# Green Street Project Design Guidelines

## SMCWPPP C.3 Workshop Part 2
## June 17, 2020

Jill Bicknell, P.E., EOA, Inc.

Special thanks to Shauna Dunton, Lotus Water, for some of the slides and photos.

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# Overview of Presentation – Focus on Bioretention in Street ROW

1. Bioretention Function and Treatment Mechanisms
2. Sizing Approaches
3. Bioretention System Component Considerations
4. Roadway Interface Considerations
5. Sidewalk Interface Considerations
6. Utility Conflicts
7. Available Design Guidance and References

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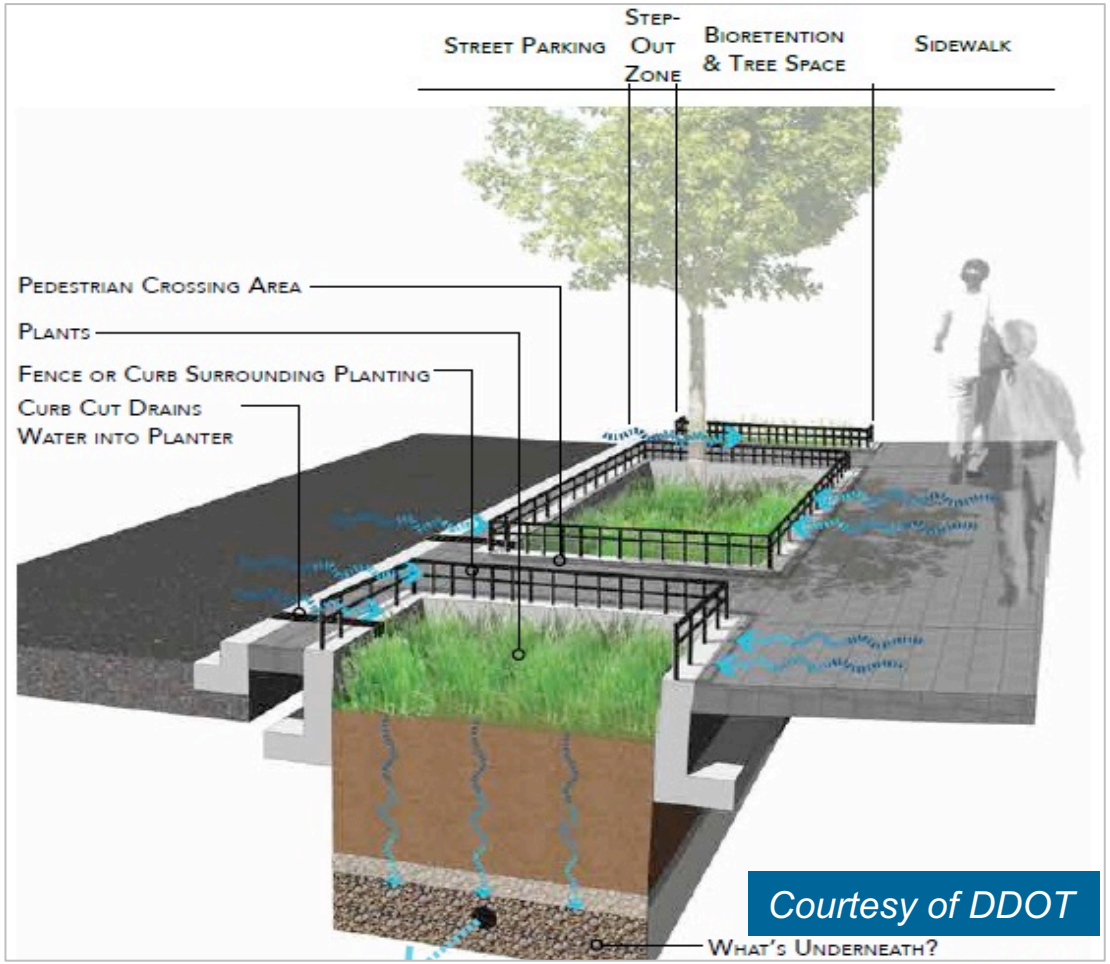
# Bioretention System Functions

- Capture runoff from adjacent impervious surfaces
- Treat runoff via plants, mulch, soil media, and infiltration where feasible
- Release treated runoff to storm drain system
- Bypass runoff exceeding design storm quantities
- Reduce runoff peaks and volumes and improve water quality




*Courtesy of DDOT*

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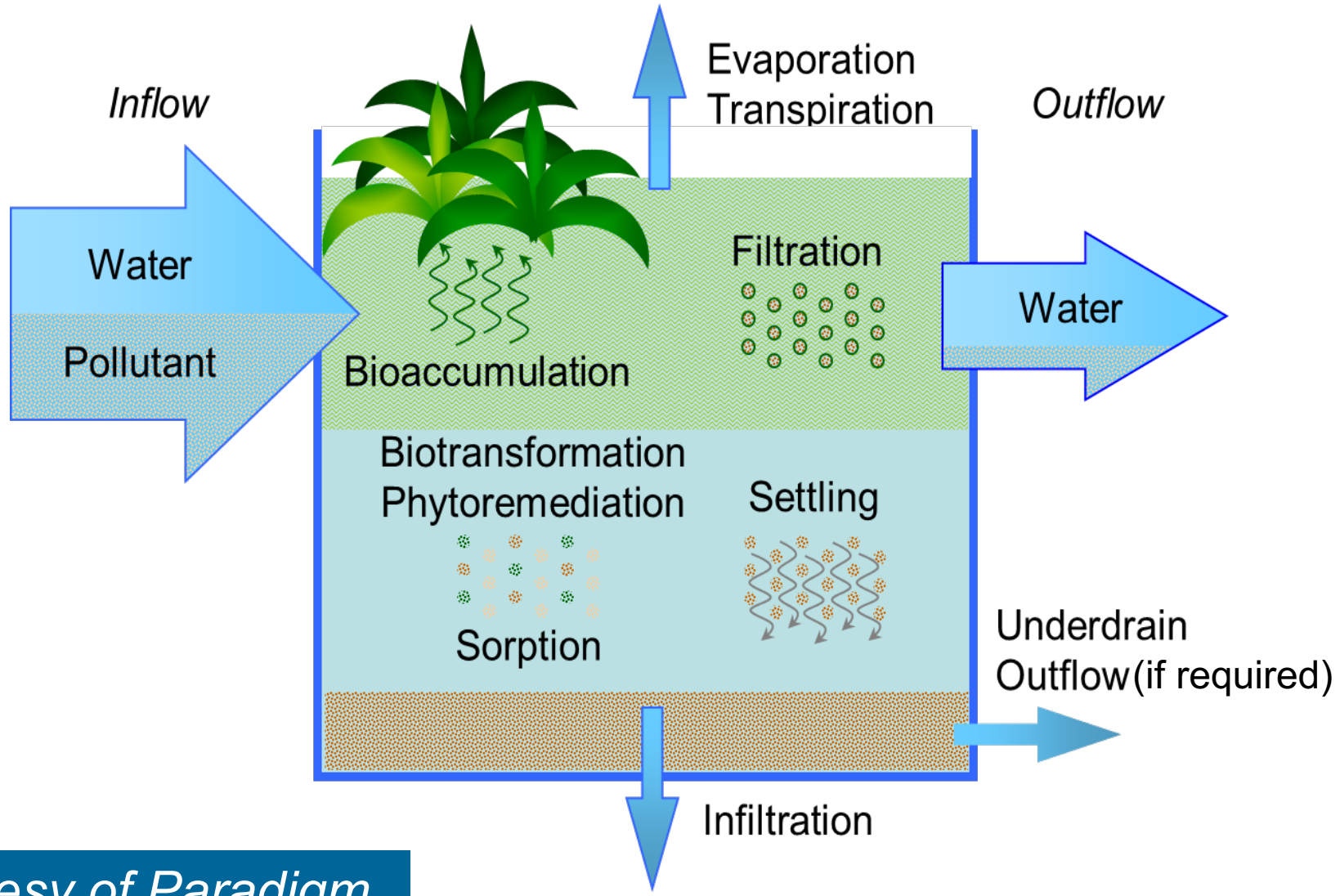
# Treatment Mechanisms




*Courtesy of Paradigm*

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# Sizing Approaches

- Simplified Flow-Based Sizing Method
  - Surface area of biotreatment measure is sized to be 4% of the contributing impervious area
- Combination Flow/Volume Approach
  - Typically results in a surface area of approximately 3% of the contributing impervious area
- BASMAA Sizing Guidance for Sizing Green Street Projects (2018)
  - In San Mateo Co., may use as low as a 2.0 – 2.5% sizing factor
  - See Appendix 7 of GI Design Guide
- Recommendation
  - Size for no smaller than 3% sizing factor; and 4% is better
  - Allows for modification in the field and DMA uncertainty

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# Drainage Area

- Area contributing runoff to bioretention area is known as drainage management area (DMA)
- Size of DMA is important factor in feasibility analysis and design
- Challenges in ROW retrofit situation:
  - Working with existing grades and inlets
  - Determining drainage from adjacent sites
  - May need to adjust DMA size to match available space or desired size for bioretention area

# Sizing Example

- 28 ft. wide residential street
- Total catchment area = 22,940 sq. ft. (includes 6,785 sq. ft. of driveway)
- With 4% method, need ~920 sq. ft. of bioretention area
- Propose 8 bioretention areas in curb extensions 4 ft. wide, 30-60 ft. long
- Total treatment area = 960 sq. ft.
- Loss of 10 parking spaces

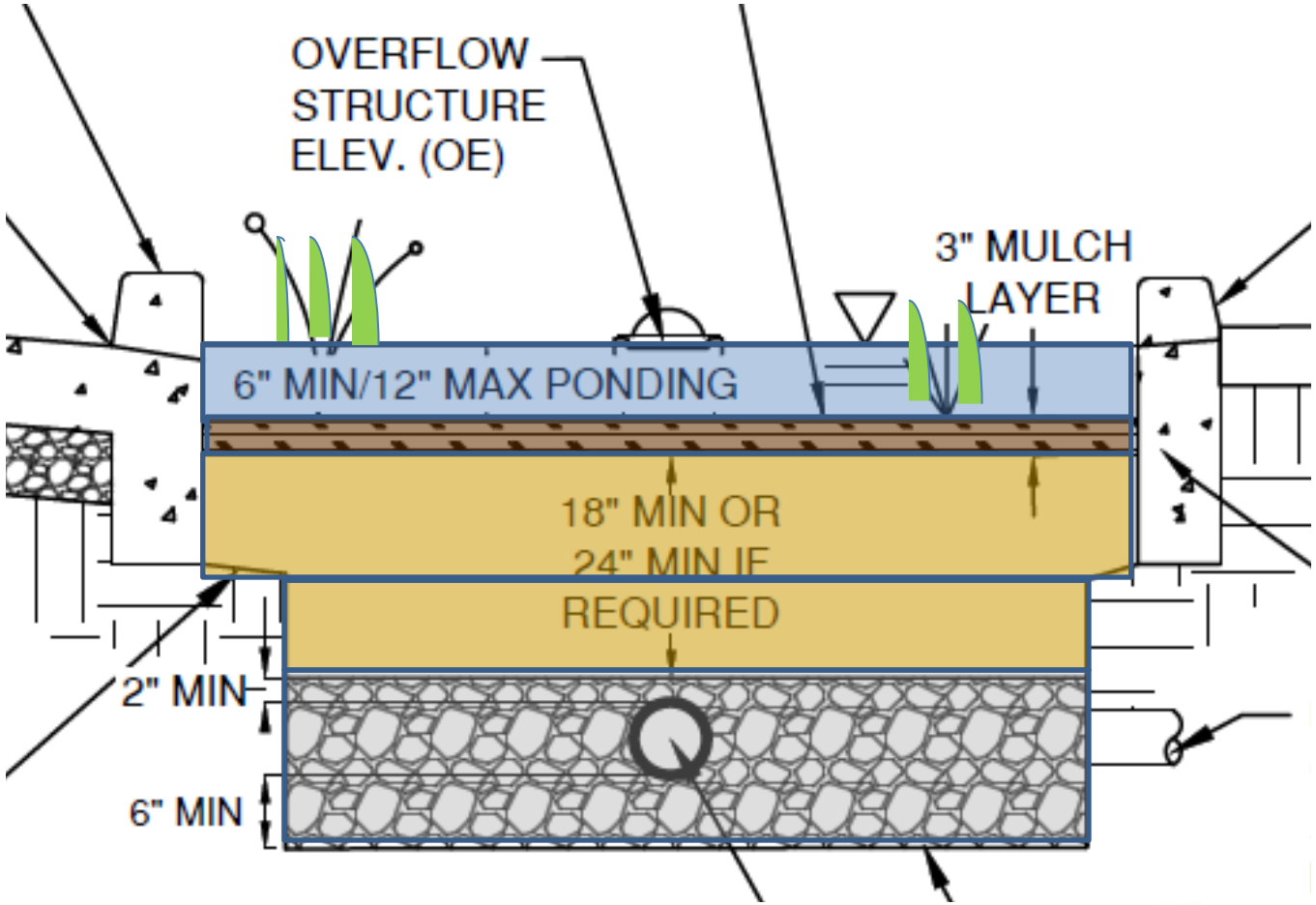
Existing Residential Street

Stormwater Allocation Plan

*Courtesy of San Mateo County Sustainable Streets Guidebook*

# Basic Component Overview

- Ponding Depth / Freeboard
- Plants
- Mulch
- Biotreatment Soil Media
- Aggregate
- Underdrains / Cleanouts
- Inlets
- Outlets/Overflow Risers

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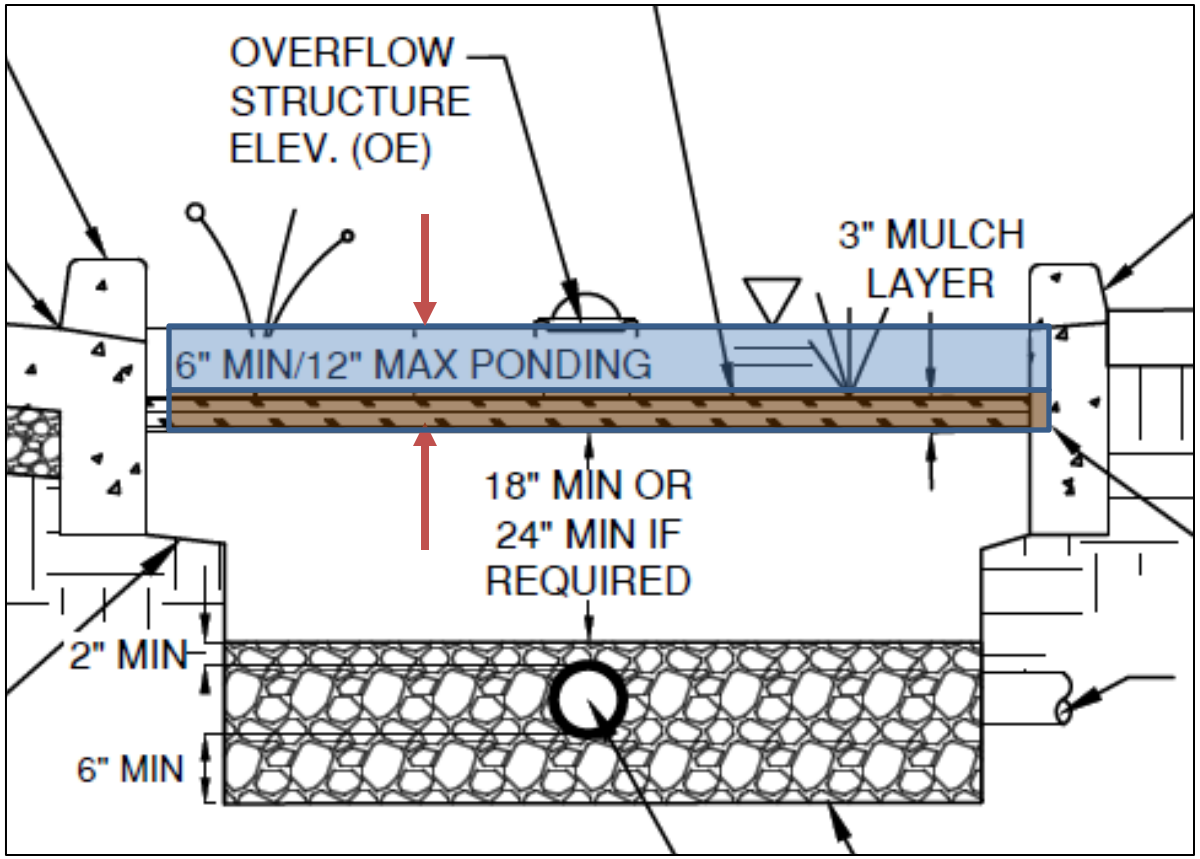
# Ponding Depth / Freeboard

- Surface of bioretention area should be flat so runoff distributes evenly (edges may slope up to grade)
- Recommended depth of ponding above BSM surface is 6”, with maximum of 12” if allowed
- Freeboard (height above overflow elevation) should be a minimum of 2” or more, per local requirements
- Avoid creating facility with large drop from adjacent sidewalk or street, or add barrier

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# Plants

- Selection of appropriate plants is critical to bioretention function
- Desired plant qualities:
  - Drought tolerant, native/adapted, non-invasive species
  - Tolerant of well-drained soils as well as periodic flooding
  - Thrive without synthetic fertilizer or pesticides
  - Low maintenance needs
- Trees may be incorporated into certain types of bioretention systems – should have adequate soil volume and access to native soil for root growth

# Mulch

- Mulch protects BSM from erosion and provides benefits to plants
- State Water Efficient Landscape Ordinance requires 3” of mulch
- Wood mulch
  - Adds organic matter and nutrients and increases water retention
  - Best type is aged/composted arbor mulch, with pieces of different sizes, to avoid floating
  - Needs annual replenishment


Aged/composted arbor mulch

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# Mulch, continued

- Rock mulch
  - Stays in place and does not biodegrade
  - Best type is clean, washed small to medium-sized aggregates such as pea gravel or small river rock (larger than overflow grate openings)
  - May use larger cobble for extra erosion control where needed
  - Maintenance/safety concerns
- Combination
  - Rock mulch along flow line
  - Wood mulch on slopes

Rock and cobble mulch with temporary blockage of inlet during plant establishment in San Francisco

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# Biotreatment Soil Media (BSM)

- BSM provides healthy plant growth and filters runoff at a controlled rate (long term rate of 5 in/hr)
- Bay Area spec includes 30-40% compost and 60-70% sand (see Appendix K of C3 RP Guide)
- Depth of BSM is a minimum of 18”

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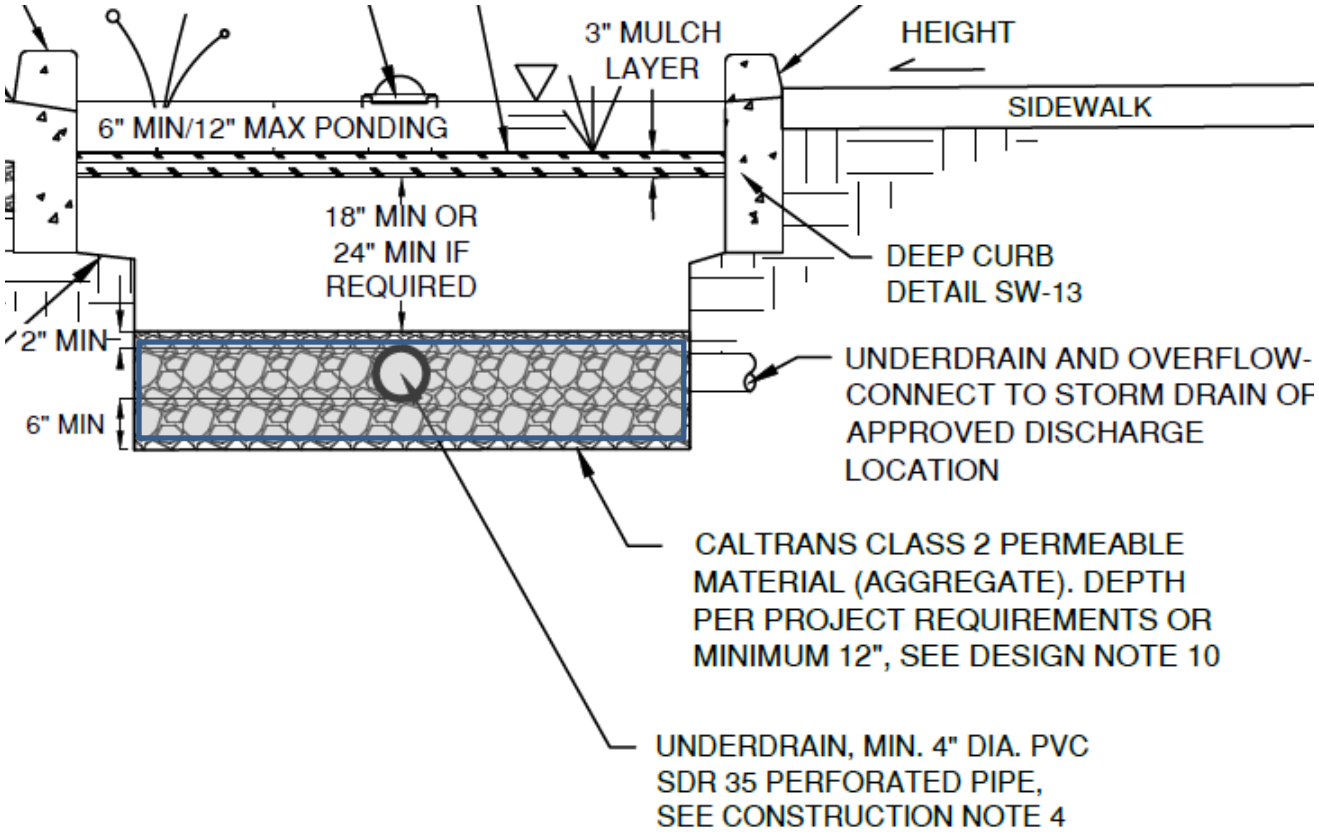
# Aggregate

- Aggregate layer allows for full drainage out of the BSM and provides storage for treated stormwater prior to infiltration to subgrade
- Typically use 12” depth of Caltrans Class 2 Permeable
- Can also use 12” of open graded rock with 1-2” of pea gravel
- Larger depths can be provided for additional retention/storage

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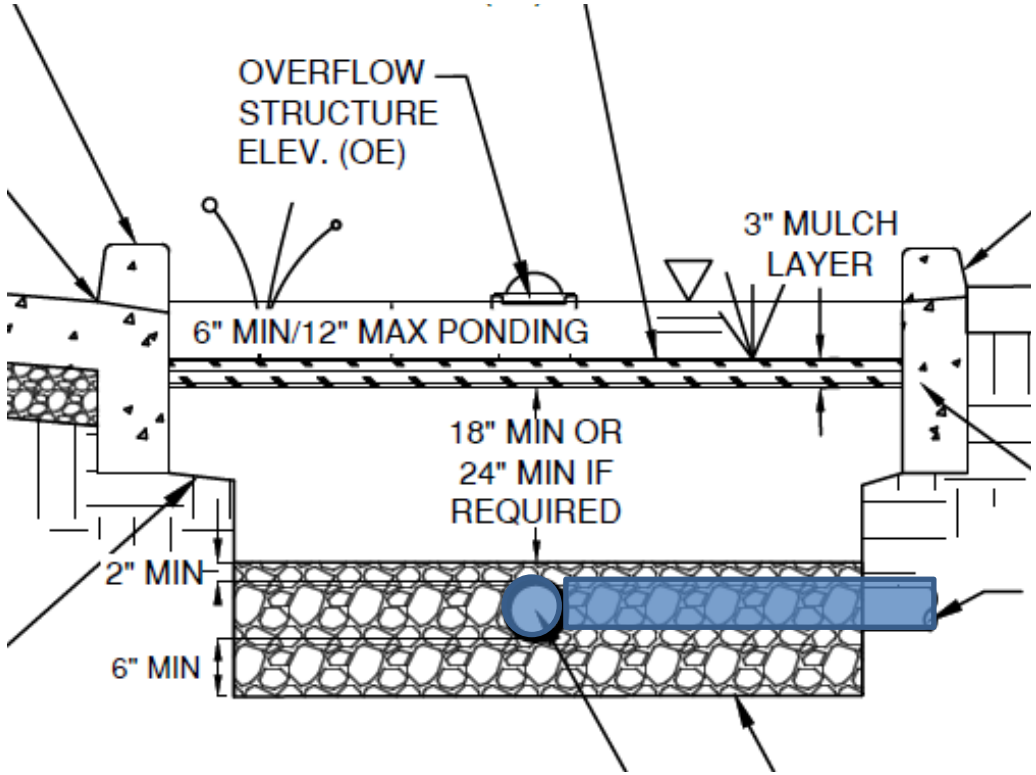
# Underdrains

- Required for installations in slow-draining native soils
- Typically min. 4” slotted or perforated pipe with cleanouts and connection to storm drain
- Underdrain is set in aggregate layer, with min. 2” cover, at min. 0.5% slope
  - If infiltration is desired, set at elevation near top of aggregate
  - If facility bottom is lined, place near bottom of aggregate

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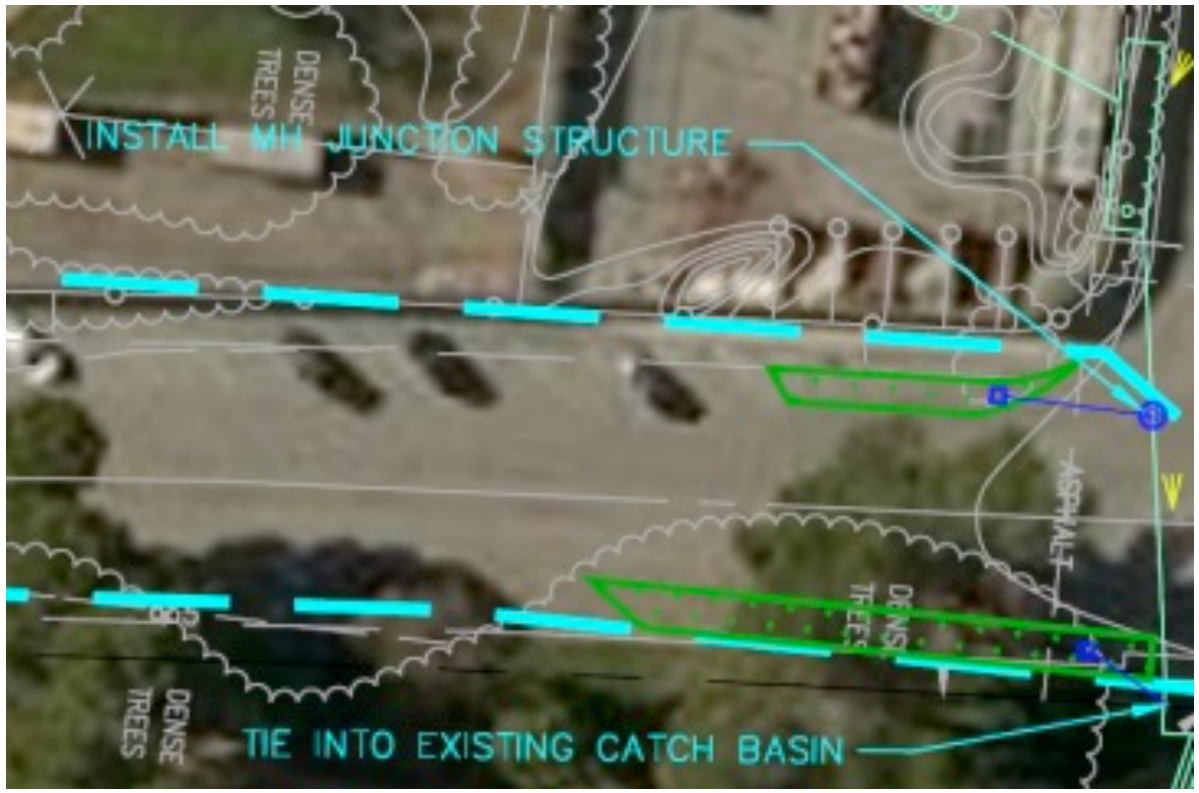
# Storm Drain Connections

If underdrains are needed, connection to storm drain is essential. Look for:

- Availability
- Proximity
- Proper depth
- Capacity
- No utility conflicts

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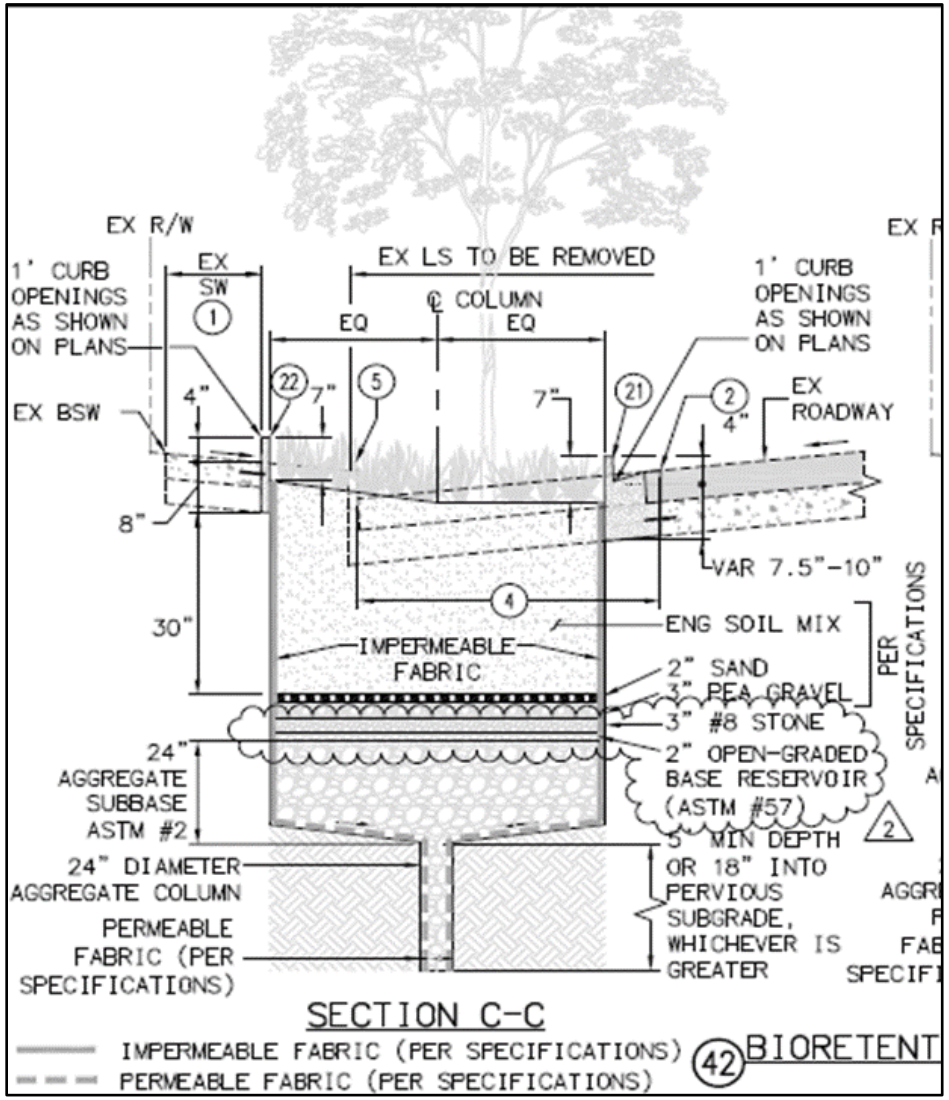
# Lack of Storm Drains – Alternative Design

Southgate Neighborhood
Green Street, Palo Alto

- Old neighborhood
- No storm drains
- Infiltration columns below bioretention
  - 2 ft diameter
  - 5-10 ft deep
  - Gravel columns with sand filter at bottom

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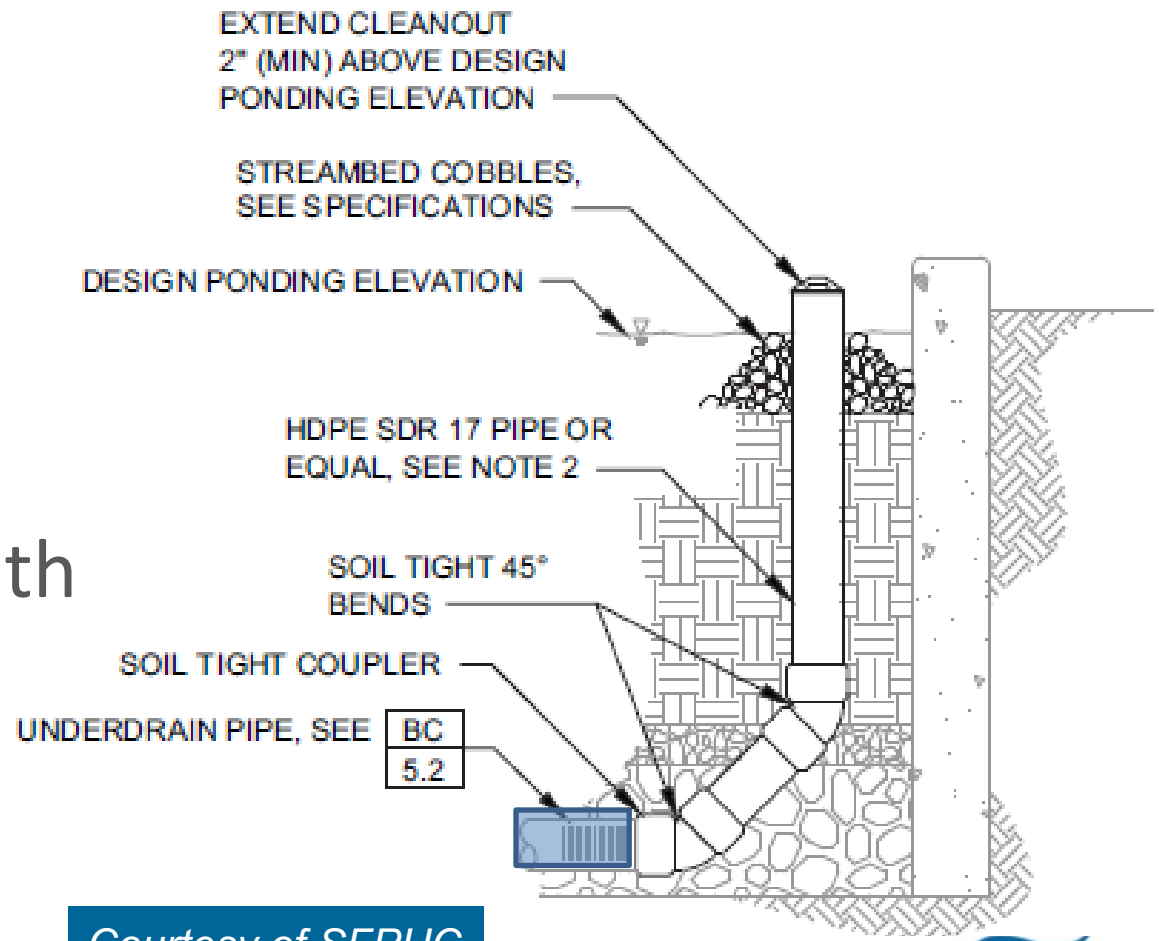
# Cleanouts

- Important for getting access clean out underdrain
- May be raised above ponding elevation or set at top of BSM with water-tight threaded cap
- Should be 4” min. diameter with sweep bend or 45º bend




*Courtesy of SFPUC*

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# Inlets

- Ensure that design flow from full DMA enters facility:
  - As overland flow (e.g., flush curb)
  - Through curb opening
  - Through trench drain
  - Through bubble-up structure
  - Through roof leader from building
- Inlets should be spaced so that runoff is dispersed across surface of bioretention area

Flush curb

Trench drain

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# Inlets – Curb Cuts

- Curb cuts should be adequately sized, spaced and sloped to convey design flows
- Recommended min. width is 18”
- Can be sloped- or vertical-sided
- Rounded inlet edges and modified gutters help direct flow into facility and avoid water bypassing inlets
- Splash aprons help prevent erosion at entrance


*Holloway Avenue Green Street, SF*

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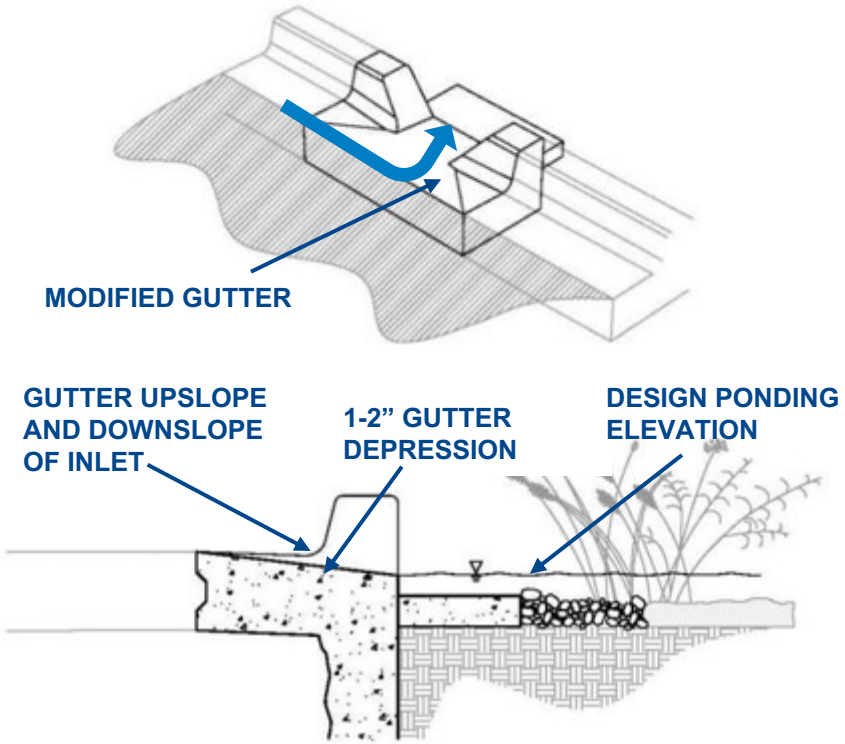
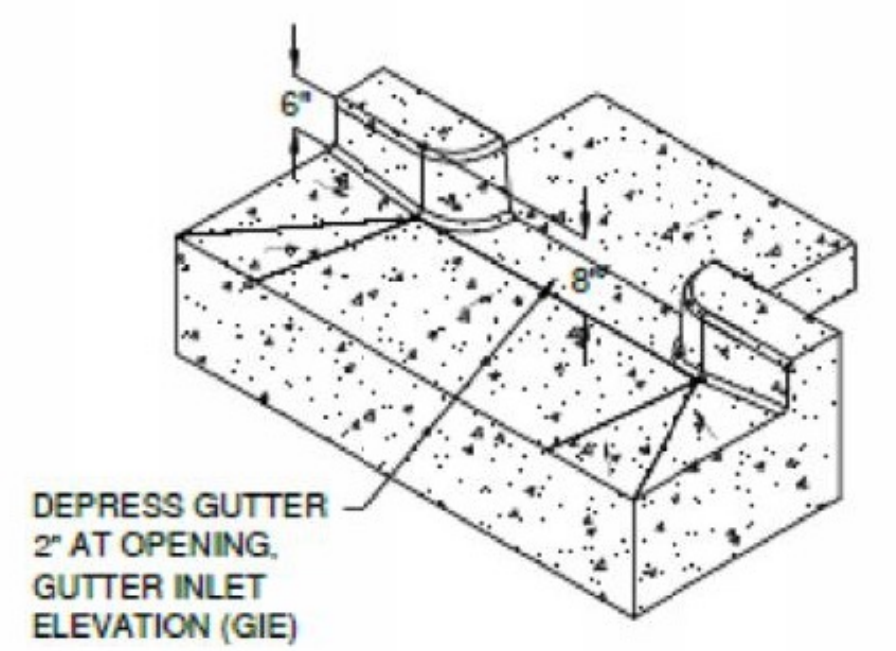
# Inlets – Curb Cuts

Modified gutters and rounded corners at curb cut inlets

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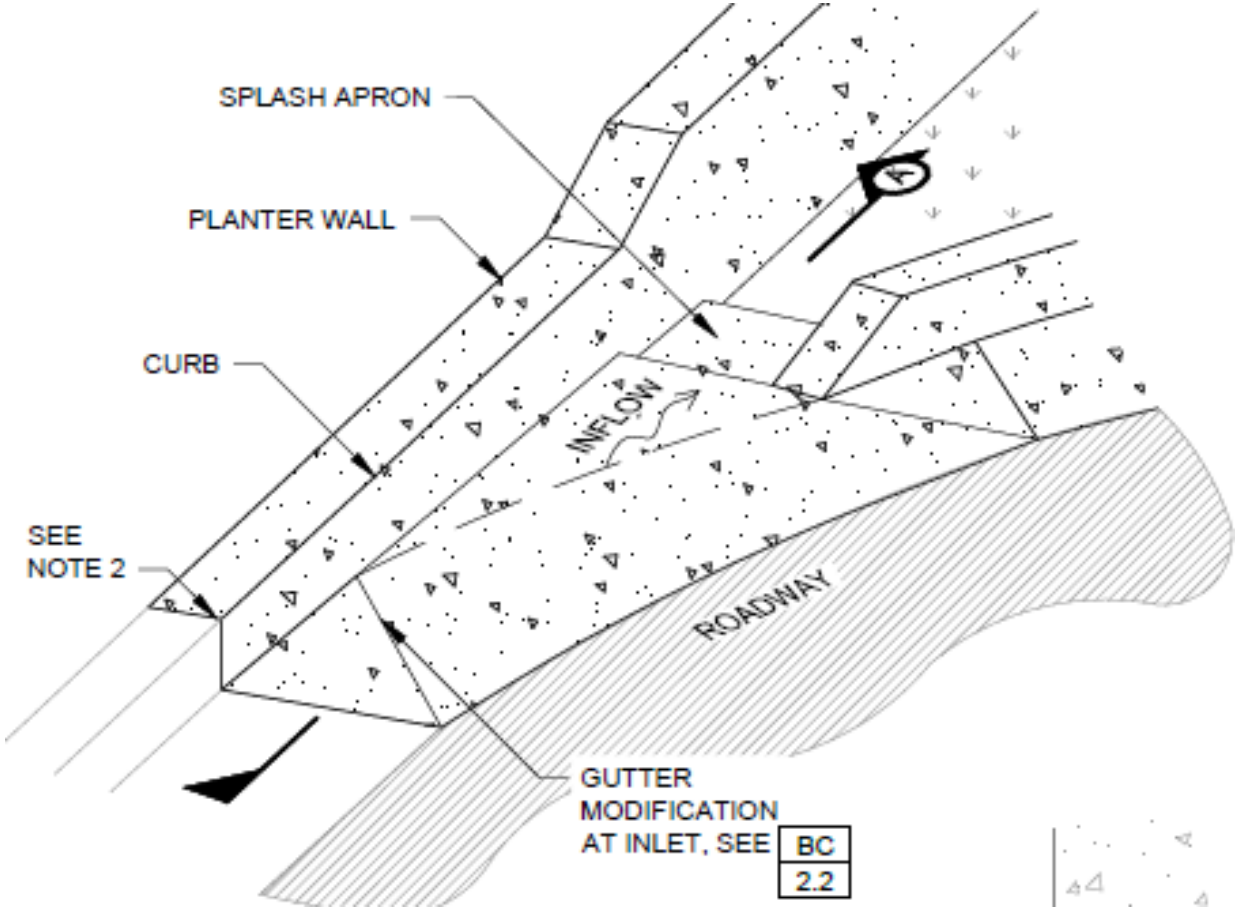
# Inline Inlets

- Provide inline inlet to bulbout planters where feasible





*Holloway Avenue Green Street, SF*

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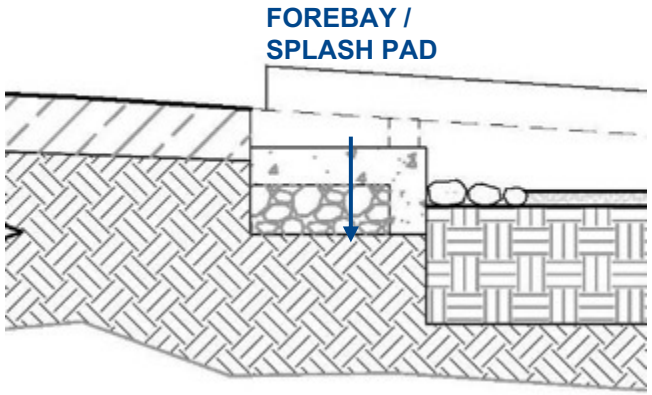
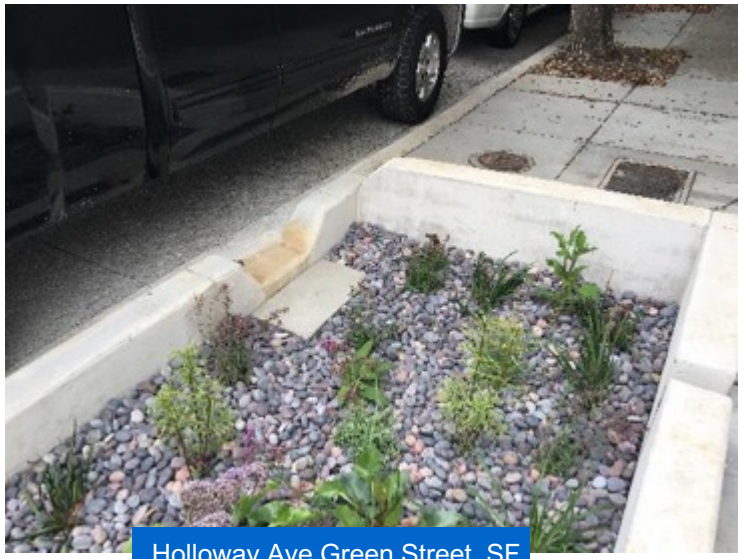
# Inlets – Erosion Protection

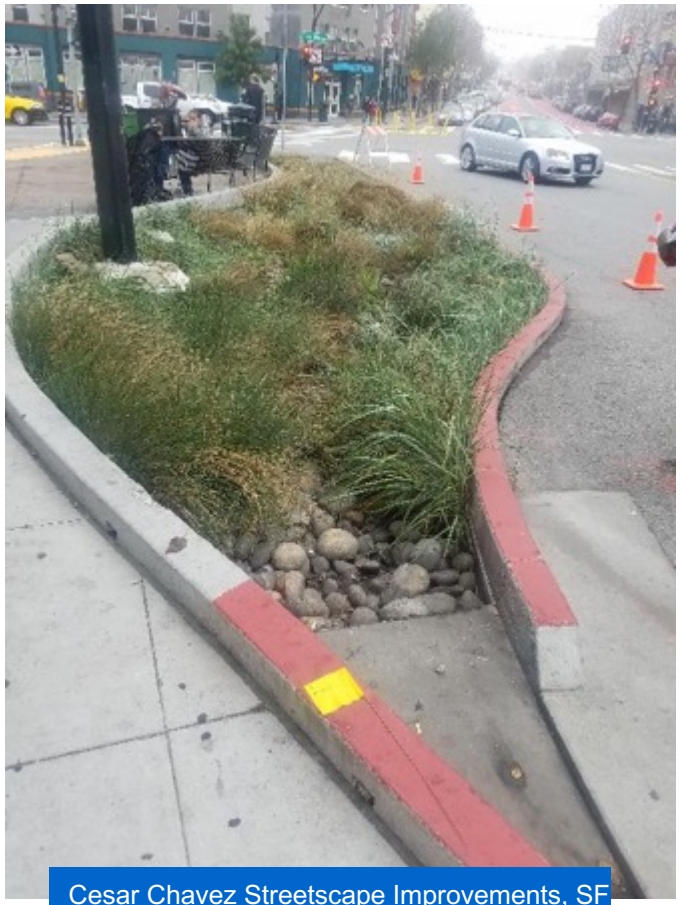
## Splash apron pad + cobbles

- Flat pad allows for easy removal of sediment and debris
- Cobbles provide energy dissipation



Holloway Ave Green Street, SF



Cesar Chavez Streetscape Improvements, SF

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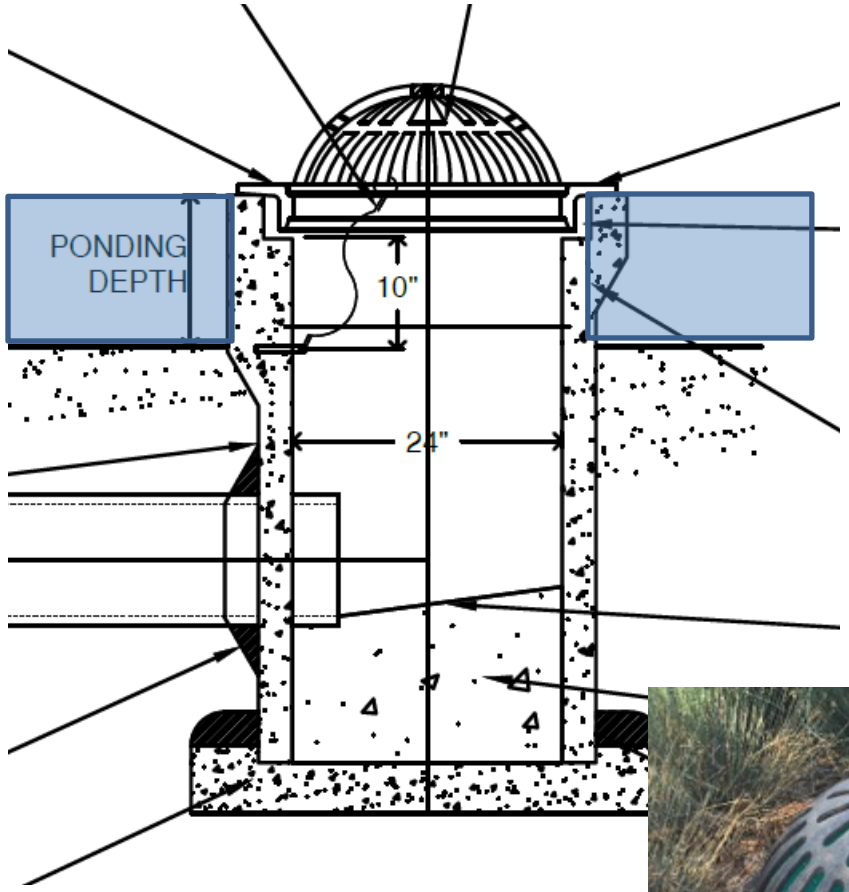
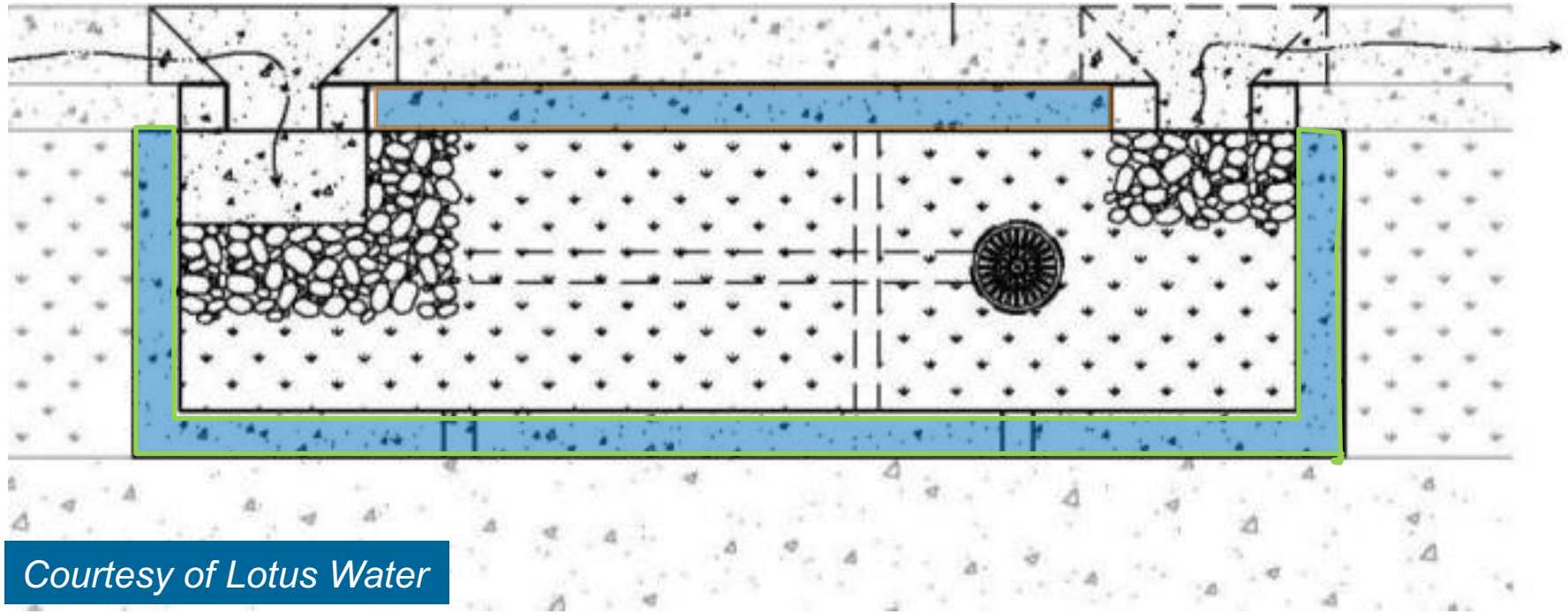
# Overflow Risers

- Risers allow ponded water to overflow at a set elevation (based on design ponding depth)
- Also provide outflow pipe to nearby storm drain and connection point for underdrains
- An atrium or “beehive” grate keeps debris and mulch from settling on top of grate
- Flat grates are also common




# Flow-through Outlets

- Design is similar to inlets (either curb cut or inline, depending on type of design)
- May be used in combination with overflow risers



*Courtesy of Lotus Water*

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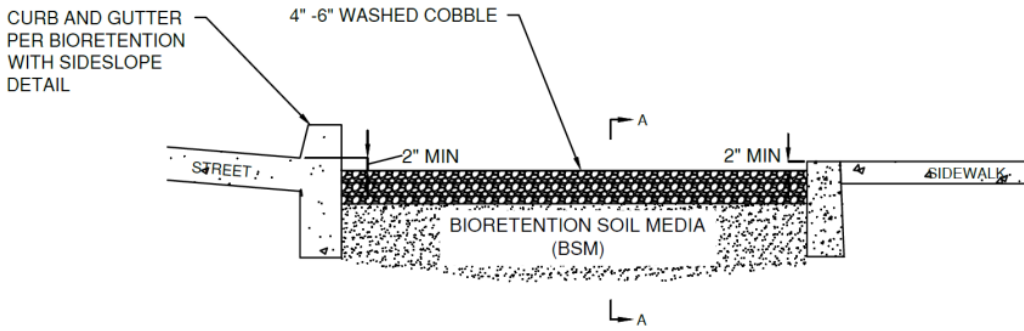
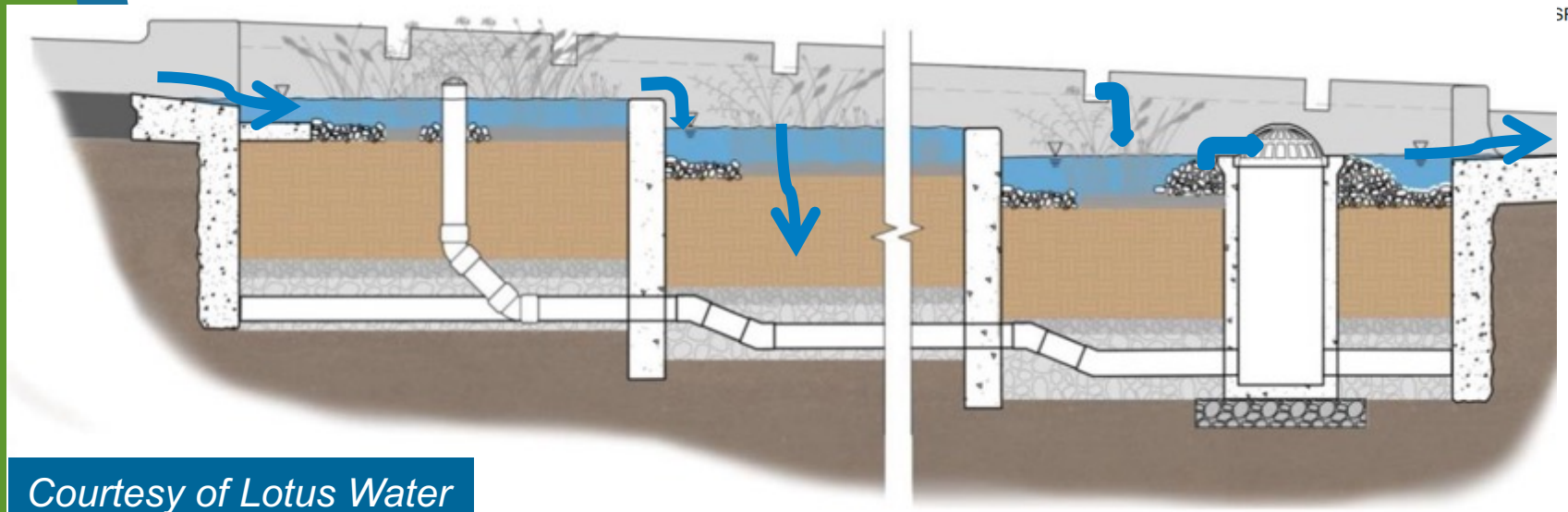
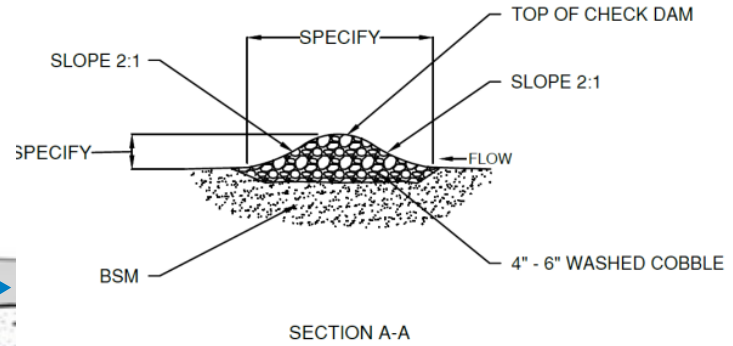
# Slope / Check Dams

- Can use metal, concrete, or gravel dam
- Keep cells level
- Minimize drop






*Courtesy of Lotus Water*

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# Roadway Interface – Edge Conditions

Edge restraint structure should:

- Meet traffic loading, pedestrian and traffic safety, and other code requirements
- Maintain infiltrative footprint
- Integrate with landscape design
- Be cost-effective

Source: City of Portland BES

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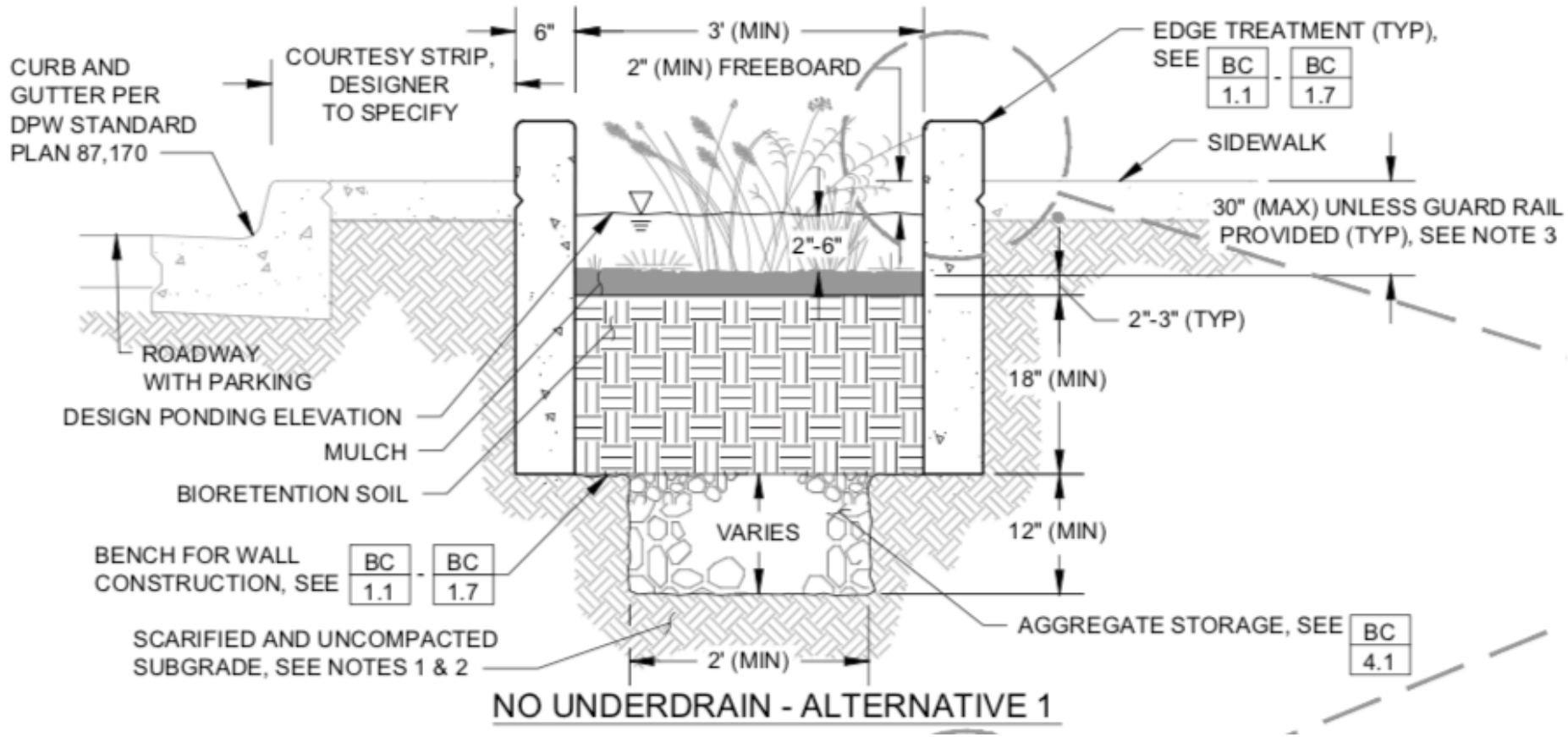
# Edge Treatment – Roadside Planter with Parking

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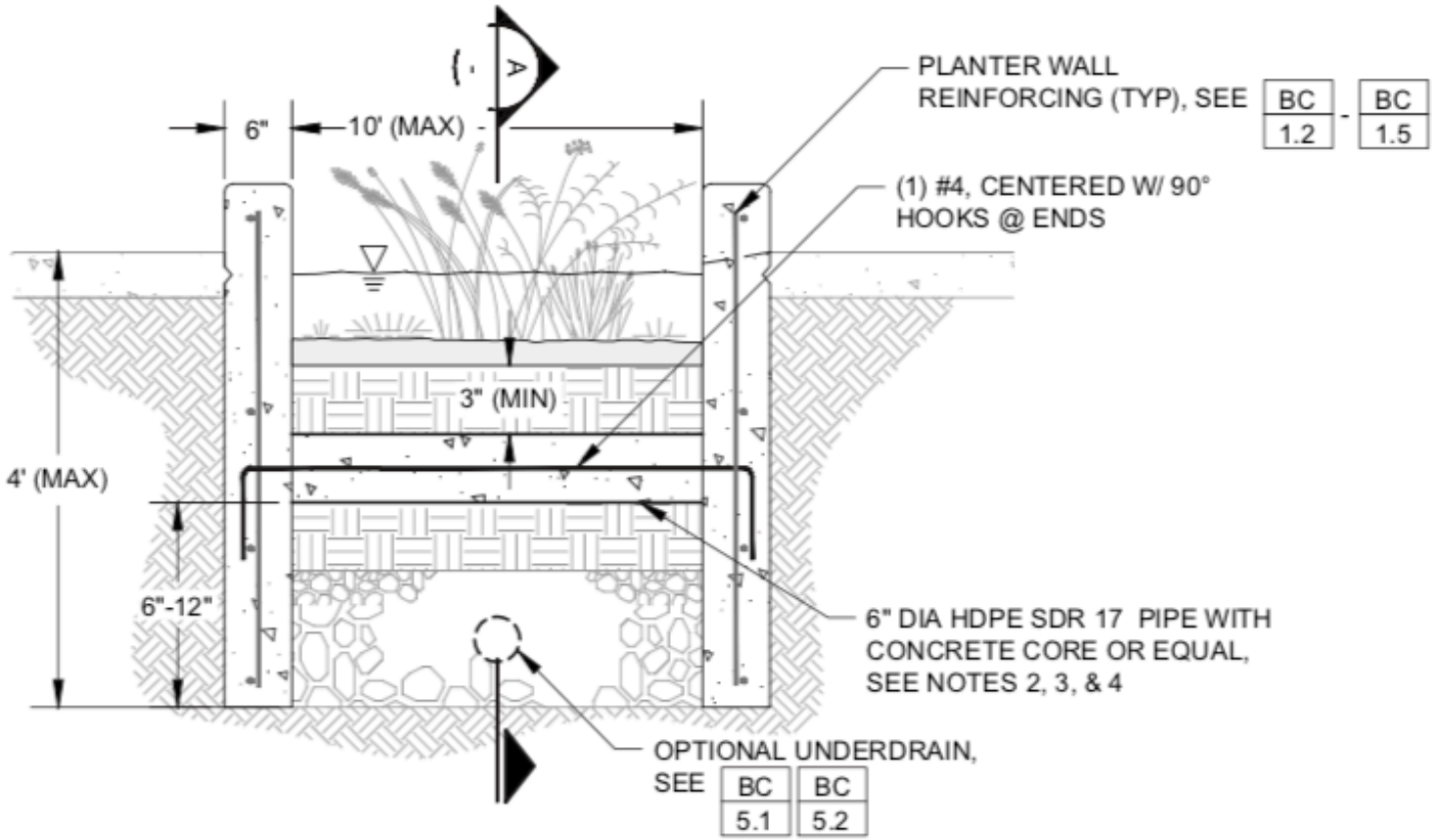
# Edge Treatment – Lateral Bracing




CONCRETE STRUT

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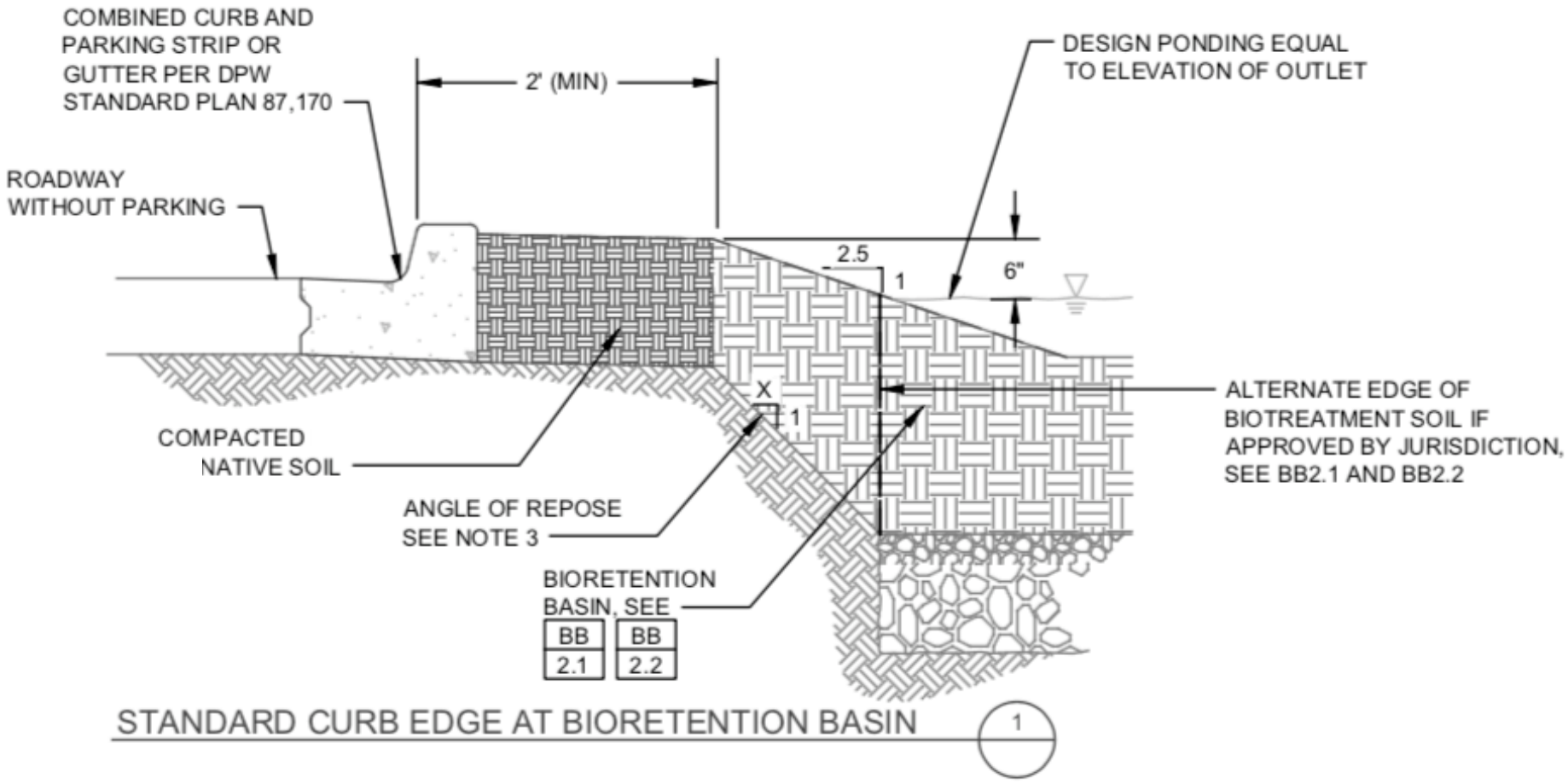
# Edge Conditions – Basin, No Parking

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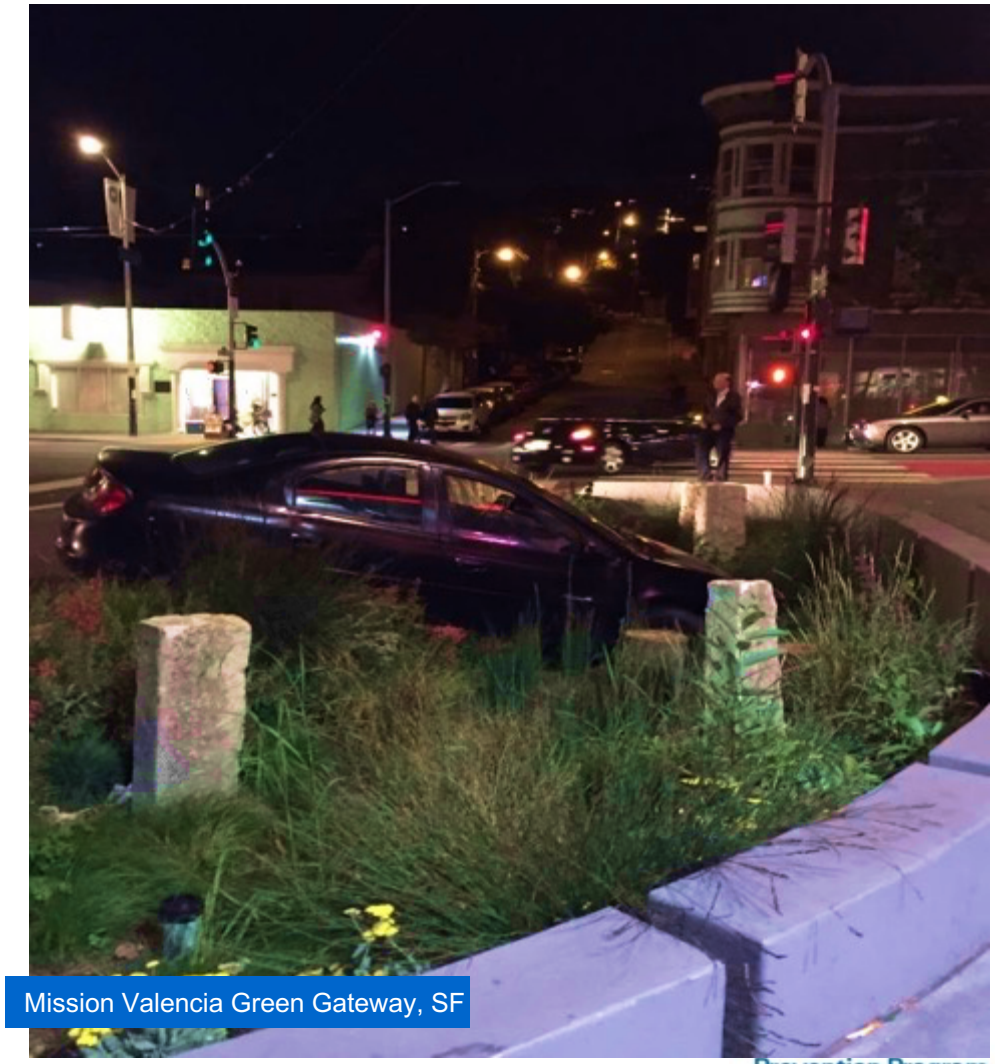
# Roadway Interface – Common Challenges

Driver, cyclist and pedestrian safety

- Especially important in retrofit projects
- Temporary and/or permanent visual warnings may be necessary in addition to physical barriers



Mission Valencia Green Gateway, SF

# Roadway Interface – Vehicular Safety

- Standard curb and gutter at roadside edge
- 1-foot setback curb face to edge of  travel or bike lane
- Red painted curbs in urban settings to prevent parking along bulbouts and alert drivers
- Limit vegetation height to maintain sight distance

Cesar Chavez Streetscape Improvements, SF

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# Roadway Interface – Vehicular/Pedestrian Safety

- Step-out zone and trench drain inlets adjacent to parallel parking
- Pedestrian crossing to sidewalk
- Reflectors within bulb-outs on corners

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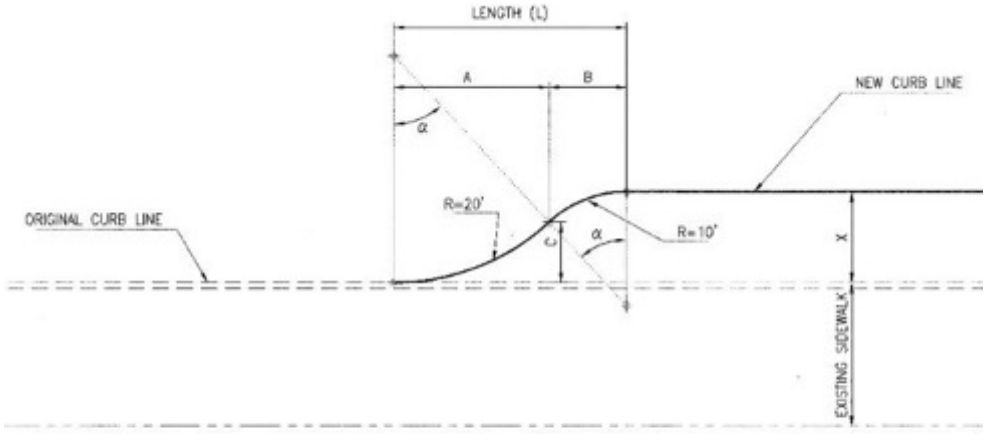
# Roadway Interface – Maintenance

- Design bulb-out transition alignments that can be maneuvered by city street sweeping vehicles




CURB BULBS & OTHER SIDEWALK WIDENING
LAYOUT OF TRANSITION


Holloway Avenue Green Street, SF

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# Sidewalk Interface – Design Solutions

- Reduce elevation drop-off wherever feasible
- Provide sloped sides if possible

Mission Bay, SF


Campbell, CA

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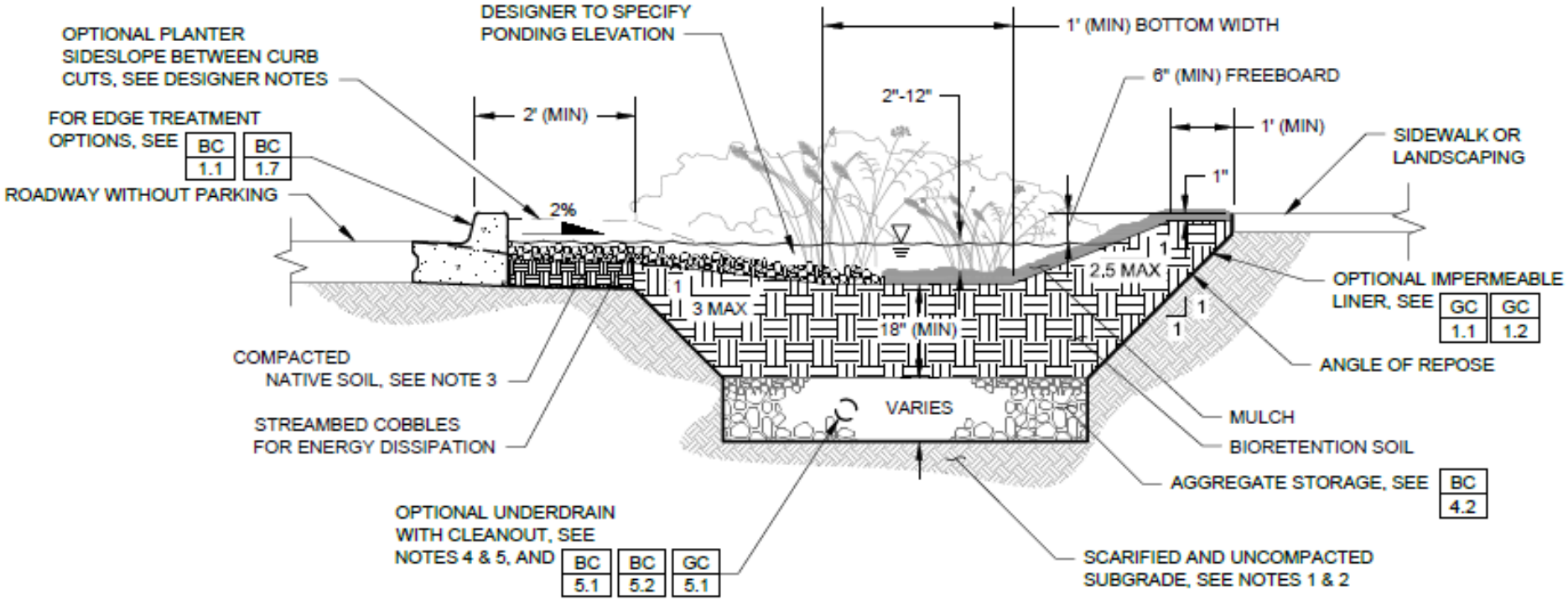
# Sidewalk Interface – Design Solutions

- If space is available, provide flat buffers at edges to eliminate need for raised curbs



# Sidewalk Interface – ADA Considerations

- Make sure ADA compliance is considered in typical details and design and not an after-thought
- Minimize “bathtub” effect by reducing overall drop down to planter soil (30” max but 12” or less preferred)
- Integrate raised perimeter curb or short decorative fence/rail that meets ADA requirements
- Seat walls and other landscape features can provide barriers

Wiggle Neighborhood Green Corridor, SF

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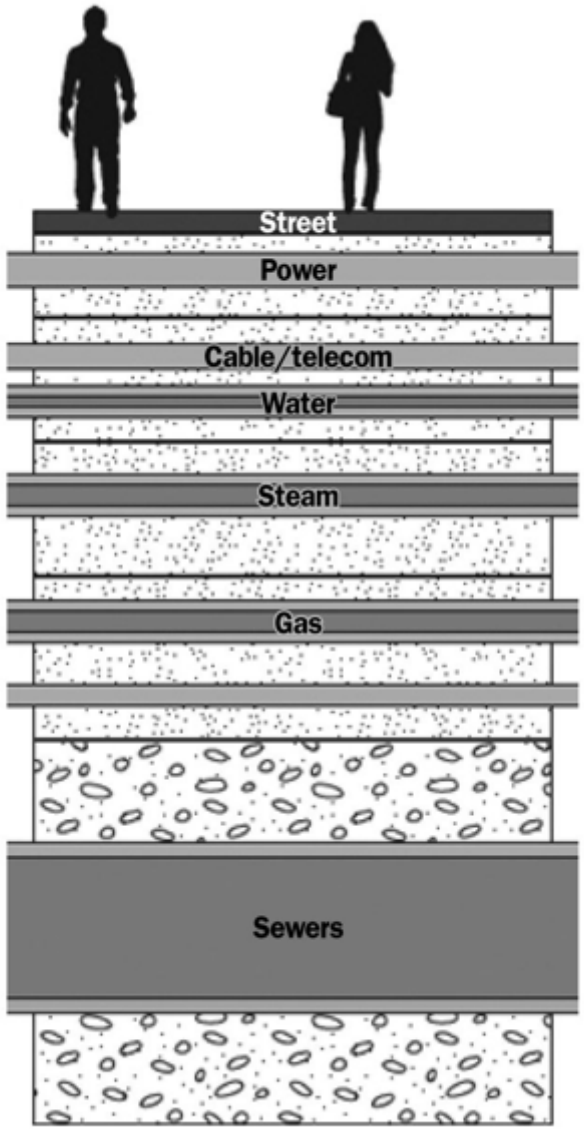
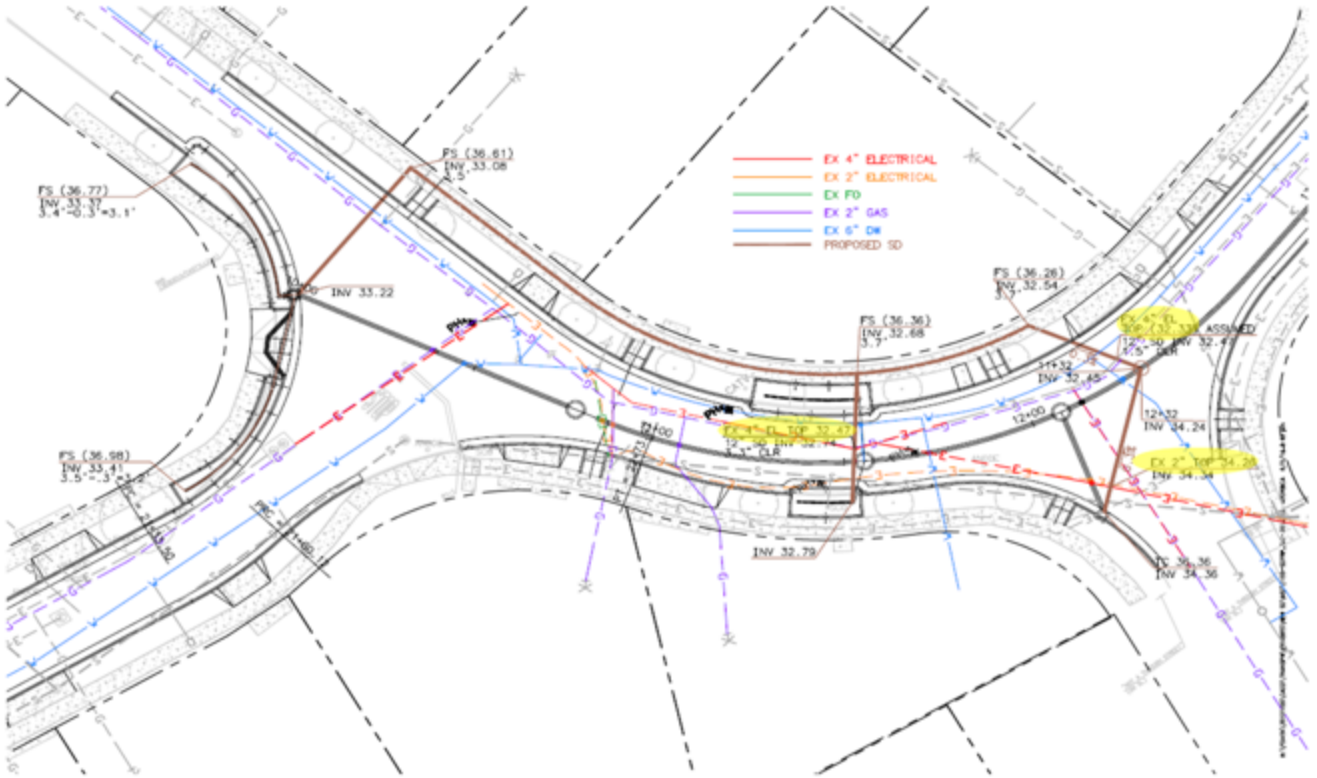
# Utilities in the Public Right of Way

- Electrical Power lines (underground or overhead)
- Gas distribution
- Potable water distribution
- Recycled water distribution
- Sewer mains and service laterals
- Communication and fiber-optic lines
- Vaults and valves
- Streetlights
- Traffic signal loops
- Fire hydrants
- Joint trenches



# Identifying Potential Utility Conflicts

- Use existing plans, map requests, and field inspection for utility identification
- Pothole for existing utilities
- Underground Service Alert (USA) North Design Inquiry
- Identify required clearances for all existing utilities and requirements for moving or protecting in place
- Coordinate with utility companies early and often

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# Approach to Utility Coordination with GSI
# Step 1: Avoid Utility Conflicts

- Siting to avoid utility conflicts
  - Location
  - Vertical or horizontal clearance
- Selecting an appropriate GI measure
  - Size
  - Depth of excavation
- Sizing
- Avoid utility vaults

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# Step 2: Accept and Incorporate Utility in Design

- Encase Utility: Utility owner should determine/approve how to encase the utility
  - Sleeve/casing
  - Insulating wrap
  - Impervious waterstops
  - Utility trench dam – prevents flow along utility trenches
- Encase GI Facility
  - Impermeable liners above the utility could solve the problem if the GI facility is not meant to infiltrate

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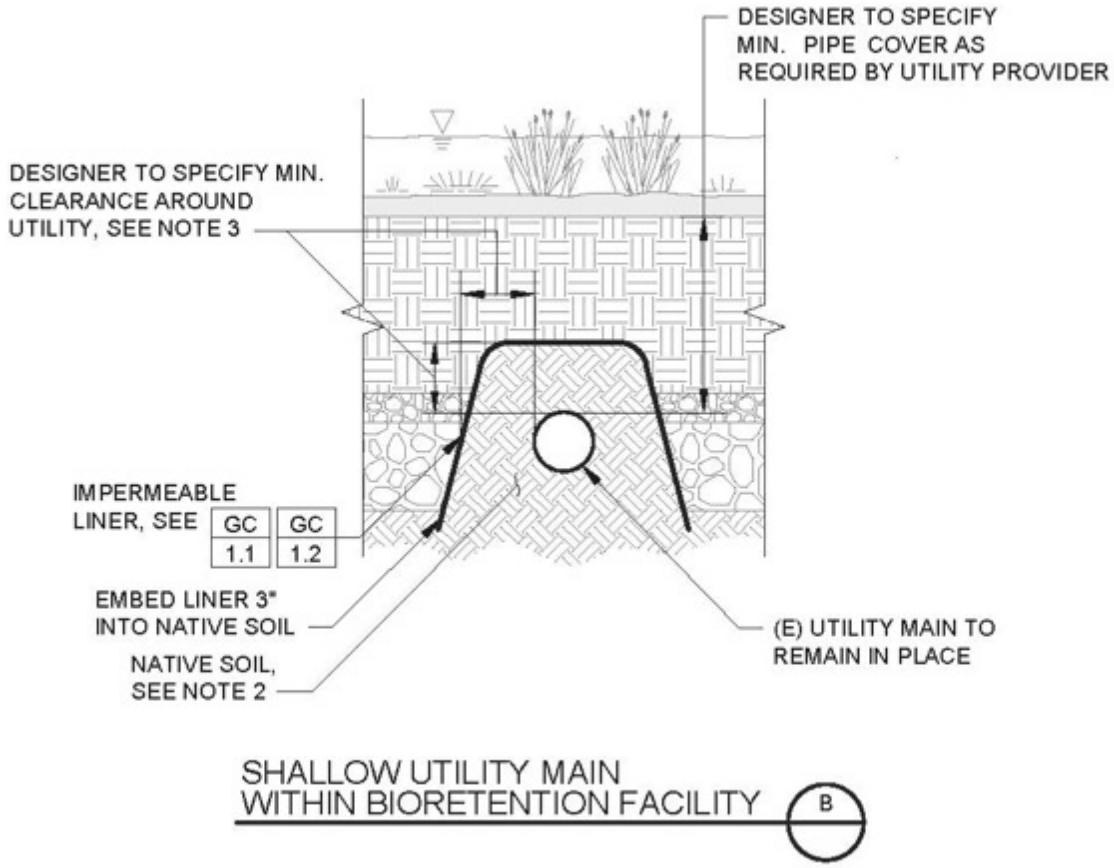
# Step 3: Mitigation

- Design around the utility
  - Shape of facility adjustment
  - Adjust laterally
  - Change in depth of GI measure
  - Change in type of GI measure
- Smaller facility may still meet sizing requirements per BASMAA guidance




SFPUC Utility Crossings Detail

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# Step 4: Utility Relocation and Replacement

- Start early
- Work with utility owner to determine schedule
- Costs may be substantial for utility relocations
  - Sewer mains or laterals
  - Utility poles
  - Fiberoptic
  - High pressure gas transmission
  - High voltage electrical transmission
- Potential to share costs with utilities if replacement is needed

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# Design Guidance & References

- SMCWPPP GI Design Guide

https://www.flowstobay.org/data-resources/resources/green-infrastructure-design-guide/

  - Sustainable Streets Typical Design Details available in Appendix 3
  - Sustainable Streets Specifications available in Appendix 4

- CASQA LID/GI Resources

  www.casqa.org/resources/california-lid-gi

  - Standard LID Design Plans and Specifications
  - Developed in collaboration with Central Coast LID Initiative

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# Questions?


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