a degree such that no variations greater than 3/8-inch are present between the straightedge and pavement surface.

6. Grade: Porous asphalt shall be true to designed spot elevations plus or minus ½ inch and shall not deviate from designed slope more than ¼ inch in ten (10) feet. Where abutting existing facilities such as sidewalks, walkways, curbs, driveways or other pavements, the porous asphalt shall be flush.

7. Line: Porous asphalt margins shall be true to designed lines plus or minus ½ inch at any point.

8. Slope: Porous asphalt shall be sloped as shown on the Plans. Slope shall be consistent to within 1/4 inch in ten (10) feet.

9. Thickness: Each core sample shall be equal to the minimum section depth or more as specified on the Plans.

DESIGNER NOTE: Revise the load slip specification as needed to align with the measurement and payment specifications.

10. Load Slip: Each load of porous asphalt transported to the location of placement shall have a load slip delivered with the load that is certified by a licensed weightmaster and includes the combined mixture weight.

DESIGNER NOTE: Designer should specify consequences of any failed acceptance tests (e.g., reduced payment for lower infiltration rate and lower percent voids, reduced payment for failed smoothness tests) or if consequences are full replacement.

11. Reduced Payment Factors: The reduced payment factors in Caltrans Standard Specification 39-2.03A (Testing) do not apply.

DESIGNER NOTE: The following table is a Sample Owner Quality Assurance Sampling and Testing Plan is provided to illustrate the type and frequency of testing that may be required. Frequency and standard for all tests should be project specific.

Sample Owner Quality Assurance Sampling and Testing Plan					
Quality Characteristic	**Test Standard**	**Frequency**	**Sample Location**	**Responsibility**	**Attribute or Tolerance**
Plant Operations					
Street Operations					
Asphalt Binder Content	CT 382	Daily	Hopper	Engineer	Design ± 0.5%
HMA Moisture Content (%, max)	CT 226	Daily	Hopper	Engineer	1.0
Lift Thickness	Measured	Hourly	Cores of Finished Surface	Engineer	Per Specifications
Air Void Content by Paraffin Wax (%)	AASHTO T275 (with AASHTO T209 and ASTM D3203)	Daily	Cores of Finished Surface	Engineer	16–20%
Tensile Strength	AASHTO 283	Daily	Cores of Finished Surface	Engineer	>= 80%
Long./Transverse Joints	Visual	Continuous	Pavement Joints	Engineer	Per Specifications
Smoothness	10 ft straightedge	Hourly	Finished Surface	Engineer	Per Specifications
Infiltration Rate (average inches per hour)	ASTM C1701	3/day	Finished Surface	Engineer	Each Test: 50”/hr min Daily Avg.: 100”/hr min
Pavement Transitions	Visual	Daily	AC Transitions	Engineer	Per Specifications

PART 2 PRODUCTS

DESIGNER NOTE: If a product is not available, the designer needs to ensure that the desired voids and surface texture will meet the desired pavement characteristics for surface smoothness, voids, and bonding.

2.01 POROUS ASPHALT

Porous Asphalt mixture must comply with the approved Job Mix Formula (See Section 1.05 of this Specification). The components of the asphalt mixture must comply with the specifications below.

A. Asphalt Binder: Asphalt binder must comply with Caltrans Specification Section 92 except as noted below.

1. Performance Graded (PG) Asphalt Binder: PG asphalt binder must be PG 70-10 per Caltrans Specification Section 92-1.02B.

2. PG Polymer Modified Asphalt Binder:

PG polymer modified asphalt binder must be PG 76-22 PM per Caltrans Specification Section 92-1.02B for use in vehicular applications.

PG polymer modified asphalt binder must be either PG 64-28 PM or PG 76-22 PM per Caltrans Specification Section 92-1.02B for use in pedestrian applications.

B. Aggregates: Aggregates shall conform to Caltrans Specification Section 39-1.02E for Open Graded Friction Course (OGFC) with the following additions and modifications:

1. Durability Index: 35 (minimum) tested in accordance with California Test 229 at least once per 750 tons of porous asphalt.

2. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 750 tons of porous asphalt.

3. Aggregate for porous asphalt shall meet the following gradation:

Porous Asphalt Aggregate Gradation	
Sieve[1]	**Percent Passing by Weight**
3/4 inch	100
1/2 inch	85 to 100
3/8 inch	55 to 75
No. 4	10 to 25
No. 8	5 to 12
No. 30	0 to 10
No. 200	0 to 3

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

C. Materials Not to Be Used: The following materials shall not be used unless approved in advance by the Engineer.

1. Geosynthetic pavement interlayer

2. Tack Coat (except on vertical faces of curbs, edges of PCC structures, or when paving over areas with impermeable bases).

3. Asphalt Rubber Binder.

4. Crumb Rubber Modifier.

5. Reclaimed Asphalt Pavement.

6. Paint Binder per Section 212.06 of the DPW Standard Specifications

D. Job Mix Formula (JMF): The JMF shall comply with the requirements of Section 1.05.C of this Specification.

2.02 PAVEMENT BASE

A. Pavement Base Material shall consist of clean, mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove clay, organic matter, extraneous debris, or objectionable materials. Recycled materials are not permitted. The Material shall be obtained only from a source(s) approved by the Engineer. Written

requests for source approval shall be submitted to the Engineer not less than 10 Working Days prior to the intended use of the Material. Should the proposed source be one that the Engineer has no history of Material performance with, the Engineer reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract. The Engineer shall reserve the right to sample and test Material at any time including at the source.

B. Pavement Base shall consist of up to two (2) layers as specified on the Plans and included herein:

1. "Base Course" shall be ASTM No. 3 (modified) or ASTM No. 57 (modified) stone per Section 2.02.C.

DESIGNER NOTE: This layer of the pavement base is intended to provide structural (load bearing) capacity to the pavement.

2. "Reservoir Course" shall be ASTM No. 2 (modified), ASTM No. 3 (modified), or ASTM No. 57 (modified) stone per Section 2.02.C.

DESIGNER NOTE: This layer of the pavement base is intended to provide storage and drainage of the pavement, structural support, and a capillary break. The materials specified should be crushed, clean, washed gravel to provide the desired structural capacity, maintain good drainage, function as a capillary barrier, and minimize clogging of the subgrade due to export of fines.

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying coarser graded materials or reduction in permeability relative to the underlying material. Refer to the SFPUC aggregate filter criteria guidance document for information on selecting appropriate alternate materials.

C. Pavement Base Material shall meet the following specifications for grading and quality.

1. Aggregate Gradation tested in accordance with ASTM C136 at least once per 500 cubic yards of base material.

Sieve[1]	Percent Passing by Weight			
	ASTM No. 2 (modified)	**ASTM No. 3 (modified)**	**ASTM No. 8 (modified)**	**ASTM No. 57 (modified)**
3 inch	100	–	–	–
2 1/2 inch	90 to 100	100	–	–
2 inch	35 to 70	90 to 100	–	–

Sieve[1]	Percent Passing by Weight			
	ASTM No. 2 (modified)	ASTM No. 3 (modified)	ASTM No. 8 (modified)	ASTM No. 57 (modified)
1 1/2 inch	0 to 15	35 to 70	–	100
1 inch	–	0 to 15	–	95 to 100
3/4 inch	0 to 5	–	–	–
1/2 inch	–	0 to 5	100	25 to 60
3/8 inch	–	–	85 to 100	–
No. 4	–	–	10 to 30	0 to 10
No. 8	–	–	0 to 10	0 to 5
No. 16	–	–	0 to 5	–
No. 100[2]	0 to 2	0 to 2	0 to 2	0 to 2

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Gradation modified from ASTM for portion passing the No. 100 sieve.

2. R-Value: 78 (minimum) tested in accordance with California Test 301.

3. L.A. Abrasion: 30 percent (maximum) tested in accordance with ASTM C 131.

4. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 500 cubic yards of base material.

5. Crushed Particles: 90 percent (minimum) with two (2) or more fractured faces tested in accordance with California Test 205.

6. The combined portion of Material retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent wood waste by weight. The portion of Material passing a U.S. No. 10 sieve shall not have wood waste that results in more than 250 parts per million of organic matter by calorimetric tests when tested. The color shall be measured after the sample has been in the test solution for 1 hour.

2.03 GEOTEXTILE FOR SOIL SEPARATION

DESIGNER NOTE: Geotextile is not typically required under permeable pavement applications unless recommended by a geotechnical engineer. Geotextile can be placed vertically for material separation between side walls of reservoir course and native soil.

A. Geotextile shall be woven, consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties specified herein:

Geotextile Property	Test Method	Requirement
Grab Tensile Strength, minimum in weakest direction	ASTM D4632	200 lbs/in
Apparent Opening Size (AOS)	ASTM D4751	40 to 50
Ultraviolet (UV) Radiation Stability, minimum strength retained after 500 hours in weatherometer	ASTM D4355	50%
Flow Rate, minimum	ASTM D4491	140 gal/min/ft^2

DESIGNER NOTE: The designer should consider including specifications for signage and pavement markings in this section.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION AND PROTECTION

A. Construct subgrade to +/- ¾ inch of the grades and slopes specified on the Plans.

B. Grading of subgrade shall be with low ground pressure equipment when within six (6) inches of final subgrade elevation.

C. Compact subgrade to 90 percent (+/- 2 percent) of the maximum dry density per standard Proctor test (ASTM D698), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6939.

DESIGNER NOTE: The designer should set compaction requirements based on consideration of site specific geotechnical properties of the native soil (e.g., permeability, stiffness) and performance requirements for the pavement section (e.g., traffic loading, infiltration, cost).

D. Areas of the subgrade which are over-compacted, as determined by the Geotechnical Engineer, shall be ripped/tilled to a depth of 12 inches (minimum) or as directed by the Geotechnical Engineer, and shall be recompacted in accordance with 3.01.C. Contractor shall locate all utilities within pavement footprint prior to ripping and re-compacting subgrade

E. Proof-roll prepared subgrade with loaded dump truck, remove soft spots, and replace with permeable structural fill as directed by the Engineer to achieve uniform subgrade.

F. After compaction and proof roll, scarify subgrade ¼ to ½ inch deep by hand rake. Once scarified, materials or equipment shall not be permitted within the prepared subgrade area so as to avoid recompaction or clogging of the scarified subgrade.

G. The subgrade shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the subgrade during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

H. Areas of subgrade over-compacted by construction traffic or other impacts by the Contractor or Subcontractors shall be ripped/tilled and re-compacted in accordance with Section 3.01.D. All work and materials required to correct the over-compacted subgrade, including utility locates within the pavement footprint, shall be at the Contractor's expense.

I. Areas of subgrade contaminated by the accumulation of silty material following rains or other debris or contamination shall be removed and disposed at the Contractor's expense.

J. The subgrade shall be inspected and accepted by the Engineer prior to placement of the geotextile or pavement base.

K. Place geotextile, if required, on scarified subgrade. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer, at the Contractor's expense. Overlaps of the geotextile shall be a minimum of 1 foot or to the manufacturer's recommendation, whichever is greater.

DESIGNER NOTE: The use of geotextile under permeable pavement systems should be avoided unless required by the project geotechnical engineer as it can be prone to subsurface clogging.

3.02 PAVEMENT BASE

A. Construct pavement base to the lines, grades, and thicknesses shown on the Plans.

B. Place the pavement base so as to prevent loaded dump trucks from driving directly on the prepared subgrade.

C. Compact pavement base, in six (6)-inch (maximum) lifts, by making a minimum of three passes over the pavement base material with a ten (10)-ton vibratory roller, or as directed by the Geotechnical Engineer. The first two (2) passes (minimum) shall be in vibratory mode. The final pass shall be in static mode. Acceptance of the pavement base will be based on Engineer's observation of aggregate movement during final compaction pass. Compaction equipment shall be accepted by the Engineer prior to use.

DESIGNER NOTE: For areas or sites that cannot accommodate a vibratory roller compactor, consider allowing compaction of pavement base with a 13,500 lbf (60 kN) minimum vibratory plate compactor with a compaction indicator. At least two passes should be made over each lift of the aggregates.

D. Pavement base shall be true to the designed grade and slope, +/- 0.05 feet, after compaction for each layer. In the event of low spots additional material

shall be added and recompacted. In the event of high spots, excess material shall be removed and the area recompacted.

E. The pavement base shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the pavement base during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

F. Any damage to the pavement base (including contamination by silty run-off) shall be repaired to the satisfaction of the Engineer at the Contractor's expense. Contaminated pavement base shall be removed and replaced to the limits as determined by the Engineer.

G. The pavement base shall be inspected and accepted by the Engineer prior to placing any porous asphalt.

3.03 POROUS ASPHALT PREPARATION

DESIGNER NOTE: Designer should specify where a tack coat should be applied, if at all. See 3.03.A.2 for list of potential locations.

A. Preparation for placement of porous asphalt pavement shall comply with Section 39-1.09 of the Caltrans Standard Specifications, except as noted below.

1. Pavement Base: Confirm that the completed pavement base conforms to these specifications.

2. Tack Coat: Shall not be used except on vertical faces of curbs, edges of PCC structures, or when paving over areas with impermeable bases.

3. Geosynthetic Pavement Interlay: Shall not be used.

4. Environmental Conditions: Do not place porous asphalt when the ambient temperature is less than 60 degrees Fahrenheit, on any wet surface, or when the average ground surface temperature is less than 45 degrees Fahrenheit.

5. Qualified Personnel: The qualified foreman as defined in 1.05.B.2 shall be onsite for the duration of porous asphalt preparation.

3.04 POROUS ASPHALT PLACEMENT

DESIGNER NOTE: Designer should specify where a tack coat should be applied (e.g., face of curb, structures,) if at all.

A. Porous asphalt equipment, transportation, spreading, and compacting shall comply with the Caltrans Specification applicable to Open Graded Friction

Course (OGFC), except as noted below or as specified in the approved mix design.

B. Qualified Personnel: The qualified foreman as defined in 1.05.B.2 shall be onsite for the duration of porous asphalt placement.

C. Spreading and Compacting Equipment: shall conform to Section 39-1.10 of the Caltrans Standard Specifications except that pneumatic tire rollers shall not be used.

DESIGNER NOTE: The compaction could be established by the contractor rather than prescribed below depending on whether the contracting agency prefers to take a prescriptive approach or performance based approach. Prescriptive is used here because full depth porous asphalt is an emerging technology and there are limited density specifications for open graded (porous) asphalt mixtures. But care must be taken to ensure this prescriptive specification is compatible with the acceptance criteria.

D. Spreading and Compacting:

The type of rollers to be used and their relative position in the compaction sequence shall be dictated by the contractor provided the requirements below are met and the completed porous asphalt meets the required quality characteristics specified in Section 1.05. Deviation from the requirements below must be approved in advance by the Engineer.

1. The porous asphalt shall be laid in lifts of up to 4 inches in thickness using approved equipment to achieve the total thickness indicated in the Plans.

DESIGNER NOTE: Designer should consider using thinner lifts to the extent practical to ensure better compaction.

2. The temperature of the Porous HMA mix during laying, breakdown rolling, and finished rolling, shall be within the supplier-recommended temperature range.

3. Breakdown rolling shall be performed with one or two passes of a 7.5- to 10-ton vibratory roller operated in low amplitude mode when the mix temperature is within the supplier-recommended temperature range.

4. Finished rolling shall be performed with a double-drum finish roller operated in static mode when the mix temperature is within the supplier-recommended temperature range.

5. Finished paving shall be even, without pockets, and graded to elevations shown on the Plans. Finished porous asphalt shall meet the acceptance criteria for Smoothness set forth in Section 1.05.D.

DESIGNER NOTE: Designer should specify details of the straightedge test and tolerance if different than specified in Section 1.05E.

6. The Contractor shall take care to insure that the porous asphalt lifts join completely to previous lifts. The Contractor shall keep the time between lift placements to a minimum, keeping the surface of the previous lift clear from dust and moisture between lifts, and restrict traffic from initial lifts until the full depth of asphalt pavement has been placed.

7. Sufficient time shall be allowed between lifts to allow the asphalt to set and cool to at or below the supplier recommended maximum temperature for placement of subsequent lifts.

3.05 OPENING TO TRAFFIC

A. After final rolling, no vehicular traffic of any kind shall be permitted on the pavement surface until cooling and hardening has taken place, and in no case within the first six (6) hours. Provide traffic control measures as necessary to prevent vehicular use and remove when no longer required.

3.06 PROTECTION OF PAVEMENT

A. Hardened porous asphalt pavement surface shall be kept clean and free of clogging debris and soils from the Contractor's operations and all upstream and adjacent debris. If debris or soils contaminate the porous pavement voids, the pavement shall be cleaned at the Contractor's expense and to the satisfaction of the Engineer. If porous asphalt pavement cannot be unclogged, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

3.07 REJECTION

A. Porous asphalt that does not meet the acceptance criteria set forth in Section 1.05.E will be rejected by the Engineer. Porous asphalt that has been rejected by the Engineer shall be removed and replaced at the Contractor's expense.

END OF SECTION

DIVISION 32 – EXTERIOR IMPROVEMENTS

Section 32 13 43 – Pervious Concrete

DESIGNER NOTE: The specifications below are based on the best available information. Designer should modify the specifications to satisfy project-specific constraints.

DESIGNER NOTE: Green text corresponds to notes to the designer. Blue text corresponds to requirements taken directly from ACI 522.1.

PART 1 GENERAL

1.01 SUMMARY

A. This section includes:

1. Pervious Concrete
2. Pavement Base
3. Geotextile for Soil Separation

B. Related Sections:

DESIGNER NOTE: The designer should list any additional specification sections which relate to the pervious concrete work (i.e., temporary erosion control, utilities, earthwork, etc.)

1.02 STANDARDS AND CODES

A. Reference Standards This section incorporates by reference the latest versions of the following documents. These references are a part of this section as specified and modified.

Reference	Title
Caltrans	Standard Specifications
San Francisco DPW	Engineering Standard Specifications
AASHTO	Standards of the American Association of State Highway and Transportation Officials, 1998 or latest edition
ACI 522.1	Specifications for Pervious Concrete Pavement
ACI 301	Specifications for Structural Concrete
ACI 305.1	Standard Specifications for Hot Weather Concreting
ACI 306.1	Standard Specifications for Cold Weather Concreting
ACI 308.1	Standard Specifications for Curing Concrete
ASTM	Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, PA, 1997 or latest edition.

1.03 REFERENCES

DESIGNER NOTE: Designer to provide references to related industry manuals and guidance and all project specific documents (e.g., geotechnical report).

1.04 SUBMITTALS

A. Bid Submittals: The Contractor shall submit to the Owner the following as part of the bid proposal:

1. National Ready Mix Concrete Association (NRMCA) Pervious Concrete Contractor Certifications and project experience as specified in Section 1.05.A for the crew assigned to this project.

DESIGNER NOTE: The designer should incorporate by reference these requirements in Division 00 of the Specifications.

B. Pre-Installation Submittals: The Contractor shall submit to the Engineer the following a minimum of 20 calendar days prior to the construction of the pervious cement concrete pavement:

1. NRMCA Certifications for the batch plant to be used in the production of pervious concrete for this project.

2. Proposed mix design including the following:

a. Batch weights of all constituents.

b. Portland cement type and brand.

c. Non-Portland cement pozzolan type and source.

d. Microfiber brand and type.

e. Admixture type and brand.

f. Aggregate source(s), gradation(s), LA abrasion, and cleanness value(s).

g. Fresh density of the pervious concrete per ASTM C1688.

No concrete shall be placed until the Engineer has provided written acceptance of the mix design per Section 1.05.B.

3. Source certificates, gradations, R-values, LA abrasion, and cleanness values of aggregates for base and reservoir course materials performed within one (1) month of product delivery to site.

DESIGNER NOTE: Consider revising acceptable age of sieve test depending on scale of project. On a larger project it may be appropriate to require testing by an independent lab with samples taken at the supplier's yard from the stockpile to be used for the project.

4. Product data sheets for all proposed admixtures and geotextiles.

5. A detailed plan of the proposed paving pattern showing the location and type (saw cut or rolled in plastic concrete) of all planned joints. No deviation from the jointing pattern shown on the Plans will be allowed without written approval of the Engineer.

6. A detailed procedure for the production, transportation, placement, protection, curing, and temperature monitoring of concrete for hot

and/or cold weather, unless written approval of the Engineer waiving the requirement is received.

7. Field technician qualifications as specified in Section 1.05.A.

8. Testing agency qualifications as specified in Section 1.05.A.

9. Density of fresh pervious concrete, length of cores, and density of cores for one (1) reference panel. Reference panel shall be placed, jointed, cured, and tested as specified in Section 1.05.D.1 and be within tolerance of the required thickness defined by the Contract Documents.

1.05 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect concrete materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered later, nor shall it constitute final acceptance.

1. Contractor and Personnel Qualifications

a. Contractor qualification: Unless otherwise approved by Engineer, Contractor shall provide evidence of employment for one (1) NRMCA certified Pervious Concrete Installer and four (4) NRMCA certified Pervious Concrete Technicians who must be on site, working as members of each placement crew, during all concrete placement.

For all projects where the total pervious concrete pavement area exceeds 20,000 square feet (sf), the Contractor shall provide evidence of employment for at least one (1) NRMCA certified Pervious Concrete Craftsman who must be onsite, working as part of the placement crew, during all concrete placement. Additionally, for every 10,000 sf of pavement area over 20,000 sf, one (1) additional NRMCA certified Pervious Concrete Installer is required on site, working as part of the placement crew.

The Contractor shall provide documentation showing three (3) successful pervious concrete projects completed in the last three (3) years collectively totaling more than 20,000 square feet. Documentation shall include name and address of project, and contact information for project owner.

DESIGNER NOTE: The designer should adjust as required based on the availability of qualified bidders and the size of the project.

b. Field technician qualification: Field tests of concrete required in the responsibilities of the testing agency shall be performed by an individual certified as both an NRMCA Certified Pervious Concrete Technician, or equivalent, and an ACI Concrete Field Testing Technician – Grade I, or equivalent.

DESIGNER NOTE: The designer should adjust as required based on the availability of qualified personnel and the size of the project.

c. Testing agency qualification: Agencies that perform testing on concrete materials shall meet the requirements of ASTM C1077 and provide evidence of employment for at least one (1) NRMCA Certified Pervious Concrete Technician, responsible for testing, or providing direct oversight of testing, of all concrete materials. Agencies inspecting the Work shall meet the requirements of ASTM E329. Testing agencies performing the testing shall be accepted by the Engineer before performing any Work.

d. Batch plant qualification: Batch plant used for pervious concrete shall be a semi-automatic or automatic batching plant with a current NRMCA certification.

DESIGNER NOTE: Volumetric (truck mounted) Site Mixed Mobile Mixers may be used at the designers discretion. Mixing operations should be per manufactures directions. Designer should specify certification and calibration requirements for Volumetric Mobile Mixers including, but not limited to:

- Proof of Volumetric Mixer Manufacturer Bureau (VMMB) certification, compliance with VMMB 100-01 Volumetric Mixer Standards, and associated VMMB rating plate, or equal
- Provisions for calibration of Volumetric Mobile Mixers performed with aggregate manufactured for the project and recalibrated with each restocked stock pile

Additionally, the designer should specify required quality control measures to ensure aggregates, cementitious material, and admixtures are free from contamination from deleterious material or other stockpiles/storage containers, protected from damage by equipment, vehicles, or weather, and properly batched in lieu of batch ticket (e.g., labeling of aggregate bins to ensure correct aggregate is fed into appropriate mixer material compartment.

B. Approved Mix Design: Once accepted by the Engineer, the mix design meeting the criteria specified in Section 2.01.F shall become the Approved Mix Design and shall not be modified in any way. The Approved Mix Design shall be determined from information submitted under Section 1.04 and from results of reference panel testing as described in Section 1.05.D.1.

Modifications to the Approved Mix Design will not be allowed and any modified mix placed in the Work will be rejected. Proposed modifications to the Approved Mix Design shall be submitted as a new mix design and shall require a new reference panel to validate the proposed mix design and determine the new Approved Mix Design. If accepted by the Engineer, the

new mix design shall become the Approved Mix Design. The requirement for a new reference panel may be waived at the discretion of the Engineer. Only one (1) Approved Mix Design shall be valid at any time. Admixture and water dosages may be modified as needed to maintain mix properties.

C. Responsibilities of Contractor

1. Pre-Placement Conference: A mandatory pre-placement conference will take place including at a minimum the Engineer, the Owner, general contractor, pervious concrete installer, concrete supplier, and field testing agency representative. The document Checklist for the Concrete Pre-Construction Conference (available from the National Ready Mix Concrete Association) will be used to review all materials, personnel qualifications, concrete production, delivery, maintaining moisture retention of fresh mixture, preparation, placing, curing (including timing, placement, and securing of curing cover), jointing, testing procedures, and responsibilities. Meeting emphasis will be on how pervious concrete differs from conventional concrete.

2. Reference Panel: Place reference panels on the project site, on a subgrade and base prepared as specified, using the material and construction requirements for pavement in this Specification. Each panel must have a surface area of at least 225 square feet, and a width and thickness as specified for the pavement in the Contract Documents. The Engineer shall observe and accept each element of the pervious concrete construction. Construction and evaluation of the reference panel(s) will occur as follows:

   a. Notify the Engineer at least ten (10) Working Days before installing pervious concrete reference panel.

   b. Coordinate the location of the reference panel with the Engineer.

   c. Notify the Engineer when each element of the reference panel is ready for inspection.

   d. Remove, replace, and dispose of any unsatisfactory portions of reference panel as determined by the Engineer and at no additional cost to the Owner.

   e. Retain and maintain approved reference panels during construction in an undisturbed condition as a standard for judging completed portions of the final installations.

   Approved reference panels may remain as final installations of the Work at the discretion of the Engineer. If not retained, the reference panel shall be removed and disposed of at no additional cost to the Owner.

3. Testing facilitation: Owner's use of testing services will not relieve Contractor of the responsibility to furnish materials and construction in full compliance with the Contract Documents. Unless otherwise

specified in the Contract Documents, Contractor shall assume the following duties and responsibilities:

a. Furnish the materials to be tested, including concrete cores.

b. Furnish any necessary labor to assist Owner's testing agency in obtaining and handling samples, including concrete cores, at the project site or at the source of materials.

c. Provide measures to collect slurry and debris during coring operation in order to avoid sealing adjacent pavement.

d. Fill core holes in accordance with Section 1.05.D.2.

e. Advise Owner's testing agency at least 24 hours in advance of operations to allow for completion of quality tests and for assignment of personnel.

4. Pressure wash testing: Before final acceptance by the Engineer, the Contractor shall pressure wash the pervious concrete. Pressure washing shall be provided and completed by using portable washer equipment working at a minimum of 3,000 psi at 2.0 to 2.5 gpm. The nozzle shall be a zero degree nozzle and be held a maximum of three (3) inches off the concrete surface. The Contractor shall pressure test three (3) locations per lot or as determined by the Engineer. Any sections of pervious concrete that breaks up, ravels, or does not infiltrate shall be removed and replaced with acceptable pervious concrete to the nearest joints. The Engineer will reject the concrete if the pressure washing dislodges aggregate particles from more than two (2) percent of the pervious concrete in a single panel (joint to joint) or dislodges aggregates from a contiguous area of the pavement surface exceeding five times the nominal maximum aggregate size in any direction.

   The Contractor shall decide, after placing the pervious concrete, when to perform the quality assurance pressure wash testing for the acceptance.

DESIGNER NOTE: The designer should consider requiring verification of subgrade infiltration rate and provision to increase reservoir course depth based on results.

D. Testing

1. Reference Panel: Testing for the reference panel shall adhere to the requirements for testing of Pavement per Section 1.05.D.2 for approval by the Engineer. Each test shall meet the acceptance criteria for Reference Panel as defined in Section 1.05.E.1.

   The Engineer shall inspect and approve the reference panel prior to the placement of additional pervious concrete.

Failure to install acceptable reference panels of pervious concrete will indicate an unqualified installer.

Production sections of this Work shall not be placed until achieving a complete reference panel that fully complies with the Plans and Specifications and has written acceptance issued by the Engineer.

The completed and accepted reference panels shall be maintained and protected throughout the duration of the Work and may not be demolished and disposed of without written permission from the Engineer. If a reference panel is incorporated into the Work, it shall remain in place and be accepted as a single lot.

Unless otherwise determined by the Engineer, density testing of fresh concrete and hardened cores will be used to validate the mix design per the design criteria set forth in Section 1.04.B and the acceptance criteria in Section 1.05.E.1.

The average fresh density and average hardened density of the cores shall be the densities used for the Approved Mix Design.

2. Pavement: The following testing shall be conducted for approval by the Engineer for each reference panel and each lot of pervious concrete placed, where a lot is defined as the lesser of one (1) day's production or 5,000 square feet of pervious concrete, in place, unless otherwise specified below:

   a. Density testing of at least one (1) cubic foot of fresh concrete in accordance with ASTM C1688.

   b. Thickness testing of three (3), four- (4)-inch hardened concrete cores in accordance with ASTM C174 and adhering to the following requirements:

      1) Removed not less than seven (7) days after placement of pervious concrete.

      2) Location selected in accordance with ASTM D3665.

      3) Cut in accordance with ASTM C42.

   c. Density and void content testing of the three (3) hardened concrete cores extracted for thickness testing and trimmed to produce flat core ends per ASTM C42 paragraph 7.4.1 and 7.4.2. Samples shall be tested in accordance with ASTM C1754.

   d. Surface infiltration tests per ASTM C1701 and at the frequency described below.

      1) Three (3) test locations per 10,000 square feet of pervious concrete, in place

      2) One (1) additional test location per 5,000 square feet of pervious concrete, or fraction thereof, in place

DESIGNER NOTE: Designer to specify the number and location(s) of required post construction infiltration tests.

Core holes shall be filled with solid concrete, pre-blended grout, or pervious concrete and shall match adjacent pavement color, and grade. At the Engineer's discretion, a sacrificial panel for cores may be required or allowed.

Each test shall meet the acceptance criteria for Pavement as defined in Section 1.05.E.2.

E. Acceptance

1. Reference Panel: Acceptance of the reference panel will be based on the criteria for acceptance of Pavement per Section 1.05.E.2 with the following deviations:

   a. Hardened Density: The density of each core shall be within five (5) pounds per cubic foot of the average hardened density of the three (3) cores.

   b. Fresh Density: The fresh density shall be within or equal to five (5) pounds per cubic foot of the average fresh density of the three (3) samples.

2. Pavement: Acceptance of a lot of pervious concrete will be based on the following criteria:

   a. Smoothness: Pervious concrete pavement smoothness shall be checked with a 10-foot straightedge. Vertical measurement should be taken between the pavement's determined plane and straight edge, discounting surface void and roughness irregularities, in a direction perpendicular and parallel to the centerline. The finished pavement shall be uniform to a degree such that no variations greater than 3/8-inch are present between the straight edge and pavement surface over a distance of at least 6 inches.

   b. Grade: Pervious concrete shall be true to designed spot elevations plus or minus ½ inch and shall not deviate from designed slope more than ¼ inch in ten (10) feet. Where abutting existing facilities such as sidewalks, walkways, curbs, driveways or other pavements, the pervious concrete shall be flush.

   c. Line: Pervious concrete margins shall be true to designed lines plus or minus ½ inch at any point.

   d. Slope: Pervious concrete shall be sloped as shown on the Plans. Slope shall be consistent to within 1/4 inch in ten (10) feet.

   e. Thickness: Each core sample shall be equal to the minimum section depth or more as specified on the Plans.

f. Hardened Density: The density of the core samples for each lot shall be within five (5) pounds per cubic foot of the density as accepted in the reference panel.

g. Void Content: The total void content of the core samples for each reference panel and lot shall be twenty (20) percent, plus or minus five (5) percent, in place, as constructed.

h. Infiltration Rate: The average of all surface infiltration tests shall be greater than 250 inches per hour with no single test less than 100 inches per hour.

DESIGNER NOTE: The designer should adjust infiltration rates to reflect project specific conditions such as anticipated sediment loading based on pavement use (e.g., vehicular, pedestrian) and design run-on from adjacent surfaces. The recommended criteria are as follows:

- For permeable pavement that will accept run-on from adjacent impervious and/or pervious surfaces OR pavement that will be subject to vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 250 inches per hour with no single test less than 100 inches per hour
- For permeable pavement not subject to run-on OR vehicular traffic:
  - The average of all surface infiltration tests shall be greater than 100 inches per hour with no single test less than 75 inches per hour

i. Fresh Density: The fresh density shall be within or equal to five (5) pounds per cubic foot of the fresh density indicated by the Approved Mix Design.

j. Batch Ticket: Each load of pervious concrete transported to the location of placement shall have a Batch Ticket delivered with the load. Batch Tickets shall be provided upon request for each load and shall be in accordance with ASTM C94, with the following additions:

1) Batch weights of all constituents in the mix, including cement, aggregate, admixtures, water, and fibers

2) Signature of responsible representative of the concrete producer, affirming the accuracy of the information provided

k. Appearance: Each lot of finished pervious concrete will be inspected for appearance by the Engineer after completion of pressure wash testing per Section 1.05.C.4. The pervious concrete shall have a consistent surface texture, shall have no

more than five (5) percent of the surface area within each panel (joint to joint) filled with paste, shall be free of ridges or other surface imperfections, shall have joints that are in the specified location and are constructed per specification, shall be free of cracks and shall not be raveled.

A panel will be considered raveled if aggregate is dislodged from a contiguous area of the pavement surface or longitudinally along a joint exceeding five times the nominal maximum aggregate size in any direction OR if aggregate particles are dislodged from more than two (2) percent of the pervious concrete within each panel (joint to joint).Raveling occurring during the first three (3) months after installation is subject to complete removal and replacement of affected panels with acceptable pervious concrete at the Owner's discretion and Contractor's expense. Requirement to replace affected panels shall continue until three (3) months after the date of replacement. Written notification of defects is the sole responsibility of the Owner.

DESIGNER NOTE: The designer should incorporate by reference these requirements in Division 00 of the Specifications.

I. Conformance to Approved Mix Design: The pervious concrete used shall conform to the Approved Mix Design within the limits set forth in ASTM C94.

3. Required Inspections: Notify the Engineer at least 48 hours prior to required inspections specified in Sections 3.01, 3.02, and 3.03.B.

PART 2 PRODUCTS

DESIGNER NOTE: Designers should maximize the use of regionally available materials.

2.01 PERVIOUS CONCRETE

DESIGNER NOTE: No reinforcing bars or tie bars will be used in the installation of pervious concrete.

Pervious Concrete shall comply with ASTM C94, except sections 4.2, 6.1.2, 6.1.3, 6.1.4, 6.1.5, 7, 8, 16, 17, 18, 19, 20 and the requirements specified herein. The volume of fresh concrete in a given batch shall be determined from the total mass of the batch divided by the design density of the concrete. The total mass of the batch shall be determined as the net mass of the concrete in the batch as delivered, including the total mixing water as defined in ASTM C94 Paragraph 9.3.

A. Cement: Cement in the mix design shall conform to the requirements for Portland Cement or Blended Hydraulic Cement as specified herein:

1. Portland Cement: Portland Cement shall meet the requirements of ASTM C150 Type I, II, or V Portland cement.

2. Blended Hydraulic Cement: Blended Hydraulic Cement shall be Type IP or IS Cement conforming to ASTM C595. Type IP(X), Portland Pozzolan Cement, and IS(X) where (X) dictates pozzolan and slag percentage, respectively, shall be Portland Cement and Pozzolan. The pozzolan shall be limited to fly ash or ground granulated blast furnace slag.

   The fly ash or ground granulated blast furnace slag constituent content in the finished cement shall not vary more than plus or minus 5 percent by weight of the finished cement from the certified value.

3. Supplementary cementitious material shall be as specified herein:

   a. Fly Ash: Fly ash shall conform to the requirements of ASTM C618, Class F or C.

   b. Slag Cement: Slag cement shall meet the requirements of ASTM C989, Grade 100 or Grade 120.

   c. Silica Fume: Silica fume shall meet the requirements of ASTM C1240.

B. Aggregates: Aggregates shall conform to ASTM C33 except as specified herein, unless otherwise approved by the Engineer.

1. Aggregate Gradation tested in accordance with ASTM C136 at least once per 300 cubic yards of concrete.

Sieve[1]	Percent Passing by Weight				
	Coarse Aggregate				Fine Aggregate
	ASTM No. 7	ASTM No. 8	ASTM No. 89	ASTM No. 9	
2 inch	–	–	–	–	–
1 1/2 inch	–	–	–	–	–
1 inch	–	–	–	–	–
3/4 inch	100	–	–	–	–
1/2 inch	90 to 100	100	100	–	–
3/8 inch	40 to 70	85 to 100	90 to 100	100	100
No. 4	0 to 15	10 to 30	22 to 55	85 to 100	95 to 100
No. 8	0 to 5	0 to 10	5 to 30	10 to 40	80 to 100
No. 16	–	0 to 5	0 to 10	0 to 10	50 to 85
No. 30	–	–	0 to 5	0 to 5	25 to 60
No. 50	–	–	–	–	5 to 30
No. 100	–	–	–	–	0 to 10
No. 200	–	–	–	–	0 to 3

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

In individual tests, a variation of 4 percent under the minimum percentages or over the maximum percentages will be allowed. The average of three successive tests shall be within the

percentages stated above. Aggregate shall contain no pieces larger than two times the maximum sieve size for the specified grading measured along the line of greatest dimension.

2. Coarse Aggregate

   a. LA Abrasion: 35 percent (maximum) tested in accordance with ASTM C131 at least once per 300 cubic yards of concrete.

   b. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 300 cubic yard of concrete.

3. Acceptance of grading and quality of the aggregate may be based on samples taken from stockpiles at the concrete plant or a submitted gradation report at the discretion of the Engineer. The point of acceptance will be determined in the field by the Engineer.

C. Admixtures

1. Air Entraining Admixtures: Air entraining admixtures shall meet the requirements of ASTM C260.

2. Water Reducing Admixtures: Water reducing admixtures shall meet the requirements of ASTM C494, Type A.

3. Hydration Stabilizing Admixtures: Hydration stabilizing admixtures shall meet the requirements of ASTM C494, Type B or Type D.

4. Superplasticizers: Superplasticizers and retarders shall meet the requirements of ASTM C494, Type F or Type G and ASTM C1017, Type 1.

5. Viscosity Modifying Admixtures: Viscosity modifying admixtures may be used if approved by the Engineer.

6. Color Pigment: Color pigment shall meet the requirements of ASTM C979 for integrally colored concrete. Pigments shall be color stable, non-fading, and resistant to lime and other alkalis.

   DESIGNER NOTE: Designer to specify color, as indicated by manufacturer's designation, architect's sample, etc. with provision for approved equal color.

D. Water: Clean potable water or water conforming to ASTM C1602 shall be used in the mix design and on the jobsite. The use of hot water is not permitted.

E. Microfibers: Microfibers shall conform to the requirements of ASTM C1116, Type III and shall be monofilament and ½ inch in length.

F. Mix Design:

1. General: The Contractor shall propose a mix design for pervious concrete and shall submit the mix design to the Engineer for acceptance prior to constructing the reference panels. Pervious concrete shall not

be placed in the reference panels without a mix design that has been reviewed and accepted by the Engineer.

2. Mix Design Criteria: The Contractor shall include the following elements and results of the described procedures in the proposed mix design:

   a. The cementitious content, including pozzolans if used, shall be a minimum of 480 and a maximum of 600 pounds per cubic yard.

   b. The mix may incorporate up to 5 percent fine aggregate, by weight.

   c. The mix shall incorporate a hydration stabilizing admixture.

   d. The mix may incorporate microfibers or fibers per Manufacturer's recommendations.

   e. The mix shall be designed to meet the acceptance criteria for Void Content per Section 1.05.F.2 as determined by the testing methods specified in Section 1.05.E.2.

   f. The water/cement ratio shall be between 0.27 and 0.35.

   g. Up to 50 percent of cementitious material in the mix, by weight, may be fly ash, slag cement, or a combination of silica fume and either or both of the above, with silica fume not exceeding 10 percent.

   Deviations from this mix design, such as the use of internal curing admixtures, cementitious content outside of the range specified, or finer aggregate gradations may be permitted at the sole discretion of the Engineer provided the Contractor can demonstrate the viability of the mix design through past successful installations or sound science.

2.02 PAVEMENT BASE

A. Pavement Base Material shall consist of clean, mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove clay, organic matter, extraneous debris, or objectionable materials. Recycled materials or round river gravel are not permitted. Material shall be obtained only from a source(s) approved by the Engineer. Written requests for source approval shall be submitted to the Engineer not less than Working 10 days prior to the intended use of the Material. Should the proposed source be one that the Engineer has no history of Material performance with, the Engineer reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract. The Engineer shall reserve the right to sample and test Material at any time including at the source.

B. Pavement Base shall consist of up to two (2) layers as specified on the Plans and included herein:

1. "Base Course" shall be ASTM No. 3 (modified) or ASTM No. 57 (modified) stone per Section 2.02.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide structural (load bearing) capacity to the pavement.

2. "Reservoir Course" shall be ASTM No. 2 (modified), ASTM No. 3 (modified), or ASTM No. 57 (modified) stone per Section 2.02.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide storage and drainage of the pavement, structural support, and a capillary break. The materials specified should be crushed, clean, washed rock to provide the desired structural capacity, maintain good drainage, function as a capillary barrier, and minimize clogging of the subgrade due to export of fines.

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying courser graded materials or reduction in permeability relative to the underlying material. Refer to the SFPUC aggregate filter criteria guidance document for information on selecting appropriate alternate materials.

C. Pavement Base Material shall meet the following specifications for grading and quality.

1. Aggregate Gradation tested in accordance with ASTM C136 at least once per 500 cubic yards of base material.

Sieve[1]	Percent Passing by Weight			
	ASTM No. 2 (modified)	ASTM No. 3 (modified)	ASTM No. 8 (modified)	ASTM No. 57 (modified)
3 inch	100	–	–	–
2 1/2 inch	90 to 100	100	–	–
2 inch	35 to 70	90 to 100	–	–
1 1/2 inch	0 to 15	35 to 70	–	100
1 inch	–	0 to 15	–	95 to 100
3/4 inch	0 to 5	–	–	–
1/2 inch	–	0 to 5	100	25 to 60
3/8 inch	–	–	85 to 100	–
No. 4	–	–	10 to 30	0 to 10
No. 8	–	–	0 to 10	0 to 5
No. 16	–	–	0 to 5	–
No. 100[2]	0 to 2	0 to 2	0 to 2	0 to 2

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Gradation modified from ASTM for portion passing the No. 100 sieve.

2. R-Value: 78 (minimum) tested in accordance with California Test 301.
3. L.A. Abrasion: 30 percent (maximum) tested in accordance with ASTM C131.
4. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 500 cubic yards of base material.
5. Crushed Particles: 90 percent (minimum) with two (2) or more fractured faces tested in accordance with California Test 205.
6. The combined portion of Material retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent wood waste by weight. The portion of Material passing a U.S. No. 10 sieve shall not have wood waste that results in more than 250 parts per million of organic matter by calorimetric tests when tested. The color shall be measured after the sample has been in the test solution for 1 hour.

2.03 GEOTEXTILE FOR SOIL SEPARATION

DESIGNER NOTE: Geotextile is not typically required under permeable pavement applications unless recommended by a geotechnical engineer. Geotextile can be placed vertically for material separation between side walls of reservoir course and native soil.

A. Geotextile shall be woven, consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties specified herein:

Geotextile Property	Test Method	Requirement
Grab Tensile Strength, minimum in weakest direction	ASTM D4632	200 lbs/in
Apparent Opening Size (AOS)	ASTM D4751	40 to 50
Ultraviolet (UV) Radiation Stability, minimum strength retained after 500 hours in weatherometer	ASTM D4355	50%
Flow Rate, minimum	ASTM D4491	140 gal/min/ft^2

DESIGNER NOTE: The designer should consider including specifications for signage and pavement markings in this section.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION AND PROTECTION

A. Construct subgrade to +/- ¾ inch of the grades and slopes specified on the Plans.

B. Grading of subgrade shall be with low ground pressure equipment when within six (6) inches of final subgrade elevation.

C. Compact subgrade to 90 percent (+/- 2 percent) of the maximum dry density per standard Proctor test (ASTM D698), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6939.

DESIGNER NOTE: The designer should set compaction requirements based on consideration of site specific geotechnical properties of the native soil (e.g., permeability, stiffness) and performance requirements for the pavement section (e.g., traffic loading, infiltration, cost).

D. Areas of the subgrade which are over-compacted, as determined by the Geotechnical Engineer, shall be ripped/tilled to a depth of 12 inches (minimum) or as directed by the Geotechnical Engineer and shall be recompacted in accordance with Section 3.01.C. Contractor shall locate all utilities within pavement footprint prior to ripping and re-compacting subgrade.

E. Proof-roll prepared subgrade with loaded dump truck, remove soft spots, and replace with permeable structural fill as directed by the Engineer to achieve uniform subgrade.

DESIGNER NOTE: Other subgrade verification methods may be required if site conditions limit proof rolling. Consult with geotechnical engineer for acceptable methods.

F. After compaction and proof roll, scarify subgrade ¼- to ½-inch deep by hand rake. Once scarified, materials or equipment shall not be permitted within the prepared subgrade area so as to avoid recompaction or clogging of the scarified subgrade.

G. The subgrade shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the subgrade during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

H. Areas of subgrade over-compacted by construction traffic or other impacts by the Contractor or Subcontractors shall be ripped/tilled and re-compacted in accordance with Section 3.01.D. All work and materials required to correct over-compacted subgrade, including utility locates within the pavement footprint, shall be at the Contractor's expense.

I. Areas of subgrade contaminated by the accumulation of silty material following rains or other debris or contamination shall be removed and disposed at the Contractor's expense.

J. The subgrade shall be inspected and accepted by the Engineer prior to placement of the geotextile or pavement base.

K. Place geotextile, if required, on scarified subgrade. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer at no additional cost to the Owner. Overlaps of the geotextile shall be a minimum of one (1) foot or to the manufacturer's recommendation, whichever is greater.

DESIGNER NOTE: The use of geotextile under permeable pavement systems should be avoided unless required by the project geotechnical engineer as it can be prone to subsurface clogging.

3.02 PAVEMENT BASE

A. Construct pavement base to the lines, grades, and thicknesses shown on the Plans.

B. Place the pavement base so as to prevent loaded dump trucks from driving directly on the prepared subgrade.

C. Compact pavement base, in six (6) inch (maximum) lifts, by making a minimum of three passes over the pavement base material with a ten (10) ton vibratory roller, or as directed by the Geotechnical Engineer. The first two (2) passes (minimum) shall be in vibratory mode. The final pass shall be in static mode. Acceptance of the pavement base will be based on Engineer's observation of aggregate movement during final compaction pass. Compaction equipment shall be accepted by the Engineer prior to use.

DESIGNER NOTE: For areas or sites that cannot accommodate a vibratory roller compactor, consider allowing compaction of pavement base with a 13,500 lbf (60 kN) minimum vibratory plate compactor with a compaction indicator. At least two passes should be made over each lift of the aggregates.

D. Pavement base shall be true to the designed grade and slope, +/- 0.05 feet, after compaction for each layer. In the event of low spots, additional material shall be added and recompacted. In the event of high spots, excess material shall be removed and the area recompacted.

E. The pavement base shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the pavement base during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

F. Any damage to the pavement base (including contamination by silty run-off) shall be repaired to the satisfaction of the Engineer at the Contractor's expense. Contaminated pavement base shall be removed and replaced to the limits as determined by the Engineer.

G. The pavement base shall be inspected and accepted by the Engineer prior to placing any pervious concrete.

DESIGNER NOTE: Consider developing a testing plan for the required testing and inspection of the pavement base. Verification of the in place density/compaction of the open graded base materials is typically not possible with the use of a nuclear densometer due to nature of these materials. Therefore other means to verify these materials are firm and unyielding (such as observation of the compaction process by a geotechnical engineer) are necessary.

DESIGNER NOTE: Consider requiring the Contractor to compact aggregates without crushing them.

3.03 MIXING, PLACEMENT & CURING OF PERVIOUS CONCRETE

A. Pervious concrete formwork

1. Forms shall be made of steel or wood and shall be in good condition, clean, and capable of being anchored in place so as to ensure pavement placement true to the grades, lines and slopes as specified on the Plans.
2. Forms that are bent, warped, unclean, or otherwise deemed inadequate by the Engineer shall not be used.
3. Existing curbs, structures, or the vertical face of previously placed pervious concrete may be used as a form.
4. Set, align, and brace forms to satisfy the lines, grades, and slopes on the Plans.
5. Apply form-release agent to the form face immediately before placing concrete.
6. No pervious concrete shall be placed until the forms are inspected and accepted by the Engineer.
7. Slip forming is an acceptable method for placement of pervious concrete.

B. Batching, mixing, and delivery

1. Pervious concrete shall be batched and centrally mixed at a batching plant meeting the requirements set forth in Section 1.06.A.4. Pervious concrete shall not be shrink mixed or transit mixed.
2. Begin mixing immediately after cement has been added to aggregates. Batch and mix concrete in compliance with ASTM C94, with the following exceptions:

a. Placement of concrete shall occur no more than 60 minutes from the time water or aggregate is added to the cement.

b. If a hydration-stabilizing admixture is used, up to 60 minutes may be added to the placement time, resulting in a maximum placement time of 120 minutes.

Additional water may be added on site, but the fresh density must still meet the requirements of Section 2.01.F.2 after water addition.

C. Placing and consolidation

1. Pervious concrete shall not be placed on standing water or frozen pavement base.

2. Wet the pavement base with water before concrete placement such that the material is saturated but without any standing water on the prepared base immediately before concrete placement.

3. Place pervious concrete on the prepared pavement base as close to its final position as possible, either directly from the transporting equipment or by conveyor, unless otherwise specified. Spread the concrete using mechanized equipment or hand tools, without segregation.

4. Strike off concrete between forms using a form riding paving machine or roller screed at the appropriate height, as determined by the Contractor, to allow for compaction to finished grade. Equipment used for striking off the pervious concrete shall leave a smooth surface, free of ridges or other imperfections, without drawing excessive paste to the surface. Vibratory screeds are not permitted. Other strike-off devices may be used when accepted by the Engineer.

5. Compact pervious concrete with a purpose built pervious concrete cross roller or alternate method approved by the Engineer. Rollers shall be of sufficient weight and width to compact the fresh pervious concrete to grade, leaving a smooth surface, free of ridges or other imperfections, without drawing excessive paste to the surface. Compacted pervious concrete shall meet the acceptance criteria for Smoothness set forth in Section 1.05.E.2.

6. Contractor's personnel shall take care to avoid foot traffic in the pervious concrete to prevent non-uniform compaction and to keep contaminated material from entering the pavement mix. Foot traffic on the fresh concrete shall not be allowed after it has been struck off.

7. Place pervious concrete continuously. Where placement has been halted for a period of 15 minutes, a header shall be placed between the forms and a construction joint formed. The construction joint shall be located at a contraction joint location, unless otherwise approved by the Engineer. The pervious concrete shall be compacted and finished to the header before placement may continue. Upon resuming placement, the header may be carefully removed and a construction joint formed at

that location. Any sloughing or sagging of the previously placed pervious concrete at the header location shall be corrected prior to placing new pervious concrete against the joint.

D. Edging: Edging of the top surface shall be completed in plastic concrete to a radius of not less than 1/4 inch. Defects shall be repaired immediately.

E. Jointing: Joints shall be of three (3) types: construction, contraction, and isolation. Wherever possible, the angle between intersecting joints shall be between 80 and 100 degrees. Construct joints at the locations and to the horizontal dimensions indicated on the Plans.

1. Construction Joints: Construction joints shall be formed at the end of a day's work or when necessary to stop production for any reason.

   a. Construction joints shall be located as near as possible to the location of a planned contraction or isolation joint.

   b. Construction joints are to be formed by placing a header between the forms, at right angles, to the full depth of the finished pervious concrete, and set to the height of the forms. Pervious concrete shall be placed against the header and compacted and finished as normal, including edging.

   c. Upon resuming paving, the header shall be carefully removed and new pervious concrete placed directly against the existing pervious concrete. The new pervious concrete shall be compacted and finished against the hardened pervious concrete as if it were a form.

   d. If an isolation joint is planned at this location, then the premolded joint filler shall be placed against the existing pervious concrete and the new pervious concrete shall be placed against the premolded joint filler. The joint shall be tooled on both sides of the premolded joint filler.

2. Contraction Joints: Contraction joints shall be used to control random cracking.

   a. Contraction joints shall be placed every 15 feet unless otherwise shown on the Plans.

      DESIGNER NOTE: Designer should consider size and aspect ratio of panels when locating joints.

   b. Plastic Formed Joints: Contraction joints may be formed in the plastic concrete using a roller designed for this purpose or by other methods accepted by the Engineer.

      1) Rollers shall have sufficient weight to produce the joint and shall not otherwise damage or mar the surface.

      2) Plastic formed joints shall be a minimum depth of 1 and 3/4 inches and have a width of no more than 1/8 inch.

3) Joints shall be tooled on both sides of the joint with a radius not less than 1/4 inch.

c. Saw Cut Joints: At the option of the Contractor, contraction joints may be saw cut provided joints are early-entry dry-cut type.

1) Joints shall be cut using purpose built early-entry saw cutting equipment.

2) Saw cut joints shall be a minimum depth of 1/4 of the pervious concrete thickness, up to a maximum required depth of 1 and 1/4 inches, and have a joint width of no more than 1/8 inch.

3) Saw cutting shall occur as soon as the concrete is sufficiently cured so that it may be cut without raveling or dislodging aggregate from the finished surface, no longer than four (4) hours after placement of pavement.

4) Remove cuttings from surface immediately after saw cutting of joints.

5) To minimize drying, curing materials shall be removed only as needed to make cuts and shall be replaced immediately after cutting. The exposed pervious concrete shall be kept moist for the entire duration of exposure.

3. Isolation Joints: Isolation joints shall be used where the pervious concrete abuts existing facilities or where shown on the Plans.

a. Isolation joints shall continue through the depth of the pervious concrete using a 3/8 inch premolded joint filler.

b. Isolation joints may be formed by inserting the premolded joint filler into the plastic concrete or by forming a construction joint and affixing the premolded joint filler against one side of the joint and placing fresh pervious concrete against it.

c. Isolation joints and filler shall be flush with the surrounding pervious concrete and shall not deviate from the acceptance criteria for Grade as specified in Section 1.05.E.2.

d. The edges of the pervious concrete on either side of the premolded joint filler shall be hand tooled to a radius not less than 1/4 inch.

F. Curing

1. Begin curing within 20 minutes of concrete discharge from the truck, unless otherwise specified or approved by the Engineer.

2. Completely cover the pavement surface and all exposed edges with a minimum six- (6)-mil-thick white polyethylene sheet, unless otherwise specified or approved by the Engineer. No wetted burlap or cloth shall be used.

3. Thoroughly secure a polyethylene sheet at all exterior edges and interior laps without using soil. The method of securing the cover material shall prevent wind from removing the sheet and from blowing under the sheet across the surface of the concrete.
4. Curing compound shall not be used on any pervious cement concrete surface.
5. Cure pavement for a minimum of 7 uninterrupted days, unless otherwise specified or approved by the Engineer.
6. With the exception of saw cutting equipment, all traffic shall be kept off of the pervious concrete during the curing period.
7. Any testing for acceptance shall not occur until the end of the curing period.

G. Cold-weather construction

1. Protect concrete from freezing and record concrete temperature no less than twice per 24-hour period in accordance with ACI 306.1.

3.04 OPENING TO TRAFFIC

A. No traffic shall be allowed on the pervious cement concrete pavement for 10 days.

3.05 PROTECTION OF PAVEMENT

A. Cured and exposed pervious cement concrete pavement surface shall be kept clean and free of clogging debris and soils from the Contractor's operations and all upstream and adjacent debris. If debris or soils contaminate the pervious pavement voids, the pavement shall be cleaned at the Contractor's expense and to the satisfaction of the Engineer. If pervious cement concrete pavement cannot be unclogged, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

3.06 REJECTION

A. Pervious concrete that does not meet the acceptance criteria set forth in Section 1.05.E.2 will be rejected by the Engineer on a lot-by-lot basis. Pervious concrete that has been rejected by the Engineer or the Contractor shall be removed and replaced at no additional cost to the Owner.

END OF SECTION

DESIGNER NOTE: The specifications below are based on the best available information. Designer should modify the specifications to satisfy project-specific constraints. The City uses the term “Permeable Unit Pavers” when infiltration achieved via aggregate filled joints and “Porous Unit Pavers” when infiltration is achieved through the paver material itself.

DESIGNER NOTE: Green text corresponds to notes to the designer.

PART 1 GENERAL

1.01 SUMMARY

A. This section Includes:

1. Permeable/Porous Unit Pavers
2. Joint Filter Aggregate
3. Pavement Base
4. Edge Restraints
5. Geotextile for Soil Separation

B. Related Sections

DESIGNER NOTE: The designer should list any additional specification sections which relate to the permeable/porous unit paver work (i.e., temporary erosion control, utilities, earthwork, etc.)

1.02 STANDARDS AND CODES

A. Reference Standards: This section incorporates by reference the latest version of the following documents. These references are a part of this section as specified and modified.

Reference	Title
Caltrans	Standard Specifications
San Francisco DPW	Engineering Standard Specifications
ASTM C67	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM C13	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Method for Sieve Analysis for Fine and Coarse Aggregate
ASTM C140	Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
ASTM D448	Standard Classification for Sizes of Aggregate for Road and Bridge Construction

ASTM C936	Standard Specification for Solid Interlocking Concrete Pavers
ASTM C979	Specification for Pigments for Integrally Colored Concrete
ASTM C1781	Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems
ASTM E2835	Standard Test Method for Measuring Deflections using a Portable Impulse Plate Load Test Device

1.03 REFERENCES

DESIGNER NOTE: Designer to provide references to related industry manuals and guidance and all project specific documents (e.g., geotechnical report).

A. Interlocking Concrete Pavement Institute (ICPI)

1. Permeable Interlocking Concrete Pavement manual.

DESIGNER NOTE: The designer should consider the use of the ICPI Permeable Design Pro software for structural design and determination of adequate depth for the pavement section.

1.04 SUBMITTALS

A. Bid Submittals: The Contractor shall submit to the Owner the following as part of the bid proposal:

1. Paver Installation Subcontractor:

a. A copy of Subcontractor's current certificate from the Interlocking Concrete Pavement Institute's Concrete Paver Installer Certification program.

b. Job references from three (3) projects of a similar size and complexity. Provide Owner/Client/General Contractor names, postal address, phone number, and email address.

DESIGNER NOTE: The designer should incorporate by reference these requirements in Division 00 of the Specifications.

B. Pre-Installation Submittals: The Contractor shall submit to the Engineer the following a minimum of 20 calendar days prior to the construction of the permeable/porous unit pavers:

1. Paver manufacturer's/installation subcontractor's drawings and details indicating perimeter conditions, junctions with other materials, expansion and control joints, paver layout/patterns, joint spacing and/or tabs, color arrangement, and installation [and setting] procedures. Drawings and details shall also indicate layout, pattern and relationship of paving joints to fixtures and project formed details.

2. Source certificates, gradations, R-values, LA abrasion, and cleanness values of aggregates for base, reservoir course, and joint filler materials performed within one (1) month of product delivery to site.

   DESIGNER NOTE: Consider revising acceptable age of sieve test depending on scale of project. On a larger project it may be appropriate to require testing by an independent lab with samples taken at the supplier's yard from the stockpile to be used for the project.

3. Product data sheets for unit pavers and geotextiles.

4. Laboratory test reports certifying compliance of the concrete pavers with ASTM C936.

5. Manufacturer's certification of concrete pavers by ICPI as having met applicable ASTM standards.

DESIGNER NOTE: Especially when using colored pavers, consider requiring submittal of full-size samples of each paver type, thickness, color, and finish. Require submittal of samples indicating the range of color expected in the finished installation. Accepted samples would become the standard of acceptance for the work of this Section.

1.05 QUALITY CONTROL AND QUALITY ASSURANCE

A. General: Test and inspect permeable/porous unit paver materials and operations as Work progresses as described in this section. Failure to detect defective Work or materials at any time will not prevent rejection if a defect is discovered later, nor shall it constitute final acceptance.

1. Paver Installation Subcontractor Qualifications:

2. Installer shall provide documentation showing three (3) successful permeable/porous unit paver installations completed in the last three (3) years, collectively totaling more than 10,000 square feet. Documentation shall include name and address of project, and contact information for project owner.

3. Installer shall utilize job foremen holding a record of completion from the Interlocking Concrete Pavement Institute PICP Installer Technician Course.

DESIGNER NOTE: Consider changing these requirements to match scale and complexity of project including a minimum total amount of pavers placed.

B. Responsibilities of Contractor

1. Pre-Placement Conference: A mandatory pre-placement conference will take place, including at a minimum the Engineer, the Owner, general Contractor, and paver installer, to review the manufacturers' quality control plan, personnel qualifications, and the paver installers' Method Statement and Quality Control Plan.

2. Reference Panel: Place reference panels on the project site, on a subgrade and base prepared as specified, using the material and construction requirements for pavement in this Specification. Each panel must have a surface area of at least 100 square feet (sf), and a width and thickness as specified for the pavement in the Contract Documents. The Engineer shall observe and accept each element of the paver construction prior to the placement of additional pavement. Failure to install acceptable reference panels of permeable/porous unit pavers will indicate an unqualified installer. Construction and evaluation of the reference panel(s) will occur as follows:

   a. Notify the Engineer at least ten (10) Working Days before installing paver reference panel.

   b. Coordinate the location of the reference panel with the Engineer.

   c. Notify the Engineer when each element of the reference panel is ready for inspection.

   d. Remove, replace, and dispose of any unsatisfactory portions of reference panel as determined by the Engineer and at no additional cost to the Owner.

   e. Retain and maintain approved reference panel during construction in an undisturbed condition as a standard for judging completed portions of the final installations.

   Approved reference panels may remain as final installations of the Work at the discretion of the Engineer. If not retained, the reference panel shall be removed and disposed at no additional cost to the Owner.

   DESIGNER NOTE: Mechanized installations may require a larger mock up area. Consult with the paver installation (Sub) Contractor on the size of the reference panel.

   DESIGNER NOTE: Use this panel to determine expected settlement (surcharge) of the leveling course, joint sizes, and lines, laying pattern, color and texture of the job.

   DESIGNER NOTE: The designer should consider requiring verification of subgrade infiltration rate and provision to increase reservoir course depth based on results.

3. Infiltration Testing: Perform surface infiltration tests per ASTM C1781 as described below.

   a. Three (3) test locations per 10,000 square feet of permeable/porous unit pavers, in place

   b. One (1) additional test location per 5,000 square feet of permeable/porous unit pavers, or fraction thereof, in place

   DESIGNER NOTE: Designer to specify the number and location(s) of required post construction infiltration tests.

C. Acceptance

1. The surface elevation of pavers shall be 1/8 to 1/4 inch (3 to 6 mm) above adjacent drainage inlets, concrete collars or channels.
2. Lippage: No greater than 1/8 inch (3 mm) difference in height between adjacent pavers.
3. Bond lines for paver courses shall be within ½ inch (± 15 mm) over a 50-foot (15 m) string line.
4. The final surface tolerance of compacted pavers shall not deviate more than ± 3/8 inch (10 mm) under a 10-foot (3 m) long straightedge.
5. Infiltration Rate: The average of all tests shall be greater than 50 inches per hour with no single test less than 25 inches per hour.

   DESIGNER NOTE: The designer should adjust infiltration rates to reflect project specific conditions such as anticipated sediment loading based on pavement use (e.g., vehicular, pedestrian) and design run-on from adjacent surfaces. The recommended criteria are as follows:

   - For permeable/porous unit pavers that will accept run-on from adjacent impervious and/or pervious surfaces OR pavement that will be subject to vehicular traffic:
     - The average of all surface infiltration tests shall be greater than 100 inches per hour with no single test less than 50 inches per hour
   - For permeable pavement not subject to run-on OR vehicular traffic:
     - The average of all surface infiltration tests shall be greater than 50 inches per hour with no single test less than 25 inches per hour

DESIGNER NOTE: The surface of the pavers may be 1/8 to 1/4 inch (3 to 6 mm) above the final designed elevations after compaction. This helps compensate for possible minor settling normal to pavements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirement Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged container packaging with identification tags intact on each paver bundle.

1. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.
2. Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by forklift or clamp lift.

D. Unload pavers at job site in such a manner that no damage occurs to the product or existing construction.

E. Storage and Protection: Store materials in a protected area such that they are kept free from mud, dirt, and other foreign materials.

1.07 MAINTENANCE

DESIGNER NOTE: Consider requiring the provision of additional pavers to be retained and stored by the Owner for future maintenance.

- Extra materials: Provide [Specify area] [Specify percentage] additional material for use by Owner for maintenance and repair.
- Extra pavers shall be from the same production run as installed materials.

PART 2 PRODUCTS

DESIGNER NOTE: Some projects may include permeable/porous and solid unit pavers. Specify each product, as required.

2.01 PERMEABLE/POROUS UNIT PAVERS

A. Manufacturer: [Specify manufacturer name.].

1. Contact: [Specify ICPI member manufacturer contact information.].

B. Permeable/Porous Unit Paver Type: [Specify name of product group, family, series, etc.].

1. Material Standard: Comply with ASTM C 936.
2. Color [and finish]: [Specify color.] [Specify finish].
3. Color Pigment Material Standard: Comply with ASTM C979.
4. Size: [Specify.] inches [({Specify.}mm)] x [Specify.] inches [({Specify}mm)] x [Specify.] inches [({Specify.} mm)] thick.
5. Joint Gap Size: [Specify.] inches
6. Joint Gap Mechanism: [Specify if integral spacer, or other paver spacer.] type
7. Bevel Size: [Specify.] inches, [Specify.] type

DESIGNER NOTE: Concrete pavers with spacers integral to each unit are recommended for mechanically installed pavers and pavers subject to vehicular traffic. Verify with manufacturer that overall dimensions do not include spacers.

2.02 JOINT FILLER AGGREGATE

A. Crushed Particles: 90 percent (minimum) tested in accordance with California Test 205.

B. LA Abrasion: Less than 40 tested in accordance with ASTM C131.

C. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 500 cubic yards of base material.

D. Rounded river gravel may not be used.

E. Permeable Unit Paver: The following aggregate shall be used to fill joints unless manufacturer recommends otherwise. Aggregate gradations shall be per Section 2.03.C.1. If manufacturer recommendation is different from the gradations shown below the Contractor shall be notified at least 48 hours prior to placement of the joint filler.

Gap Width	Aggregate Gradation
3/8" or ½"	ASTM No. 8 (modified)
¼"	ASTM No. 89 (modified)
1/8"	ASTM No. 10 (modified)

F. Porous Unit Pavers: Joint filler shall be per manufacturer's recommendation.

2.03 PAVEMENT BASE

A. Pavement Base Material shall be consist of clean, mechanically crushed stone, substantially free from adherent coatings. Materials shall be washed thoroughly to remove clay, organic matter, extraneous debris, or objectionable materials. Recycled materials or rounded river gravel are not permitted. Material shall be obtained only from a source(s) approved by the Engineer. Written requests for source approval shall be submitted to the Engineer not less than ten (10) Working Days prior to the intended use of the Material. Should the proposed source be one that the Engineer has no history of Material performance with, the Engineer reserves the right to take preliminary samples at the proposed source, and make preliminary tests, to first determine acceptability of the new source and then perform the applicable Material approval testing. Continued approval of a source is contingent upon the Materials from that source continuing to meet Contract requirements. Materials shall meet the Standard Specifications for grading and quality for use in the Work; however, allowable exceptions may be specified in the Contract. The Engineer shall reserve the right to sample and test Material at any time including at the source.

B. Pavement Base shall consist of up to three (3) layers as specified on the Plans and included herein:

1. "Leveling Course" shall be ASTM No. 8 (modified) stone per Section 2.03.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide a smooth, level surface for placement of pavers.

2. "Base Course" shall be ASTM No. 57 (modified) stone per Section 2.03.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide structural (load bearing) capacity to the pavement.

3. "Reservoir Course" shall be ASTM No. 2 (modified), ASTM No. 3 (modified), or ASTM No. 57 (modified) stone per Section 2.03.C.

   DESIGNER NOTE: This layer of the pavement base is intended to provide water storage and drainage of the pavement, structural support, and a capillary break. The materials specified should be crushed, clean, washed rock to provide the desired structural capacity, maintain good drainage, function as a capillary barrier, and minimize clogging of the subgrade due to export of fines.

   DESIGNER NOTE: ASTM No. 2 stone is preferred.

DESIGNER NOTE: If the designer chooses to specify materials that differ from those provided herein, the designer should check their filter criteria to evaluate the likelihood of finer-graded material migration into underlying courser graded materials or reduction in permeability relative to the underlying material. Refer to SFPUC aggregate filter criteria guidance document for information on selecting appropriate alternate materials.

C. Pavement Base Material shall meet the following specifications for grading and quality.

DESIGNER NOTE: If the designer chooses to specify materials per the procedure above, provide the required gradation the in the table below.

1. Aggregate Gradation tested in accordance with ASTM C136 at least once per 500 cubic yards of base material.

Sieve[1]	Percent Passing by Weight					
	ASTM No. 10 (modified)	**ASTM No. 89 (modified)**	**ASTM No. 8 (modified)**	**ASTM No. 57 (modified)**	**ASTM No. 3 (modified)**	**ASTM No. 2 (modified)**
3 inch	–	–	–	–	–	100
2 1/2 inch	–	–	–	–	100	90 to 100
2 inch	–	–	–	–	90 to 100	35 to 70
1 1/2 inch	–	–	–	100	35 to 70	0 to 15
1 inch	–	–	–	95 to 100	0 to 15	–
3/4 inch	–	–	–	–	–	0 to 5
1/2 inch	–	100	100	25 to 60	0 to 5	–
3/8 inch	100	90 to 100	85 to 100	–	–	–
No. 4	85 to 100	20 to 55	10 to 30	0 to 10	–	–
No. 8	–	5 to 30	0 to 10	0 to 5	–	–
No. 16	–	0 to 10	0 to 5	–	–	–
No. 30	–	–	–	–	–	–
No. 50	–	0 to 5	–	–	–	–
No. 100[2]	10 to 30	–	0 to 2	0 to 2	0 to 2	0 to 2
No. 200[2]	0 to 2	0 to 2	–	–	–	–

[1] Sieve provided in nominal size square openings or United States Standard Sieve Series sizes.

[2] Gradation modified from ASTM for portion passing the No. 100 and 200 sieve, as shown.

2. R-Value: 78 (minimum) tested in accordance with California Test 301.
3. L.A. Abrasion: 30 percent (maximum) tested in accordance with ASTM C131.
4. Cleanness Value: 75 (minimum) tested in accordance with California Test 227 at least once per 500 cubic yards of base material.
5. Crushed Particles: 90 percent (minimum) with two (2) or more fractured faces tested in accordance with California Test 205.
6. The combined portion of Material retained on the U.S. No. 4 sieve shall not contain more than 0.1 percent wood waste by weight. The portion of Material passing a U.S. No. 10 sieve shall not have wood waste that results in more than 250 parts per million of organic matter by calorimetric tests when tested. The color shall be measured after the sample has been in the test solution for 1 hour.

2.04 ACCESSORIES

A. Provide accessory materials as follows: Edge Restraints

1. Manufacturer: [Specify manufacturer.].
2. Material(s): [Pre-cast concrete] [Cut stone] [steel].
3. Material Standard: [Specify material standard.].
4. Configuration: [Specify geometry, manufacturer's model number, stakes or spikes, paver spacers, coatings, color, etc.]

DESIGNER NOTE: Curbs will typically be cast-in-place concrete or precast set in concrete haunches. Cast in place concrete curbs should be specified in another Section. Do not use plastic edging with steel spikes to restrain unit pavers for vehicular applications.

2.05 GEOTEXTILE FOR SOIL SEPARATION

DESIGNER NOTE: See ICPI publication, Permeable Interlocking Concrete Pavements for guidance on geotextile selection. Geotextile is not typically required under permeable pavement applications unless recommended by a geotechnical engineer. Geotextile can be placed vertically for material separation between side walls of reservoir course and native soil.

A. Geotextile shall be woven, consisting only of long chain polymeric fibers or yarns formed into a stable network such that the fibers or yarns retain their position relative to each other during handling, placement, and design service life. At least 95 percent by weight of the material shall be polyolefins or polyesters. The material shall be free from defects or tears. The geotextile shall also be free of any treatment or coating which might adversely alter its hydraulic or physical properties after installation. The geotextile shall conform to the properties specified herein:

Geotextile Property	Test Method	Requirement
Grab Tensile Strength, minimum in weakest direction	ASTM D4632	200 lbs/in
Apparent Opening Size (AOS)	ASTM D4751	40 to 50
Ultraviolet (UV) Radiation Stability, minimum strength retained after 500 hours in weatherometer	ASTM D4355	50%
Flow Rate, minimum	ASTM D4491	140 gal/min/ft^2

DESIGNER NOTE: The designer should consider including specifications for signage and pavement markings in this section.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION AND PROTECTION

A. Construct subgrade to +/- ¾ inch of the grades and slopes specified on the Plans.

B. Grading of subgrade shall be with low ground pressure equipment when within six (6) inches of final subgrade elevation.

C. Compact subgrade to 90 percent (+/- 2 percent) of the maximum dry density per standard Proctor test (ASTM D698), or as directed by the Geotechnical Engineer. Determination of in-place density shall be made using a nuclear gauge per ASTM D6939.

DESIGNER NOTE: The designer should set compaction requirements based on consideration of site specific geotechnical properties of the native soil (e.g., permeability, stiffness) and performance requirements for the pavement section (e.g., traffic loading, infiltration, cost).

D. Areas of the subgrade which are over-compacted, as determined by the Geotechnical Engineer, shall be ripped/tilled to a depth of 12 inches (minimum) or as directed by the Geotechnical Engineer and shall be recompacted in accordance with Section 3.01.C. Contractor shall locate all utilities within pavement footprint prior to ripping and re-compacting subgrade.

E. Proof-roll prepared subgrade with loaded dump truck, remove soft spots, and replace with permeable structural fill as directed by the Engineer to achieve uniform subgrade.

DESIGNER NOTE: Other subgrade verification methods may be required if site conditions limit proof rolling. Consult with geotechnical engineer for acceptable methods.

F. After compaction and proof roll, scarify subgrade ¼- to ½-inch deep by hand rake. Once scarified, materials or equipment shall not be permitted within the prepared subgrade area so as to avoid recompaction or clogging of the scarified subgrade.

G. The subgrade shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the subgrade during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

H. Areas of subgrade over-compacted by construction traffic or other impacts by the Contractor or Subcontractors shall be ripped/tilled and re-compacted in accordance with Section 3.01.D. All work and materials required to correct the over-compacted subgrade, including utility locates within the pavement footprint, shall be at the Contractor's expense.

I. Areas of subgrade contaminated by the accumulation of silty material following rains or other debris or contamination shall be removed and disposed at the Contractor's expense.

J. The subgrade shall be inspected and accepted by the Engineer prior to placement of the geotextile or pavement base.

K. Place geotextile, if required, on scarified subgrade. Care shall be taken to provide full coverage and to prevent the geotextile from being torn. Damaged geotextile shall be repaired as indicated by the manufacturer and to the satisfaction of the Engineer, at no additional cost to the Owner. Overlaps of the geotextile shall be a minimum of 1 foot or to the manufacturer's recommendation, whichever is greater.

DESIGNER NOTE: The use of geotextile under permeable pavement systems should be avoided unless required by the project geotechnical engineer as it can be prone to subsurface clogging.

3.02 PAVEMENT BASE

A. Construct pavement base to the lines, grades, and thicknesses shown on the Plans.

B. Place the pavement base so as to prevent loaded dump trucks from driving directly on the prepared subgrade.

C. Compact pavement base, in six (6)-inch (maximum) lifts, by making a minimum of three passes over the pavement base material with a ten (10)-ton vibratory roller, or as directed by the Geotechnical Engineer. The first two (2) passes (minimum) shall be in vibratory mode. The final pass shall be in static mode. Acceptance of the pavement base will be based on Engineer's observation of aggregate movement during final compaction pass. Compaction equipment shall be accepted by the Engineer prior to use.

DESIGNER NOTE: For areas or sites that cannot accommodate a vibratory roller compactor, consider allowing compaction of pavement base with a

13,500 lbf (60 kN) minimum vibratory plate compactor with a compaction indicator. At least two passes should be made over each lift of the aggregates.

D. Pavement base shall be true to the designed grade and slope, +/- 0.05 feet, after compaction for each layer. In the event of low spots, additional material shall be added and recompacted. In the event of high spots, excess material shall be removed and the area recompacted.

E. Pavement base materials shall be protected from over-compaction or contamination by silty run-off or other contaminants.

1. Provide physical barriers or direct traffic to eliminate unnecessary vehicular traffic on the pavement base during construction in accordance with SFMTA and SFDPW ordinances and specifications.

2. Do not subject placed and compacted gravel leveling course to any pedestrian or vehicular traffic before unit paver installation begins.

3. Provide flow diversion and erosion control measures to protect the permeable pavement area from sedimentation until the upstream catchment area is thoroughly stabilized.

F. Any damage to the pavement base (including contamination by silty run-off) shall be repaired to the satisfaction of the Engineer at the Contractor's expense. Contaminated pavement base shall be removed and replaced to the limits as determined by the Engineer.

G. The pavement base shall be inspected and accepted by the Engineer prior to placing any pavers.

DESIGNER NOTE: Consider developing a testing plan for the required testing and inspection of the pavement base. Verification of the in place density/compaction of the open graded base materials is typically not possible with the use of a nuclear densometer due to nature of these materials. Therefore other means to verify these materials are firm and unyielding (such as observation of the compaction process by a geotechnical engineer) are necessary.

DESIGNER NOTE: Consider requiring the Contractor to compact aggregates without crushing them.

3.03 PAVERS AND JOINT/OPENING FILL MATERIAL

A. Lay the unit pavers in the pattern(s) and joint widths shown on the Plans. Maintain straight pattern lines.

B. Fill gaps at the edges of the paved area with cut units. Cut pavers subject to tire traffic shall be no smaller than 1/3 of a whole unit.

C. Cut pavers and place along the edges with a double-bladed splitter or masonry saw.

D. Fill all openings and joints with joint filler aggregate conforming to Section 2.02.

E. Remove excess aggregate on the surface by sweeping pavers clean.

F. Compact and seat the pavers into the bedding material using a low-amplitude, 75 to 90 Hz plate compactor capable of at least 5,000 lbf (22 kN). This will require at least two passes with the plate compactor.

G. Do not compact within 6 feet (2 m) of the unrestrained edges of unit pavers.

H. Apply additional joint filler aggregate to the openings and joints if needed, filling them completely. Remove excess aggregate by sweeping, then compact the pavers. This will require at least two passes with the plate compactor.

I. All pavers within 6 feet (2 m) of the laying face must be left fully compacted and joints must be filled at the completion of each working day.

J. Compacted unit pavers shall meet the acceptance criteria set forth in Section 1.05.C.

3.04 PROTECTION OF PAVEMENT

A. Pavement surface shall be kept clean and free of clogging debris and soils from the Contractor's operations and all upstream and adjacent debris. If debris or soils contaminate the pavers/joints, the pavement shall be cleaned at the Contractor's expense and to the satisfaction of the Engineer. If pavement cannot be unclogged, it shall be removed and replaced at the Contractor's expense and to the satisfaction of the Engineer.

B. Paver installation (Sub) Contractor shall return to the site after 6 months from the completion of the Work and provide the following as needed to fully meet the specifications described herein: fill paver joints with stones, replace broken or cracked pavers, and re-level settled pavers to initial elevations. **Any additional work shall be considered part of the original bid price and with no additional compensation.**

3.05 REJECTION

A. Pavers that do not meet the acceptance criteria set forth in Section 1.05.C will be rejected by the Engineer on a lot by lot basis. Permeable/porous unit pavers that have been rejected by the Engineer or the Contractor shall be removed and replaced at no additional cost to the Owner.

END OF SECTION

Low Impact Development Initiative (LIDI)
Bioretention Technical Specifications

The following technical information is for use in conjunction with the complete set of bioretention area standard details developed by the LIDI for in the Central Coast region.

Facility Design/Dimensions

- Bottom width – provide 2' wide minimum flat bottom for facilities with side slopes and longitudinal slope.
- 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"
- 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:

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

- Slope/grades
  - Side slope - 4:1 preferred
    - Max. 3:1 allowed with min. 12" wide shoulder (2% slope toward facility) adjacent to pedestrian use or curb.
  - Longitudinal slope – Max. 6% longitudinal slope of bottom.
    - Erosion and movement of soil and mulch intensifies with increased longitudinal slope, minimize longitudinal slope.

        - Stair stepping planters on a slope to provide flat bottomed cells separated by check dam/weir overflows can provide more storage and infiltration than a sloped facility.
    - 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
- 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, 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 slope
    - Per check dam details 130,131
    - Use LIDI check dam spacing detail (under development detail TBD).
- Overflow structure – required for on-line systems without an overflow bypass
    - Per overflow structure details 140, 141
    - Connects to approved discharge point or another downstream bioretention area.
- Provide monitoring well in each facility
    - 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).
- Bioretention soil media (BSM) - use Bay Area Stormwater Management Agencies Association (BASMAA) Specification of Soils for Biotreatment or Bioretention Facilities (Attachment L).
  - Using performance specification for alternative bioretention soil mix is not recommended.
  - A pre-mixed bioretention soil media is preferable to mixing soil on-site.
- BSM depth – 18" minimum depth, 24" recommended.
  - For systems with underdrain, BSM min. depth is 24".
  - Where aggregate layer is used and trees are specified, replace aggregate with increased BSM depth in tree planting locations.
    - Tree planting in bioretention detail (TBD)
- Bioretention Soil media placement and compaction – place BSM in 6" lifts. Compact each lift with a landscape roller or by lightly wetting. Allow BSM to dry overnight before planting.
- Filter fabric - do not use fabric between BSM and aggregate layer
- Mulch depth – 2" – 3"
  - 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 compost mulch.

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).
  - Landscape Architects who have not previously designed bioretention systems should use plants from the LIDI TAM plant list. Landscape Architects with experience designing for bioretention may use additional plant species 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

- 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 be near top of aggregate layer.
  - Underdrain slope may be flat.
  - Connects to approved discharge point.
- Provide capped, threaded PVC cleanout for underdrain, 4" min. dia. with sweep bend.

Specification of Soils for Biotreatment or Bioretention Facilities

Soils for biotreatment or bioretention areas shall meet two objectives:

- Be sufficiently permeable to infiltrate runoff at a minimum rate of 5" per hour during the life of the facility, and
- Have sufficient moisture retention to support healthy vegetation.

Achieving both objectives with an engineered soil mix requires careful specification of soil gradations and a substantial component of organic material (typically compost).

Local soil products suppliers have expressed interest in developing 'brand-name' mixes that meet these specifications. At their sole discretion, municipal construction inspectors may choose to accept test results and certification for a 'brand-name' mix from a soil supplier.

Tests must be conducted within 120 days prior to the delivery date of the bioretention soil to the project site.

Batch-specific test results and certification shall be required for projects installing more than 100 cubic yards of bioretention soil.

SOIL SPECIFICATIONS

Bioretention soils shall meet the following criteria. "Applicant" refers to the entity proposing the soil mixture for approval by a Permittee.

1. General Requirements – Bioretention soil shall:
   a. Achieve a long-term, in-place infiltration rate of at least 5 inches per hour.
   b. Support vigorous plant growth.
   c. Consist of the following mixture of fine sand and compost, measured on a volume basis:
      60%-70% Sand
      30%-40% Compost
2. Submittal Requirements – The applicant shall submit to the Permittee for approval:
   a. A minimum one-gallon size sample of mixed bioretention soil.
   b. Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.
   c. Grain size analysis results of the fine sand component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils or Caltrans Test Method (CTM) C202.
   d. Quality analysis results for compost performed in accordance with Seal of Testing Assurance (STA) standards, as specified in 4.
   e. Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
   f. Grain size analysis results of compost component performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
   g. A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.

h. Provide the name of the testing laboratory(s) and the following information:

(1) Contact person(s)

(2) Address(s)

(3) Phone contact(s)

(4) E-mail address(s)

(5) Qualifications of laboratory(s), and personnel including date of current certification by USCC, ASTM, Caltrans, or approved equal

3. Sand for Bioretention Soil
   a. Sand shall be free of wood, waste, coating such as clay, stone dust, carbonate, etc., or any other deleterious material. All aggregate passing the No. 200 sieve size shall be nonplastic.
   b. Sand for Bioretention Soils shall be analyzed by an accredited lab using #200, #100, #40 or #50, #30, #16. #8, #4, and 3/8 inch sieves (ASTM D 422, CTM 202 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)**	
	Min	***Max***
3/8 inch	100	100
No. 4	90	100
No. 8	70	100
No. 16	40	95
No. 30	15	70
No. 40 or No.50	5	55
No. 100	0	15
No. 200	0	5

Note: all sands complying with ASTM C33 for fine aggregate comply with the above gradation requirements.

4. Composted Material

Compost shall be a well decomposed, stable, weed free organic matter source derived from waste materials including yard debris, wood wastes or other organic materials not including manure or biosolids meeting the standards developed by the US Composting Council (USCC). The product shall be certified through the USCC Seal of Testing Assurance (STA) Program (a compost testing and information disclosure program).

a. Compost Quality Analysis by Laboratory – Before delivery of the soil, the supplier shall submit a copy of lab analysis performed by a laboratory that is enrolled in the US Composting Council's Compost Analysis Proficiency (CAP) program and using approved Test Methods for the Examination of Composting and Compost (TMECC). The lab report shall verify:
   (1) Organic Matter Content: 35% - 75% by dry wt.
   (2) Carbon and Nitrogen Ratio: C:N < 25:1 and C:N >15:1
   (3) Maturity/Stability: Any one of the following is required to indicate stability:
      (i) Oxygen Test < 1.3 O2 /unit TS /hr
      (ii) Specific oxy. Test < 1.5 O2 / unit BVS /hr
      (iii) Respiration test < 8 mg CO_2-C /g OM / day
      (iv) Dewar test < 20 Temp. rise (°C) e.
      (v) Solvita® > 5 Index value
   (4) Toxicity: Any one of the following measures is sufficient to indicate non-toxicity.
      (i) NH_4^+ : NO_3^--N < 3
      (ii) Ammonium < 500 ppm, dry basis
      (iii) Seed Germination > 80 % of control
      (iv) Plant Trials > 80% of control
      (v) Solvita® = 5 Index value
   (5) Nutrient Content: provide analysis detailing nutrient content including N-P-K, Ca, Na, Mg, S, and B.
      (i) Total Nitrogen content 0.9% or above preferred.
      (ii) Boron: Total shall be <80 ppm;
   (6) Salinity: Must be reported; < 6.0 mmhos/cm
   (7) pH shall be between 6.2 and 8.2 May vary with plant species.

b. Compost Quality Analysis by Compost Supplier – Before delivery of the compost to the soil supplier the Compost Supplier shall verify the following:
   (1) Feedstock materials shall be specified and include one or more of the following: landscaping/yard trimmings, grass clippings, food scraps, and agricultural crop residues.
   (2) Maturity/Stability: shall have a dark brown color and a soil-like odor. Compost exhibiting a sour or putrid smell or containing recognizable grass or leaves, or is hot (120F) upon delivery or rewetting is not acceptable.
   (3) Weed seed/pathogen destruction: provide proof of process to further reduce pathogens (PFRP). For example, turned windrows must reach min. 55C for 15 days with at least 5 turnings during that period.

c. Compost for Bioretention Soil Texture – Compost for bioretention soils shall be analyzed by an accredited lab using #200, 1/4 inch, 1/2 inch, and 1 inch sieves (ASTM D 422 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)**	
	Min	***Max***

1 inch	99	100
1/2 inch	90	100
1/4 inch	40	90
No. 200	1	10

d. Bulk density shall be between 500 and 1100 dry lbs/cubic yard
e. Moisture content shall be between 30% - 55% of dry solids.
f. Inerts – compost shall be relatively free of inert ingredients, including glass, plastic and paper, < 1 % by weight or volume.

g. Select Pathogens – Salmonella <3 MPN/4grams of TS, or Coliform Bacteria <10000 MPN/gram.
h. Trace Contaminants Metals (Lead, Mercury, Etc.) – Product must meet US EPA, 40 CFR 503 regulations.
i. Compost Testing – The compost supplier will test all compost products within 120 calendar days prior to application. Samples will be taken using the STA sample collection protocol. (The sample collection protocol can be obtained from the U.S. Composting Council, 4250 Veterans Memorial Highway, Suite 275, Holbrook, NY 11741 Phone: 631-737-4931, www.compostingcouncil.org). The sample shall be sent to an independent STA Program approved lab. The compost supplier will pay for the test.

VERIFICATION OF ALTERNATIVE BIORETENTION SOIL MIXES

Bioretention soils not meeting the above criteria shall be evaluated on a case by case basis. Alternative bioretention soil shall meet the following specification: "Soils for bioretention facilities shall be sufficiently permeable to infiltrate runoff at a minimum rate of 5 inches per hour during the life of the facility, and provide sufficient retention of moisture and nutrients to support healthy vegetation."

The following steps shall be followed by municipalities to verify that alternative soil mixes meet the specification:

1. General Requirements – Bioretention soil shall achieve a long-term, in-place infiltration rate of at least 5 inches per hour. Bioretention soil shall also support vigorous plant growth. The applicant refers to the entity proposing the soil mixture for approval.
   a. Submittals – The applicant must submit to the municipality for approval:
      (1) A minimum one-gallon size sample of mixed bioretention soil.
      (2) Certification from the soil supplier or an accredited laboratory that the Bioretention Soil meets the requirements of this guideline specification.

(3) Certification from an accredited geotechnical testing laboratory that the Bioretention Soil has an infiltration rate between 5 and 12 inches per hour as tested according to Section 1.b.(2)(ii).
(4) Organic content test results of mixed Bioretention Soil. Organic content test shall be performed in accordance with by Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method".
(5) Grain size analysis results of mixed bioretention soil performed in accordance with ASTM D 422, Standard Test Method for Particle Size Analysis of Soils.
(6) A description of the equipment and methods used to mix the sand and compost to produce Bioretention Soil.
(7) The name of the testing laboratory(s) and the following information:
  (i) Contact person(s)
  (ii) Address(s)
  (iii) Phone contact(s)
  (iv) E-mail address(s)
  (v) Qualifications of laboratory(s), and personnel including date of current certification by STA, ASTM, or approved equal.

b. Bioretention Soil
(1) Bioretention Soil Texture: Bioretention Soils shall be analyzed by an accredited lab using #200, and 1/2" inch sieves (ASTM D 422 or as approved by municipality), and meet the following gradation:

Sieve Size	**Percent Passing (by weight)**	
	Min	***Max***
1/2 inch	97	100
No. 200	2	5

(2) Bioretention Soil Permeability testing: Bioretention Soils shall be analyzed by an accredited geotechnical lab for the following tests:
  (i) Moisture – density relationships (compaction tests) shall be conducted on bioretention soil. Bioretention soil for the permeability test shall be compacted to 85 to 90 percent of the maximum dry density (ASTM D1557).
  (ii) Constant head permeability testing in accordance with ASTM D2434 shall be conducted on a minimum of two samples with a 6-inch mold and vacuum saturation.

MULCH FOR BIORETENTION FACILITIES

Three inches of mulch is recommended for the purpose of retaining moisture, preventing erosion and minimizing weed growth. Projects subject to the State's Model Water Efficiency Landscaping Ordinance (or comparable local ordinance) will be 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. It is recommended to apply 1" to 2" of composted mulch, once a year, preferably in June following weeding.

Pervious Pavement
Design Guidance

May 2016

California Department of Transportation
Division of Design
Office of Storm Water Management
1120 N Street
Sacramento, California
http://www.dot.ca.gov/hq/oppd/stormwtr/

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List of Acronyms

AB	Aggregate Base
ASTM	American Society for Testing and Materials
BMP	Best Management Practice
Caltrans	California Department of Transportation
CT	California Test
EPA	Environmental Protection Agency
HDM	Highway Design Manual
HMA	Hot Mixed Asphalt
LID	Low Impact Development
MEP	Maximum Extent Practical
MR	Modulus of Rupture
M_r	Resilient Modulus
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NRCS	National Resources Conservation Service
nSSP	Non-Standard Special Provision
O&M	Operations & Maintenance
OGAC	Open Graded Asphalt Concrete
OGFC	Open Graded Friction Course
OSWMD	Office of Storm Water Management - Design
PAP	Pervious Asphalt Pavement
PCC	Portland Cement Concrete
PCP	Pervious Concrete Pavement
PE	Project Engineer
PICP	Permeable Interlocking Concrete Pavement
PPDG	Project Planning and Design Guide
PVC	Polyvinyl Chloride
QA/QC	Quality Assurance/Quality Control
RWQCB	Regional Water Quality Control Board
SF	Square Feet
TI	Traffic Index
TMDL	Total Maximum Daily Load
VER	Version
WLA	Waste Load Allocation
WQV	Water Quality Volume

1. INTRODUCTION

1.1 Overview

This guidance considers Pervious Concrete Pavement (PCP), Pervious Asphalt Pavement (PAP) (also known nationally as Porous Asphalt Pavement), and Permeable Interlocking Concrete Pavement (PICP).

While pervious pavements have become very popular in the area of stormwater management, the true applicability to the highway environment is still unclear. Local agencies and regulators continue to ask Caltrans to consider pervious pavement on projects. However, until more information is determined related to safety, maintainability, constructability, and improved water quality benefit over other approved stormwater best management practices (BMPs) the inclusion of pervious pavement into Caltrans projects needs to be carefully considered.

This document was developed to provide general guidance on the design and applicability of pervious pavements for Caltrans projects. The intent was to have consistent guidelines and standards, if a pervious pavement installation was ultimately chosen. A major concern related to pervious pavement is maintainability. Prior to implementing pervious pavement into a contract within Caltrans right of way, concurrence is needed from the Office of Stormwater Management and the Division of Maintenance. Maintenance wants to be assured that a long term maintenance plan has been developed or a maintenance agreement has been formalized.

When considering pervious pavement for stormwater treatment, a project should first evaluate the other approved BMPs and compare them to determine if pervious pavement would be considered the preferred BMP. Use Table 1-1 to help determine which locations are suitable candidates for pervious pavement and consult with the District Stormwater Coordinator.

Table 1-1: Pervious Pavement Categories

Category	Examples	Loading	Speed	Risk
A	Landscaped areas, sidewalks and bike paths (with no vehicular access), miscellaneous pavement to accept run-on from adjacent impervious areas (e.g. roofs)	No vehicular loads	N/A	Low
B	Parking lots, park & ride areas, maintenance access roads, scenic overview areas, sidewalks and bike paths (with maintenance/vehicular	Few heavy loads	Low speed (less than 30 mph)	Low

	access), maintenance vehicle pullout			
C	Rest areas, maintenance stations	Moderate heavy loads	Low speed	Low
D	Shoulders, some low volume roads, areas in front of noise barriers (beyond the traveled way)	Moderate heavy loads	High speed	Medium
E	Highways, weigh stations	High heavy loads	High speed	High

This guidance was developed with the understanding that only those project examples listed in Categories A, B & C (listed as Low Risk) would be considered at this time. Categories D and E are currently not candidates for pervious pavement on Caltrans facilities.

If the purpose of installing pervious pavement is not for NPDES permit compliance, then variation from certain siting and design requirements may be allowed. Contact the Office of Storm Water Management – Design (OSWMD).

1.2 Definition

Pervious pavements allow stormwater to filter through voids in the pavement surface into an underlying rock reservoir where it is temporarily stored and infiltrated into the surrounding materials.

While pervious pavement designs may vary, they all have a similar structure consisting of a surface pavement layer with an underlying reservoir layer.

Other terms such as ‘permeable pavement’ or ‘porous pavement’ are used in literature to describe what Caltrans has termed “pervious pavement.” Pervious pavements consist of a surface layer made of either asphalt or concrete (cast-in-place or interlocking concrete units).

1.3 Benefits

Benefits of pervious pavements include:

1. reducing the rate of runoff
2. filtering pollutants out of runoff
3. infiltrating runoff into the ground, and
4. maintaining the natural hydrologic function of the site

Pervious pavement is designed primarily to promote stormwater infiltration and improve the quality of stormwater runoff. It is typically designed to capture rainfall on the pavement surface area, but may also accept run-on from adjacent impervious areas and other hardscapes (sidewalks), rooftops, or gutters. Another benefit of pervious pavement is the reduction of pollutants that enter stormwater runoff by reducing the amount of splash and spray that wash pollutants from the underside of vehicles. This would be considered a form of source control and a useful component of stormwater compliance. Pervious pavements infiltrate the water below the pavement surface and eliminate standing water issues. This will help to eliminate concerns of mosquito breeding. Some recent studies have also found that pervious pavement can help reduce temperatures on and around pavements which helps reduce urban heat island effect.

Since pervious pavements function similarly to other infiltration devices treatment crediting should be documented in the same fashion.

1.4 Need Statement

The reduction of runoff and pollutants from Caltrans right of way is an important element of meeting the requirements of the Caltrans NPDES Permit. This can be achieved using pervious pavement by encouraging on-site infiltration of the Water Quality Volume (WQV) into a reservoir section and releasing it within a specified drawdown time through the underlying soils.

Caltrans projects also have a requirement to evaluate the downstream effects of added stormwater due to the increased impervious surface. Pervious pavement can be used to help mitigate impacts of the additional runoff through temporary storage and infiltration.

The Caltrans NPDES Permit has requirements to consider Low Impact Development (LID) principles on all projects. LID principles are sustainable practices that treat the stormwater onsite. Unlike some storm water management methods, which collect and convey stormwater runoff through storm drains, pipes, or other conveyances to a centralized stormwater facility, LID principles use site design and storm water management techniques to maintain the site's pre-project runoff rates and volumes by using design techniques that infiltrate, filter, store, evaporate, and detain runoff close to the source.

While pervious pavement would be considered to be a LID technique, the use of landscape and soil-based BMPs to treat storm water runoff is still considered first. Life cycle cost, site feasibility, and the overall water quality benefits need to be evaluated when determining which BMPs will be used.

2. SELECTION CRITERIA

2.1 Candidate Sites

After following the Project Planning and Design Guide (PPDG) and considering all of the approved treatment BMPs, the first step in considering pervious pavements for a project is to confirm that the location is appropriate and will be able to provide infiltration for the life of the pavement.

Since the primary means of stormwater treatment will be by infiltrating water, pervious pavement will act in a manner similar to other infiltration devices that are described in Appendix B.3 of the PPDG. Designers should reference this (specifically sections B.3.2 and B.3.3) when considering pervious pavement. Although there will be some differences in the design criteria, such as lower allowable infiltration rates, the general concepts are applicable.

Hydrologic Soil Groups A and/or B shown on NRCS soil surveys would be considered as the best areas for considering infiltration BMPs. However, other soil types can be considered with the understanding that the design will still be driven by the determination of the infiltration rate, adhering to drawdown time requirements and meeting the minimum separation to groundwater.

In addition to using the siting criteria listed in Appendix B of the PPDG (see table B-2), pervious pavements should not be used where the following conditions exist:

- Landscaped and other pervious areas drain to the proposed pervious pavement. Debris and sediment from these areas could lead to clogging.
- Pavement placement will be in close proximity to structural foundations. Setbacks may be reduced where liners are used or the amount of pervious pavement is small. Consult with your Storm Water Coordinator, Structures representative, or Geotechnical staff.
- It is not feasible to perform routine and long term maintenance, such as vacuuming to maintain the hydraulic function.
- Pavements regularly receive winter sanding. Seal coating or repaving are not appropriate for pervious pavements.
- Soil containing aerially deposited lead (ADL) shall be reused under the requirements of the ADL variance issued to Caltrans by DTSC, and the pervious pavement will direct water through (infiltrate in embankment or structural section with ADL), sheet flow over, infiltrate into the slope, or allow infiltration into the ADL soil in any manner. This is a violation of the ADL variance and placement of the soil considered illegal disposal of hazardous waste or a threat to water quality from a designated waste. Confer with the District Hazardous Waste Unit and NPDES coordinator for assistance on projects that will use the ADL variance or have identified ADL soils.

Also, consider the following criteria.

- Determine if pervious pavement is the most cost effective BMP during the feasibility process (e.g., the life cycle cost of an infiltration trench may be lower even if it would entail more design work to facilitate the trench fitting within the site).
- Determine that the infiltration rate will facilitate treating 100% of the WQV from the added impervious area. Only infiltrating a portion of the WQV using pervious pavement may not be worth the added cost, unless it can be coupled with upstream practices to achieve 100% WQV.
- Design pervious pavement such that surface flow will not cause ponding, flooding and/or erosion.
- Typical drainage design is still necessary to address the Caltrans HDM design storm event.
- Avoid placement in fill areas. If a small amount of new fill is required or over excavation of reservoir layer occurs during construction, consider using additional reservoir material instead of adding compacted soil.
- Check with the District Hazardous Waste Unit to evaluate for potential soil or groundwater contamination within the project area.
- Avoid placing in areas where wind erosion could supply a significant amount of windblown sediment or where offsite sediment laden storm water cannot be eliminated. This may require additional surface cleaning efforts.
- Provide a concrete curb and/or a concrete curb and gutter for edge support. These barriers can also keep unwanted sediment off the pavement. See Figure 2-1 and 2-2.
- Place a PCC strip between pervious pavement and asphalt pavement. A modified Caltrans curb (Type A1 or B1) may be used. See Figure 2-3.
- Try to keep the reservoir invert slope flat to enable even distribution and infiltration of stormwater for parking lot type applications. Do not exceed 2% slope at the reservoir invert. An exception would be for use on a maintenance access road.
- Slope designs for the surface of the pervious pavement should be in accordance with the HDM. No maximum slope is set, but the designer must realize the cost impacts to the design for the increased reservoir material. Typically, any slope greater than 5% is considered not feasible.
- Include typical surface drainage based on peak flow design with no planned attenuation by pervious pavement/reservoir.
- Consider designing the inlet grate openings for large pervious pavement areas that contain surface inlets in the interior, the resulting flow at the downstream end of these areas may resurface.
- Determine the maximum depth of ground freezing in the area of the project. The minimum depth for the pavement surface to the invert of the reservoir should be 65% of the ground freezing depth.

2.2 Feasibility Analysis

To initially assess the feasibility of using pervious pavement, follow Section 5.3.1 Site-Specific Determination of Feasibility of the PPDG (http://www.dot.ca.gov/hq/oppd/stormwtr/ppdg/PPDG-Final_2016-02.pdf).

In addition, perform a Feasibility Analysis as described in Section 3 of the Caltrans Infiltration Basins Design Guidance, as pervious pavement will function similarly to an infiltration device. This can be found under the infiltration tab at the following website. (http://www.dot.ca.gov/hq/oppd/storm1/caltrans_20090729.html).

A site investigation is critical to evaluate whether pervious pavements are an appropriate BMP for a site. The site investigation should be conducted with appropriate staff to be able to consider hydrology and hydraulic design, soil permeability, pavement thickness design, and environmental regulations.

The minimum acceptable infiltration rate when designing the reservoir section may be less than a typical infiltration device due to the large surface area being used for infiltration. Because of this design criterion, no lower limit of infiltration rate has been set.

Coordinate with Geotechnical staff to determine the necessary number of permeability test locations. Discuss the applicability of performing tests every ¼ acre of pervious pavement as a general estimate.

If the invert of the reservoir is designed with multiple invert elevations, construct an impermeable arrier between the tiers. This will keep the WQV from migrating. Consider conducting separate infiltration test sites for each tier.

In order to control over compacting the subgrade soil surface (below the reservoir layer) during construction, the following design method is prescribed:

Perform additional tests for each test site during the Geotechnical Investigation for Soil Lithology and Select Chemical Testing outlined in Section 3.3.1 Part B of Caltrans Infiltration Basins Design Guidance:

- CT 231(http://www.dot.ca.gov/hq/esc/ctms/ctmsindex200.html) (Method of Test for Relative Compaction of Untreated and Treated Soils and Aggregates by the Area Concept Utilizing Nuclear Gages) should be conducted at the invert elevation of the reservoir section to obtain compaction of the “native soil.”
- CT 220 (http://www.dot.ca.gov/hq/esc/ctms/ctmsindex200.html) (Method of Test for Permeability of Soils) will be used in the lab. Typically, three tests should be performed at different compactions. Soil samples must be representative of the invert soils of the reservoir layer and taken from the location where CT 231 performed. One of the tests should be of the native soil condition. The PE may need to coordinate with Caltrans Pavement Program, Geotechnical Services, and Construction to determine an upper compaction limit. Compaction limits are typically between 88 and 94%.

Additional soil classification and testing requirements for pavements can be found in HDM Topic 614.

Include these additional test results in the geotechnical summary report.

The intent of performing these tests is to provide compaction limits to the contractor. A site is acceptable only if the reservoir layer can be designed to infiltrate the WQV in the appropriate drawdown time using the upper compaction limit used in CT 220. The upper limit of compaction will set the minimum acceptable subgrade permeability rate used to design the reservoir layer. The lower compaction limit is typically the "native soil" condition. If the native soil compaction is less than 88%, contact the Pavement Program. The agreed upon compaction limits are then specified in the contract documents. These will give the contractor a performance based specification that will help determine the construction methods and equipment to be used.

A minimum compaction range of 4% should be specified. If this cannot be accomplished, consult with Construction. An example would be if the lower limit is set at 89% (native soil) then the minimum upper limit would be 93%. Use average results when the site has multiple test locations. If the site has multiple invert elevations, consider designing each separately. The PE should use discretion when infiltration rates vary significantly at the site.

Always strive to maximize the compaction range. For example, if the design permeability requirements can be met with 95% compaction, then increase the upper compaction limit to allow the contractor the greatest flexibility during construction. However, it will be up to the PE to determine the final compaction range, based on costs associated with the reservoir layer thickness requirement.

Key information related to the soils, as outlined above, should be documented in the Storm Water Data Report.

2.3 Cost Analysis and Typical Cross Sections

Table 2-1: Cost Analysis

PCP[1]	PAP[2]	PICP[1]
$ 2.00 to $6.50/sf	$ 4.80 to $6.00/sf	$5.00 to $10.00/sf

The costs described in Table 2-1 are for planning purposes only. PCP and PICP costs are based on 2009 data and PAP 2012, and should be adjusted based on current construction cost trends.

[1] Based on Virginia Department of Conservation and Recreation (DCR) Stormwater Design Specification No. 7, Permeable Pavement Ver. 1.6, September 30, 2009

[2] Based on Caltrans HQ Pavement Program 2012 data

During PS&E develop cost based on actual bid price data, or by contacting local Associated General Contractors chapter and requesting unit costs to assure that current local costs are reflected in the engineer's estimate. The costs listed in Table 2-1 include the reservoir and vary due to the total pavement area, site access, pavement configuration, and installation methods. As part of the BMP feasibility process outlined in Section 2.4.2.1 of the PPDG, the PE should compare different BMP types. When comparing costs keep in mind there may be additional savings in pervious pavement because there is an opportunity to reduce drainage items. This should be included in the cost comparison.

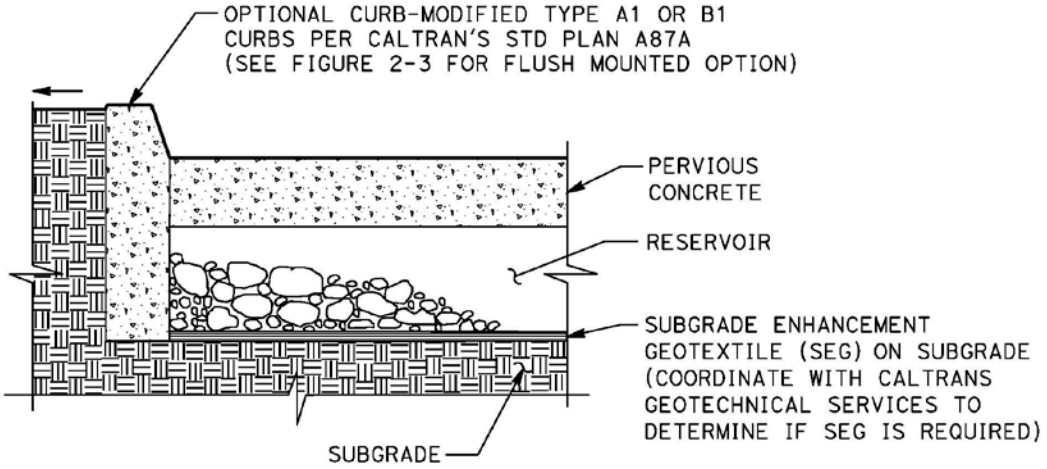


Figure 2-1 - Typical PCP Section

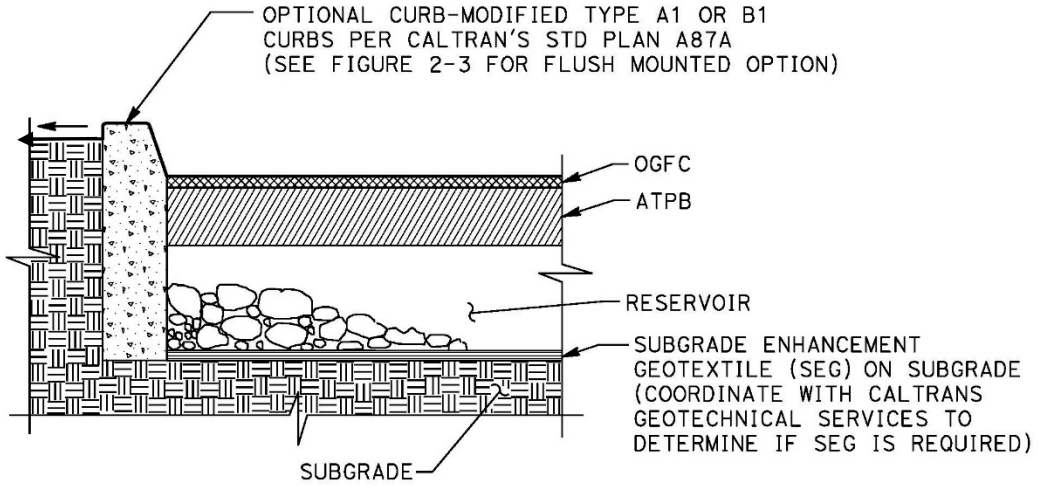


Figure 2-2 - Typical PAP Cross Section

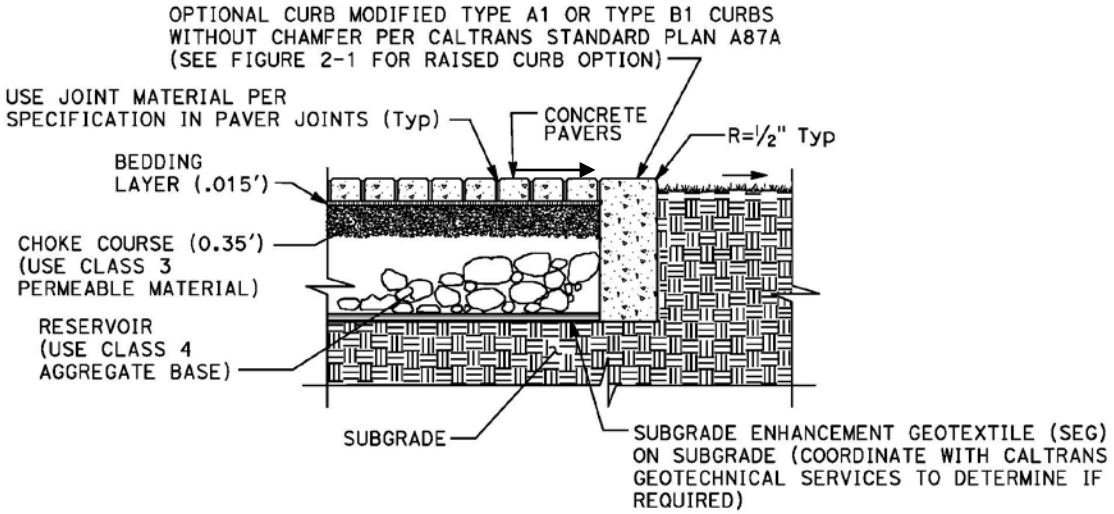


Figure 2-3 - Typical PICP Cross Section

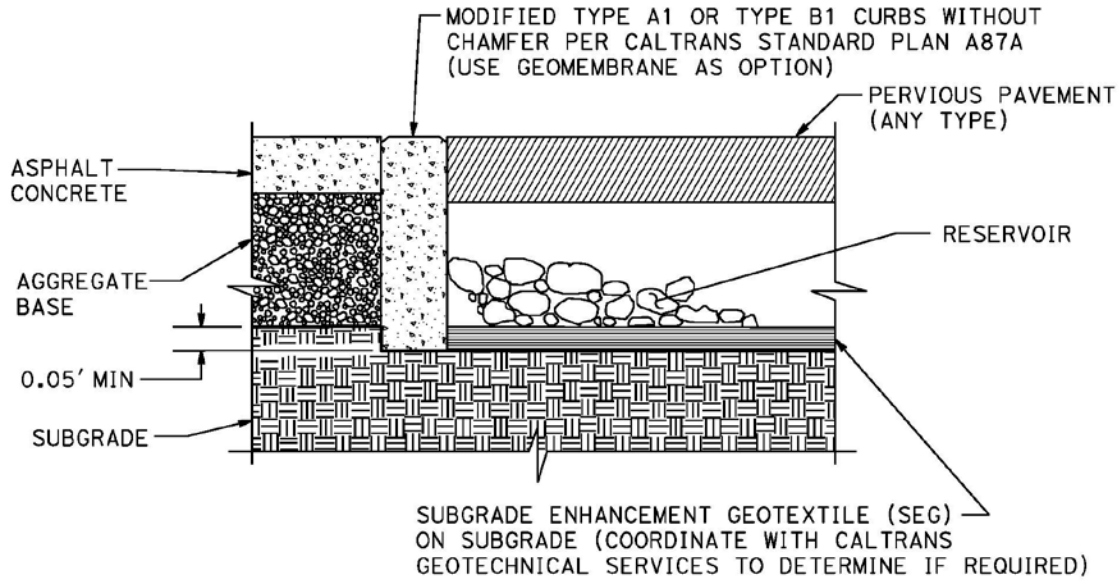


Figure 2-4- Barrier Between Pervious and AC Pavements

2.4 Other Design Considerations

There are other considerations that could be made as part of the design process that may reduce costs, while acting similar to pervious pavement and still comply with regulatory treatment requirements.

For example, maybe only a portion of a parking lot needs to have pervious pavement, such as the parking stall areas, to be in compliance with stormwater requirements. The impervious surface areas could be designed to slope onto the pervious pavement surfaces. See Figure 2-4 for a transition between pervious and impervious pavements.

Another use of the curb shown in Figure 2-4 would be for an existing pavement section that is retrofitted to use a pervious pavement. Retrofits can be considered when the existing pavement is sloped towards the proposed pervious pavement.

There may be times where a pervious pavement layer may be placed on native soil and a reservoir is not needed to achieve the desired results, such as a sidewalk.

Engineers are encouraged to use ingenuity while designing infiltration type devices. Always consider different combinations of materials, infiltration techniques and siting alternatives while trying to achieve the desired results in the most cost effective manner.

3. DESIGN CRITERIA

3.1 Structural Design

The pervious pavement surface and reservoir layer must be designed to support the maximum traffic load. The structural design process will vary according to the type of pavement section selected. In addition, the reservoir layer must be able to temporarily store the WQV. When determining the overall thickness of the pavement structure, it must satisfy both the Pavement Structural Design in Section 4 and the Reservoir Layer Design in Section 3.2.

The structural design of pervious pavement considers four main site elements:

- total traffic
- in-situ soil strength
- environmental elements (i.e., pollutants), and
- pavement section (pervious layer, bedding layer, reservoir layer, and fabric) design

3.2 Reservoir Layer Design

The reservoir layer design should be performed in consultation with the licensed engineer performing the field investigation and the design of the pavement thickness. To meet Caltrans new NPDES Permit requirements, the reservoir layer thickness will be designed to store the WQV. The reservoir layer can be designed to store other storm events to meet project requirements. Document this information in the SWDR and the drainage report.

OSWMD developed a Reservoir Design Tool to size the reservoir layer (http:/www.dot.ca.gov/hq/oppd/stormwtr/pervious.htm) using equations from several referenced Caltrans design guidance documents and methodology outlined below. The depth of the reservoir layer based on OSWMDs Reservoir Design Tool can be compared to the depth developed by the Pavement Program (see Section 4). The final reservoir layer will be the larger of the two designs. (Note: A pervious pavement design example has been developed and is included in the tool.)

Table 3-1 has been developed as a means to evaluate the reservoir depth based on infiltration rates and Water Quality Depth.

Information required prior to using Table 3-1:

- WQ Depth = Water Quality Depth from Basin Sizer
- k_c = infiltration rate used to set the upper compaction limit of site area discussed in Section 2.2

Design factors used in Table 3-1:

- The entire pavement area is pervious.

- The table values use a void ratio of 0.3 and a drawdown time of 72 hours. See equations below.
- Values for K_{min} have been calculated for WQ depths (half inch increments) and Reservoir Depths (0.1 foot increments)
- The WQ depths shown are within the range of values found in California based on the 85th percentile 24-hour storm event. Typical values are between 0.5 to 1.5 inches.
- The final reservoir depth should be rounded up to the nearest 0.1 feet.
- Interpolating the values between the rows is acceptable.

The following methodology outlines the steps needed to use Table 3-1.

Step 1: Determine the reservoir depth based on WQV requirements:

d = WQ Depth / 0.30

Where:

d = depth of the reservoir layer (ft)
WQ Depth (ft) (calculated by *Basin Sizer* (in))
0.30 = void ratio of reservoir layer

Use Table 3-1 to find the reservoir depth associated with the WQ Depth.

Step 2: Determine the infiltration rate based on the reservoir depth (calculated in Step 1) and the drawdown time.

k = d / t x C x SF x 0.30

Where:

k = minimum infiltration rate based on depth of reservoir (in/hr)
d = depth of the reservoir layer (ft) (from Step 1)
t = drawdown time (typically 72 hours)
C = conversion factor (12 to convert from inches to ft)
SF = safety factor of 1.0
0.30 = void ratio of reservoir layer

Use Table 3-1 to find the minimum infiltration rate associated with the reservoir depth (from Step 1) and drawdown time.

Step 3: Determine k_c (infiltration rate used to set the upper compaction limit of site area discussed in Section 2.2). If k_c is not available, determine the project's Hydrologic Soil Group(s) shown on NRCS soil surveys. Once the soil type(s) has been determined use typical infiltration rates associated with the HSG.

Step 4: Compare the infiltration rates determined in Steps 2 and 3. Verify that the infiltration rate from Step 3 is greater than Step 2. This condition means that the WQ depth (WQV per square foot) can infiltrate into the soil within the given

drawdown time. When the infiltration rate cannot drain the WQ Depth in the specified drawdown time, the site should be eliminated.

Step 5: Determine the reservoir depth based on the pavement structural design requirements in Section 4.3.5.

Step 6: Compare Step 1 (rounded up to the next half tenth of a foot, 0.05 ft) and Step 5. The final reservoir layer will be the greater of these compared depths.

Table 3-1: Hydrology Reservoir Design for Small Storm Events

Void Ratio	Drawdown Time (hrs)	K_{min} to Drain Reservoir Depth in Drawdown Time (in/hr)	HSG Class	WQ depth (in)	Reservoir Depth (ft)
0.3	72	0.007	D	0.5	0.14
		0.010		0.72	0.20
		0.014		1	0.28
		0.015		1.08	0.30
		0.020		1.44	0.40
		0.021		1.5	0.42
		0.025		1.8	0.50
		0.028		2	0.56
		0.030		2.16	0.60
		0.035		2.5	0.69
		0.035		2.52	0.70
		0.040		2.88	0.80
		0.042		3	0.83
		0.045		3.24	0.90
		0.049		3.5	0.97
Note: If PICP is the surface, the reservoir Depth indicated may be reduced by 0.11 ft before rounding.					

Additional information:
The elevation of the invert of the reservoir layer:

- should be no greater than 13 ft below the original ground surface (as costs increase greatly with the depth and the potential need for shoring)

- must provide the required minimum 10 foot groundwater separation (otherwise consultation with Regional Water Quality Control Board may be required)

The licensed engineer performing the drainage design should document any additional reservoir storage capacity above the minimum required WQ depth. The added storage can provide additional benefits to minimize downstream effects. This information should be documented in the Storm Water Data Report and drainage report. Some projects may be able to store the design storm event at minimal additional costs, which may provide savings in the cost of the underground storm drain system (e.g., pipes, and drainage inlets).

There are occasions when only a portion of the pavement area is designed to be pervious pavement such as in a parking lot where it may be desired to place the pervious pavement in the parking stall areas only.

Follow these steps for this type of application:

Step 1: Calculate the WQV

WQV = WQ Depth x C x A

Where:

WQV = Water Quality Volume (ft^3)

WQ Depth (ft) (calculated by *Basin Sizer* (in))

C = runoff coefficient [3]

A = the tributary area (ft^2)

Step 2: Calculate the excavated volume for the reservoir layer:

EV = WQV / 0.30

Where:

EV = excavated volume (ft^3)

WQV = Water Quality Volume (ft^3)

0.30 = porosity of reservoir layer

Step 3: Calculate the invert area based on desired depth to fit site conditions:

A_{inv} = EV / D

Where:

A_{inv} = area of invert (ft^2)

EV = excavated volume (ft^3), and

D = depth of the reservoir layer (ft)

Step 4: Calculate the width to fit site conditions:

W = A_{inv} / L

Where:

A_{inv} = adjusted area of invert (ft^2)

[3] The Tool uses a C value of 1 (slightly conservative for the partial pervious pavement design)

L = length of pervious pavement (ft)
W = width of pervious pavement (ft)

Step 5: Calculate the minimum invert area and verify it is less than the invert area calculated in Step 3. If not, adjust reservoir depth, width, and length in Steps 3 and 4.

$A_{inv\ min} = C \times SF \times 0.30 \times WQV / (k_c \times t)$

Where:

C = conversion factor (12 to convert from inches to ft)
SF = safety factor of 1.0
0.30 = void ratio of reservoir layer
WQV = Water Quality Volume (ft^3)
k_c = infiltration rate used to set the upper compaction limit of site area discussed in Section 2.2
t = drawdown time (typically 72 hours)

3.3 Material Specifications

Caltrans Pavement Program has developed non-standard specifications for pervious aggregate base (i.e., reservoir layer), PCP, and PICP (http:/www.dot.ca.gov/hq/oppd/stormwtr/pervious.htm). These specifications are currently under evaluation for constructability prior to adopting as standard specifications.

Until adopted as standard, these specifications must go through Caltrans OSWMD for approval to be used on any project within Caltrans right-of-way. Follow the sponsor request and concurrence process (http://www.dot.ca.gov/hq/oppd/stormwtr/nssp.htm).

The PE must submit documentation related to the design of the pervious pavement when requesting nSSP concurrence from OSWMD. Prior to submitting the Request Memo, the PE needs to coordinate with the following Caltrans functional groups:

- Pervious Pavement,
- Hydrology and Hydraulics (Drainage – Design),
- Geotechnical,
- Design (District/Regional Design Storm Water Coordinator), and
- Maintenance

Each function plays a role in the success of the pervious pavement implementation. It is the PEs responsibility to coordinate with these units and incorporate the nSSPs into the project. Maintenance concurrence will be through the approval of the PS&E SWDR.

PEs submittal package to OSWMD must include:

- Request Memo with narrative explaining coordination process including
    - Category and Example in Table 1-1
- Project Plans (all sheets related to the pervious pavement design, incl. shed areas)
- Engineering Estimate (only include pervious pavement items)
- nSSPs
- Pervious Pavement Design Tool Calculations
    - Include basis of infiltration rate used to design the reservoir layer, and
    - Include basis of upper and lower compaction limits used in the specification

4. PAVEMENT STRUCTURAL DESIGN

4.1 Materials and Mix Design

Caltrans Pavement Program developed specifications for pervious pavement (http:/www.dot.ca.gov/hq/oppd/stormwtr/pervious.htm).

4.2 Traffic

No traffic (neither light nor heavy) is considered for Category A facilities. For Category B and C facilities, follow the Traffic Index (TI) Guidance in HDM Index 613.5(4), specifically Table 613.5B.

4.3 Design Method

4.3.1 General

The thickness design of pervious pavements does not follow all of the standard Caltrans design methods in the HDM. In the past, such designs had to follow the design exception requirements from Headquarters. In lieu of obtaining design exceptions, use the following design methodology of this guide for pervious pavements. Variations from this guidance must be discussed with the OSWMD and headquarters Pavement Program, design exceptions may apply.

The pavement structural designs found in this guide are based on the 20 year pavement design life requirement for roadside facilities in HDM Topic 612.

4.3.2 Subgrade Preparation

Unlike traditional pavements where a major design focus is to keep water away from the subgrade soil layer, pervious pavements introduce surface water to the subgrade soils.

The pervious pavement section should be placed in an excavated area and not on embankment. If embankment material is required to design the area, it should be minimal. It is recommended to use the reservoir layer material as the fill material where needed. Consider using barriers when using embankment materials on sides. Place a detail in the project plans to show this condition.

Determine the soil classification and/or R-value of soil in accordance with HDM Topic 614 and other applicable discussions for concrete and asphalt pavements. The R-value is used to determine thicknesses for reservoir and surface layers for asphalt pervious pavement and PICP. Consult District Materials Engineer if soil meets Subgrade Type 3 on Table 623.1A of the HDM (USCS CH with plasticity index>12 or R-value is less than 10) for suitability of site for pervious pavement and possible design modifications.

Place a subgrade enhancement geotextile fabric between the subgrade soil and the bottom of the reservoir layer, only if recommended by Caltrans Geotechnical Services. A fabric may help reduce fine materials from migrating into the reservoir. Do not increase the R-value in the design calculations (HDM Index 614.5 does not apply to pervious pavement).

4.3.3 Reservoir Layer

The reservoir layer is a reservoir for the storage of storm water and it is the structural support for the surfacing, when needed. Use Class 4 AB for reservoir layer.

When an aggregate base layer is needed, the minimum thickness for all types of pervious pavement is 0.5 ft. for constructability.

- Pervious Asphalt
  For pervious asphalt design the reservoir thickness based on procedures for new pavement in HDM Topic 633. Use Gf of 1.0 for Class 4 AB.

- Pervious Concrete
  For pervious concrete use the following minimum thicknesses for the Class 4 AB layer:
  - Zero for Category A (non-auto locations)
  - 0.50 feet for Category B auto areas
  - 0.70 feet for Category B truck areas
  - 0.70 feet for Category C truck areas

  Add 0.20 ft of Class 4 AB where the R-value is less than 25.

- Permeable Interlocking Concrete Pavement
  For PICP, determine the subbase thickness using the following steps:
  (1) Determine the lifetime 18,000 lb. equivalent single axle loads or Traffic Index (TI) on the pavement.

  (2) Determine the resilient modulus of the subgrade or R-value in a saturated condition.

  (3) Find the Caltrans Water Quality Planning Tool on (http:/svctenvims.dot.ca.gov/wqpt/wqpt.aspx). Turn on map layer named 'Monthly Precipitation' by checking the appropriate box on the left of the screen. Using the California map located on the right side of the screen zoom into the project site area or use the Postmile Lookup tool located at the upper right hand corner of the screen. Once the site is located click on the nearest monthly precipitation icon (blue rain drop) nearest to the project site and a box marked 'Monthly Precipitation' should appear. This box presents a chart with the number of days per month and days of annual rainfall over 0.1 inches and 0.5 inches.

  (4) Find the number of approximate wet days per year, days the reservoir has standing water in it.

This number depends on the soil infiltration rate (Section 2). If the soil infiltration rate is 0.05 inches per hour or greater, use the annual number of days per year over 0.5 inches of rainfall. Apply that number to the top row on Table 4.1 labeled 'Number of Wet Days per Year.' The 0.05 inches per hour infiltration rate means that 0.5 inches of rainfall will be infiltrated in well less than 24 hours. This approach provides a safety factor for long-term subgrade clogging.

If the subgrade infiltration rate is less than 0.05 inches per hour, then select the annual days for rainfall over 0.1 inches at the bottom of the chart shown on the Caltrans Water Quality Planning Tool and apply value to the top row of Table 4.1, 'Number of Wet Days per Year.'

If there is runoff contributed to the PICP from adjacent surfaces, then add that depth to the rainfall depth and estimate the number of days required to infiltrate this water with the soil infiltration rate. Use this value as the number of wet days.

(5) Determine the Class 4 AB thickness from Table 4-1 or using Equation 4-1. Under the appropriate column heading with the selected number days, find the applicable R-value or resilient modulus for the soil subgrade. If R-values fall between two values provided on the chart, use the lower R-value for selecting the thickness of the Class 4 AB. Note: Resilient Modulus in psi = 1155 + 555 x R-value. R-values are rounded down to the nearest whole number.

With the selected R-value, follow that column downwards until it intersects with the row indicating the Traffic Index or ESALs. Select the Class 4 AB thickness in inches where the column and row intersects.

Table 4-1: PICP Class 4 AB thickness chart

Number of Wet Days per Year	**10 or less**				**11 to 30**			
Resilient Modulus of Subgrade, MPa (R-value)	**24 (4)**	**36 (7)**	**48 (9)**	**60 (13)**	**24 (4)**	**36 (7)**	**48 (10)**	**60 (13)**
Lifetime ESALs (Traffic Index)	**Minimum Class 4 AB Thickness (in) 1 in. Allowable Rut Depth**							
50,000 (6.3)	6.0	→			→			
100,000 (6.8)	8.5	6.0	6.0	6.0	10.5	6.0	6.0	6.0
200,000 (7.4)	12.5	8.5	6.0	6.0	14.5	10.0	6.5	6.0
300,000 (7.8)	15.0	10.5	7.0	6.0	17.0	12.5	8.5	6.0
400,000 (8.1)	17.0	12.0	8.5	6.0	19.0	14.0	10.0	7.0
500,000 (8.3)	18.0	13.5	9.5	6.5	20.0	15.0	11.0	8.0
600,000 (8.5)	19.0	14.5	10.5	7.0	21.0	16.0	12.0	9.0

700,000 (8.6)	20.0	15.0	11.0	8.0	22.0	17.0	13.0	10.0
800,000 (8.8)	20.5	16.0	12.0	8.5	22.5	17.5	13.5	10.5
900,000 (8.9)	21.0	16.5	12.5	9.0	23.5	18.0	14.0	11.0
1,000,000 (9.0)	22.0	17.0	13.0	9.5	24.0	19.0	14.5	11.5

Table 4-2: PICP Class 4 AB thickness chart (continued)

Number of Wet Days per Year	**31 to 50**				**51 to 90**				**91 or more**			
Resilient Modulus of Subgrade, MPa (R-value)	**24 (4)**	**36 (7)**	**48 (9)**	**60 (13)**	**24 (4)**	**36 (7)**	**48 (9)**	**60 (13)**	**24 (4)**	**36 (7)**	**48 (9)**	**60 (13)**
Lifetime ESALs (Traffic Index)	**Minimum Class 4 AB Thickness (in) 1 in. Allowable Rut Depth**											
50,000 (6.3)	7.0	6.0	6.0	6.0	8.5	6.0	6.0	6.0	9.0	6.0	6.0	6.0
100,000 (6.8)	11.5	7.0	6.0	6.0	13.0	8.5	6.0	6.0	13.5	9.5	6.0	6.0
200,000 (7.4)	16.0	11.5	7.5	6.0	17.0	13.0	8.5	6.0	18.0	13.5	9.5	6.0
300,000 (7.8)	18.0	13.5	9.5	6.5	20.0	15.0	11.0	8.0	20.5	16.0	11.5	8.5
400,000 (8.1)	20.0	15.0	11.0	8.0	21.5	16.5	12.5	9.5	22.0	17.5	13.0	10.0
500,000 (8.3)	21.0	16.5	12.0	9.0	23.0	18.0	13.5	10.5	23.5	18.5	14.0	11.0
600,000 (8.5)	22.0	17.5	13.0	10.0	24.0	19.0	14.5	11.0	24.5	19.5	15.0	12.0
700,000 (8.6)	23.0	18.0	14.0	11.0	25.0	19.5	15.0	12.0	25.5	20.5	16.0	12.5
800,000 (8.8)	24.0	19.0	14.5	11.5	25.5	20.0	16.0	12.5	26.5	21.0	16.5	13.5
900,000 (8.9)	24.5	19.5	15.0	12.0	26.0	21.0	16.5	13.0	27.0	21.5	17.0	14.0
1,000,000 (9.0)	25.0	20.0	15.5	12.5	27.0	21.5	17.0	13.5	27.5	22.0	17.5	14.5

Equation 4-1

$$T_{AB4} = \frac{325.9 \log ESAL + 325.9 \log M_r - 373.3(\log M_r)^2 + 7.8\sqrt{d_w} + 62.5 * \log d_w - 1346}{304.8}$$

Where: T_{AB4} = Thickness of the Class 4 AB (ft) (round up to next 0.05 ft; use 0.50 ft min)

ESAL = Equivalent single axel loading over the life of the pavement (1,000,000 Max)

M_r = Resilient modulus determined under AASHTO T307 (MPa)

d_w = Number of wet days per year as determined above (min = 1)

4.3.4 Surface Layer

Surfaces for pervious pavement must be durable and maintainable. Three options are currently provided in this guide:

- Pervious Asphalt
- Pervious Concrete

- Permeable Interlocking Concrete Pavers

Any of these options can be used where pervious pavement is determined to be suitable and the appropriate bases and soil treatments are included.

The minimum thickness and other surface layer requirements are as follows. Refer to Appendix 3 Usage Notes for Pervious Pavement nSSPs for further discussion.

- Pervious Asphalt
  - Consists of two surface layers: asphalt treated permeable base (ATPB) and Open Graded Friction Course (OGFC).
  - Do not use or specify tack coats or prime coats.
  - Design thickness of ATPB based on procedures for new pavement in HDM Topic 633 using the following values and minimums for situations with vehicular traffic.
    - Measured R-value
    - ATPB – Use Gf of 1.4. Minimum thickness: 0.25 feet.
  - Place 0.10-foot OGFC on top of the ATPB. Do not deduct thickness from ATPB or reservoir for the OGFC. OGFC is a nonstructural wearing course which protects the ATPB and can be replaced as the surface wears out.
  - When no vehicular traffic is planned (Category A) use the minimum thicknesses for ATPB and OGFC above.
- Pervious Concrete
  - Use the following minimum thicknesses for the concrete layer for 20 year pavement design life:
    - 0.35 feet for all Category A (non-auto locations)
    - 0.45 to 0.50 feet for Category B auto areas.
    - 0.70 feet for Category C truck areas (TI < 9).
    - 0.80 feet for bus stop pads and TI 9 to 10.
  - When a project is designed for a TI greater than 10 contact the Office of Concrete Pavement and Pavement Foundations for additional input.
  - Dowel bars and tie bars are not used for pervious concrete.
- Permeable Interlocking Concrete Pavement
  - The minimum thickness of the pavers for PICP subject to vehicular traffic is 3 1/8 inches. 2 3/8 inch thick pavers may be used in pedestrian areas. Concrete pavers must conform to ASTM C936.
  - Place 0.15 foot bedding layer between 0.35 feet Class 3 permeable material course and pavers.
  - Do not use PICP where TI > 9 at this time.
  - Concrete curb or curb and gutter are typically used at the pavement edges and at transitions to other pavements. The curb acts as a guide for the bedding and paver placement and assists in interlock of the pavers.

4.3.5 Minimum Pavement Structures

The following designs are the minimum needed for structural adequacy and/or constructability. . Class 4 AB (reservoir layer) thicknesses are structural minima and any thickness greater is permissible. Thicker Class 4 AB will be required in cases that the pervious pavement is adjacent to a thick section non-pervious pavement or if there is a high hydraulic storage requirement. The bottom of the Class 4 AB should be 0.05 ft lower than adjacent non-permeable pavement structure. Category A, B & C are based on Table 1-1 of the Pervious Pavement Design Guidance.

Individual project needs may require thicker sections. Please consult your District Materials Engineer for final recommendations.

Verify the reservoir layer thickness is adequate for the required water storage volume.

Category A

- *Pedestrian and bike pathways, occasional light vehicle can be permitted, and sidewalks except at driveways*

Option 1

0.20 feet OGFC over 0.50 feet AB Class 4

Option 2

0.35 foot pervious concrete on native soil

Option 3

PICP on native soil with a minimum 0.15 foot thick bedding layer over a 0.35 foot thick Class 3 permeable material and no reservoir layer

Category B

- *Maintenance vehicle pull out*

MVP must be outside shoulder area. If Unified Soil Classification is CL, CH, OH, or OL or R-value is less than 25 add 0.20 foot Class 4 aggregate base to values below. The grading plane of subgrade material should be sloped away from shoulder at 2 percent or more.

Option 1

0.10 foot OGFC over 0.35 feet ATPB on 0.50 feet Class 4 AB.

Option 2

0.45 foot pervious concrete on 0.50 foot Class 4 AB.

Option 3
PICP placed on 0.35ft Class 3 permeable material over 0.50 ft Class 4 AB.

- *Recovery zone outside shoulder and gore areas*

Follow HDM 304 - Side Slopes.
Safety slope option (1:10 or flatter):

- 0.10 foot OGFC over 0.35 feet ATPB on 0.50 feet Class 4 AB
- 0.45 foot pervious concrete on 0.50 foot Class 2 or Class 4 AB.
- PICP placed on 0.35ft Class 3 permeable material over 0.50 ft Class 4 AB.

Safety slope options (>1:10):

1. 0.10 foot OGFC over 0.25' ATPB.
2. 0.35 foot pervious concrete.
3. PICP not recommended

Grading plane of subgrade material and Class 2 AB should be sloped away from shoulder at 2 percent or more. Color treatment for pervious pavement is recommended to minimize intentional trafficking.

- *Driveway or sidewalk at driveway*

Option 1
0.10 foot OGFC over 0.40 feet ATPB on 0.70 foot Class 4 AB

Option 2
0.50 foot pervious concrete on 0.70 foot Class 4 AB

Option 3
PICP on 0.35 Class 3 permeable material over 0.70 foot Class 4 AB

- *Maintenance access road*

Option 1
0.10 foot OGFC over 0.40 feet ATPB on 0.70 foot Class 4 AB

Option 2
0.50 foot pervious concrete on 0.70 foot Class 4 AB

Option 3
PICP on 0.35 foot Class 3 permeable material over 0.70 foot Class 4 AB reservoir layer

- *Parking area for passenger vehicles including trafficked area*

Option 1

Design per procedures in HDM Topic 633. Use Gf=0 for OGFC, Gf=1.4 for ATPB, and Gf=1.0 for Class 4 AB. Use TI values from HDM Table 613.5B for all auto parking areas.

Option 2

0.50 foot pervious concrete on 0.50 foot Class 4 AB. If R-value is less than 25 add 0.20 foot base.

Option 3

PICP on 0.35 foot Class 3 permeable material. Determine Class 4 AB minimum thickness by the procedure in section 4.3.3.

Category C

- *Parking area for heavy vehicles (e.g. rest area on highway with AADTT > 3000)*

TI≤9 (See Note)

Option 1

Design per procedures in HDM Topic 633. Use Gf=0 for OGFC, Gf=1.4 for ATPB, and Gf=1.0 for Class 4 AB.

Option 2

0.70 foot pervious concrete on 0.70 foot Class 4 AB.

Option 3

PICP on 0.35 foot Class 3 permeable material. Determine Class 4 AB minimum thickness by the procedure in section 4.3.3.

TI≥9.5

Use a non-pervious paving material. Utilize current procedures in HDM to design.

- *Bus Stop Pads*

0.80 foot pervious concrete on 0.70 foot Class 4 AB.

Note:

In trafficked area that gets more than 2000 trucks per day, average, use a non-pervious surface paving material. Water from non-pervious area may flow to pervious area. Grading plane of subgrade below Class 4 AB must be below Class 2 or 3 AB of adjacent pavement. Class 4 AB may be placed under non-pervious pavement. Slope of grading plane of subgrade material should be zero percent. Place a curb between dense graded structural section and the pervious structural section. (Figure 2-4)

REFERENCES

Development and HVS Validation of Design Tables for Permeable Interlocking Concrete Pavement, UCPRC-Research Report-2014-04, UC Davis, Department of Civil and Environmental Engineering.

Highway Design Manual (HDM), Current Edition, California Department of Transportation.

Infiltration Basins Design Guidance, dated February 2011, California Department of Transportation, Division of Design, Office of Storm Water Management.

Infiltration Trenches Design Guidance, dated September 2011, California Department of Transportation, Division of Design, Office of Storm Water Management

Low Impact Best Management Practice (BMP) Information Sheet. 2008. Weston, MA: Charles River Watershed Association.

Permeable Interlocking Concrete Pavements, Fourth Edition 2011, Interlocking Concrete Pavement Institute, Herndon, Virginia.

Project Planning and Design Guide (PPDG), July 2010, California Department of Transportation (CTSW-RT-1.0-254.03).

Research Report – Laboratory Testing and Modeling for Structural Performance of Fully Permeable Pavements Under Heavy Traffic: Final Report, dated November 30, 2010, U.C. Davis, Department of Civil and Environmental Engineering (CTSW-RT-10-249.04).

VA DCR Stormwater Design Specification No. 7, Permeable Pavement Ver. 1.6, dated September 30, 2009, Department of Conservation and Recreation, Richmond, Virginia.

APPENDIX

1. CONSTRUCTION CONSIDERATIONS

When preparing to construct each type of pervious pavement, evaluate how the construction of the overall project could affect the ultimate performance of the pavement. Be sure to review and install the selected type of pervious pavement in accordance with current industry standards.

Protect the pervious pavement from adjacent stormwater runoff areas. This is especially critical if the adjacent areas are unpaved. These areas could introduce sediment-laden stormwater to flow onto the pavement, potentially clogging the surface and filling the voids in the reservoir. Temporary stormwater controls should remain in place until all disturbed areas that could reach the pervious pavement are stabilized.

If the pervious pavement is required to be constructed before completion of the project (building and fire codes commonly require hard surfaces to be in place before structures are constructed), the pervious pavement should be protected in place. Consider placing a geotextile fabric on the surface to protect the pavement from construction debris and vehicles. The fabric may require stabilization with a thin layer of clean aggregate over it to prevent wrinkling when trafficked by vehicles.

1.1 Preparation and Placement

Refer to the specifications (http://www.dot.ca.gov/hq/oppd/stormwtr/pervious.htm) and Usage Notes for Pervious Pavement nSSPs & Recommended Minimum Pavement Structures (see Appendix 3) developed by the Caltrans Pavement Program for pervious pavement applications .

The following applies to preparation and placement of the reservoir and pervious pavement materials

1.1.1 Subgrade

- A compaction range has been predetermined. The lower end has been set by Caltrans Pavement Program and the upper limit by Design with Construction concurrence. The intent of the range is to allow the Contractor to excavate the material while maintaining the soil permeability of the site to an acceptable rate.
- If area to be paved with pervious pavement exceeds the upper limit of relative compaction, the contractor must remove over compacted material and recompact to between the specified limits.
- If fill material is required underneath the reservoir layer to meet the finished grade, it should consist of additional reservoir material and not compacted soil. No fill

materials should be allowed on sides of the pervious pavement and/or the reservoir layers unless properly designed. Some type of barrier may be necessary.

It is in the best interest of the contractor to do the following to maintain the soil permeability during construction:

- Protect the site area from construction equipment that could reduce insitu permeability.
- Keep all traffic off the subgrade during construction to the maximum extent practical.
- Avoid using equipment with narrow tires.

1.1.2 Reservoir

- The reservoir layer consists of Caltrans Class 4 AB and varies in thickness depending on traffic and water storage requirements.
- Exercise care to avoid damage to the geotextile during placement of the aggregate for the reservoir.

1.1.3 Pervious Asphalt

- Do not apply prime coat prior to placement of ATPB
- Do not apply tack coat prior to placement of OGFC

1.1.4 Pervious Concrete

- The water content of pervious concrete mix can have a dominant impact on performance and should be strictly controlled.
- Laboratory testing should be performed to estimate field unconfined compressive strength based on relationship between voids and unconfined compressive strength.
- The curing should happen within a time period so that the surface does not dry out. This is critical and there should be NO exceptions. If this is not enforced, the pervious concrete structural capacity will be significantly diminished and early deterioration of the pervious concrete is expected.
- The curing membrane should extend far enough beyond the edge of the paved area to enable adequate securing of the edges. The edges must be held down to prevent air circulating under the membrane and removing curing moisture. The weights used to hold the edges down can be boards held down with sand bags or sand bags alone. Unconfined soil is not allowed because it could contaminate the pervious concrete and reservoir layers. Stapling the curing membrane to wooden forms has been successful. Care must be taken to not pierce the membrane.
- Securing the curing membrane is essential. The contractor should designate staff to visit the site on a daily basis at a minimum, including weekends and holidays, to verify the membrane is secure. If the pervious concrete is not covered for the full 7 calendar days, the pervious concrete structural capacity will be diminished and the pavement may begin to ravel shortly after installation.

- Saw cut material should be removed (water should not be of sufficient force or direction so as to wash the saw cutting debris in to the open voids) by sweeping and vacuuming.
- National Ready Mixed Concrete Association (NRMCA) certified personnel are required. The installation and curing of pervious concrete is different from conventional PCC. The following are critical items that should be inspected, checked, and/or considered during construction of a pervious concrete project:

    - Unit weight is critical in the mix design for pervious concrete.
    - Hydration stabilizers are recommended for the mix.
    - Pervious concrete mixtures cannot be pumped.
    - The wind velocity should be checked prior to placing pervious concrete, similar to conventional PCC.
    - Placement must be continuous.
    - Spreading and strike-off must be rapid.
    - Do not use bull floats, darbies, or trowels except for edging or small touchup areas.
    - Edge forms are recommended.
    - Loose sand or dirt to hold curing plastic sheeting in place is not allowed.
    - The pervious concrete should appear moist during the 7 calendar day curing period.
    - Drying shrinkage of pervious concrete develops sooner, but is much less than conventional concrete.
    - Air entrainment of the cement paste is required in areas where the pavement may become susceptible to freeze thaw conditions.

1.1.5 Permeable Interlocking Concrete Pavement

- The PICP Class 3 permeable material over the top of the reservoir material will stabilize the surface for the paving equipment. The purpose is to fill some of the surface voids created when using larger rock in the reservoir layer and help lock up the aggregate. Some of the large rocks may be visible after the Class 3 permeable material has been placed and compacted.
- Curbs are typically cast on the compacted reservoir layer. If curbs are cast on top of the reservoir, water will flow underneath the curb. If needed, a polypropylene fabric can be used to completely separate the reservoir from the adjoining soil or impervious pavement base.
- Concrete pavers are placed manually or with the assistance of machines to accelerate construction time.
- Cut pavers should be no less than 1/3 of a whole paver at edges around protrusions in the pavement.
- After all of the pavers are placed, the joints are filled with small, washed stones, No. 8, No. 89 or 9 aggregates. Pavers with joints less than ¼ inches will use No. 89 or No. 9 aggregate.

- Once an area has the joints filled, the surface is swept clean and the pavers are compacted twice with minimum 5,000 lbf plate compactor.
- The specification provides tolerances on joint straightness and height above curbs after compaction.
- Once compaction is complete, joints may require some refilling of aggregates.
- After sweeping the surface clean, it is ready to accept traffic.
- Maintenance should inspect the surface within 3 to 6 months of the completion of the original contract to determine if the surface requires additional repairs. If repairs are required a separate contract may be necessary.
- Personnel holding a PICP Installer Technician Course certificate are required. The installation of PICP is different from regular interlocking concrete pavements with sand joints and a dense-graded base.
- The following are critical items that should be inspected, checked, and/or considered during construction of a PICP project.

    - Concrete Pavers meet ASTM C936 standards per manufacturer's test results
    - Class 3 permeable material consisting of maximum 1 inch stone size.
    - Elevations, slope, laying pattern, joint widths, and placement/compaction need to meet drawings and specifications
    - No cut paver is less than 1/3 of a whole paver
    - All pavers within 6 feet of the laying face must be fully compacted at the completion of each day
    - Surface tolerance of compacted pavers complies with nSSP requirements.
    - Surface swept clean at finish
    - Elevations and slope(s) conform to drawings
    - Transitions to other paved areas separated with edge restraints
    - Surface protected from adjacent construction activities and potential sediment laden water
    - Adjacent vegetation stabilized to prevent erosion onto pavement surface

2. MAINTENANCE GUIDELINES

2.1 Maintenance

Maintenance requirements are for Caltrans or other entity through a Maintenance Agreement. It's often in the best interest of local governments or agencies to care for the facility via a Maintenance Agreement if proposed pavement will require specialized care or equipment. Early communication between Caltrans and local partners can help define respective needs, abilities, and limitations.

The primary goal of pervious pavement maintenance is to prevent the pavement surface, reservoir, and/or underlying soil (infiltration bed) from being clogged with sediments. To keep the system clean throughout the year and prolong the pervious pavement life span, the pavement surface should be inspected, tested as described below, and vacuumed.

Although the mechanical brooms used by Caltrans have a vacuum action, fine mineral and organic material is collected and tends to clog the surface of the pavement and reduce its permeability. Consequently, the mechanical broom equipment used will probably not significantly prevent clogging of permeable pavements. It is recommended that regenerative air vacuum equipment be used annually to clean the pavement surface.

If pervious pavement is installed for stormwater management, Caltrans is obligated to keep it functioning effectively as designed. This requires a Caltrans staff commitment to verify performance. To determine whether the pervious pavement is functioning, it should be tested when Maintenance determines there may be a problem with infiltration using ASTM C1701 Standard Test Method for Infiltration Rate of In-Place Pervious Concrete. A minimum tested infiltration rate of 10 inches per hour indicates that the system is approaching a near-clogged condition. The test result can be compared to the original ASTM C1701 test result completed when the pavement was installed as a comparison. This test can be used to determine and schedule maintenance. PICP surface infiltration can be tested using ASTM C1781 Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems. This test method is very similar to ASTM C1701 and results from the two tests are comparable.

Clogging typically occurs near the pavement surface. If the surface is slow draining, high performance vacuum equipment may restore the permeability and should be tried first. For PICP, the jointing aggregate and dirt can be removed with high-powered vacuum equipment and the openings re-filled with clean aggregate. A last resort option is to replace the pervious pavement while leaving the reservoir layer intact.

Where Maintenance determines a spill has occurred that may have environmental consequences the spill should be contained to limit the contaminated area of the pervious

pavement section. Repairs should be done in a timely manner to remove the contamination completely.

PAP and PCP are repaired with like material and consideration should be given to the effect of the pavement repair on the overall permeability of the pervious pavement. Do not apply seal coats to pervious pavements. Any required repair of drainage structures should be done promptly to ensure continued proper functioning of the system. For PICP, damaged paving units can be replaced with whole units after leveling, and compacting the reservoir layer and leveling the bedding layer. When reinstated, the pavers with filled joints should be ½ inch higher than the surrounding undisturbed pavers and the reinstated pavers compacted until their surface is level with the undisturbed surfaces.

Control of sediment is important to maintain the permeability of pervious pavements. Sediment control measures should be installed, and maintained to prevent sediment deposition on the pervious pavement surface. Planted areas adjacent to pervious pavement should be well maintained to prevent soil washout onto the pavement. Curbs can be used to mitigate potential washouts on the pervious pavement. If any washout does occur it should be cleaned off the pavement immediately to prevent further clogging of the pores. Furthermore, if any eroded areas are observed within the vegetated areas, they should be replanted and/or stabilized at once. Planted areas should be inspected on a semiannual basis. All trash and other litter that is observed during these inspections should be removed.

Superficial dirt does not necessarily clog the pavement voids. However, dirt that is ground in repeatedly by tires can lead to clogging. Therefore, trucks or other heavy vehicles should be prevented from tracking or spilling dirt onto the pavement. In addition, all construction or hazardous materials carriers should be prohibited from entering a pervious pavement area.

Post a sign at pervious pavement sites to alert grounds keeping and Maintenance personnel to:

- keep silt and debris from entering onto the pervious pavements
- not seal the pavement, and
- not use sand or other abrasives for snow or ice conditions because they reduce permeability.
- observe the pavement surface for signs of sediment or organic debris accumulation and remove at early stages by vacuuming.
- use high performance, regenerative air vacuum equipment to clean surface and not mechanical broom type.

Note that pervious pavements are less likely to ice since snowmelt immediately drains downward into the pavement rather than remaining on the surface. In addition, these signs can include some educational information regarding the advantages of pervious pavements.

The following maintenance issues should be part of the maintenance program.

- Check for standing water on the pavement surface.
- Repair ruts or deformations in pavement exceeding ½ inch.
- Pervious concrete may generate loose gravel over time. The loose gravel on the surface from raveling should be vacuumed. Schedule regenerative air vacuum equipment (no brooms or water spray) at least once a year. A typical hand held push broom is allowed to sweep small areas of loose gravel.
- Random cracks should not be sealed.
- Under no circumstance should the pavement surface ever be seal coated.
- Scuffing can occur on pervious concrete and pervious asphalt, and does not require maintenance.
- Maintain vegetation around pavement to filter runoff.
- How to deal with spills and repairs.
- Verify performance of pervious pavement per ASTM C1701 or C1781 as noted above when pavement has been vacuumed by high performance equipment and still determined to be clogged.

The following are suggested annual maintenance inspection points for pervious pavements:

- Inspect the surface of the pervious pavement for evidence of sediment deposition, organic debris, staining or ponding that may indicate surface clogging. If any signs of clogging are noted, use high performance vacuum equipment. Test sections by pouring water from a five gallon bucket to ensure infiltration in areas where surface clogging was identified.
- Inspect the structural integrity of the pavement surface, looking for signs of surface deterioration, such as slumping, cracking, or spalling. Replace or repair affected areas.
- Inspect inlets, pretreatment BMPs and any flow diversion structures for sediment buildup and structural damage. Perform standard maintenance procedures.

Where Caltrans will be maintaining the pervious pavement maintenance crews are encouraged to determine the most effective strategy of cleaning pervious pavement especially how many times the pavement will be swept a year due to the variability of each site. Pervious pavement should only be considered if there is an effective vacuuming program. At the early stages of planning (PID and PAED) it is the responsibility of District Maintenance to determine if vacuuming equipment is already owned or will be purchased, or procured through a service contract, and accounted for in their Maintenance budget. If the equipment is going to be provided through a service contract, make sure the equipment is available in area they will be used. Currently Caltrans does not have the required type of equipment in their inventories.

Striping of PAP and PCP typically takes twice the amount of paint as conventional PCC. Striping is generally improved with the use of a primer prior to placement of the actual colored striping.

3. USAGE NOTES FOR PERVIOUS PAVEMENT nSSPs & RECOMMENDED MINIMUM PAVEMENT STRUCTURES

3.1 Usage Notes for Pervious Pavement nSSPs

Use these specifications and specification modifications when pervious pavement is desired.

Subgrade

Section 19

2 SSPs

19-5.03B - Removes areas under pervious pavement from 95% relative compaction requirement.

19-5.03C - Sets compaction limits for areas under pervious pavement.

Use as many of these as deemed appropriate according to the permeability of the underlying soil as determined during design investigations.

Base

Section 26 (Aggregate Base)

1 nSSP

nSSP_26 - Creates Class 4 AB

Use Class 4 AB when a reservoir layer is required or if the pavement will be loaded by any heavy vehicles. Class 4 AB is probably not required under bike paths or pedestrian paths for structural support. Where required use 6 inches over soil with R-value of 25 or more otherwise use 8 inches as minimums.

Section 29 (Asphalt Treated Permeable Base)

Use ATPB as structural layer for asphalt pervious systems. No modification to existing standard specifications is required.

Section 68

1 SSP

SSP 68-5 (Permeable Material Blanket)

Use between PICP and Class 4 AB. Edit SSP to use Class 3 permeable material and remove references to fabric.

Asphalt Surfaces

Section 39 (Open Graded Friction Course)

Use OGFC as the non-structural wearing course for asphalt pervious systems. No modification to existing standard specifications is required.

Concrete and Concrete Paver Surfaces

Section 40

2 nSSPs

40-9 - Pervious Concrete Pavement - Sets paving requirements for PCP; requires that 90-7 also is used in special provisions.
40-10 - Permeable Interlocking Concrete Pavement - defines materials and placement requirements for PICP and will normally have Class 4 AB under it.

Section 90
1 nSSP
90-7 - Creates pervious concrete.