SECTION 8200 – ACHD STORMWATER DESIGN TOOLS AND APPROVED BMPS

8200 ACHD STORMWATER DESIGN MANUAL

8201 INTRODUCTION

8201.1 Purpose of This Manual

The ACHD Stormwater Design Manual and Approved BMPs (referred to herein as the Manual) provides the tools and guidance needed for designers and plan reviewers to select, design, and review stormwater systems within the jurisdiction of the ACHD. This manual is a supplement to the ACHD Section 8000 Stormwater Policy (referred to herein as the Policy).

These standards may or may not apply in all situations and allowances have been made to consider design alternatives. Compliance with these standards does not relieve the applicant of the responsibility to use sound professional judgment to comply with all local, state, or federal requirements. ACHD intends for these standards to assist, but not substitute for, competent work by design professionals.

8201.2 Modifications and Addenda

This Manual will be updated to include advances in engineering and Best Management Practices (BMPs). The designer should check the website at www.achdidaho.org to verify they have the most current version.

8202 DESIGN TOOLS AND RESOURCES

8202.1 Intensity Duration Frequency Curve (IDF Curve)

See Appendix A for the current Intensity Duration Frequency Curve to be used for Ada County.

8202.2 ACHD Stormwater Design Spreadsheet

ACHD has developed a Microsoft Excel spreadsheet to help establish consistency and assist in the review of stormwater calculations. A completed spreadsheet shall be submitted with the civil plans for ACHD review. The spreadsheet is not intended to replace the Idaho Licensed Design Professional's calculation methods or relieve the Idaho Licensed Design Professional of responsibility for the design calculations. The spreadsheet is available on the ACHD website or from the Stormwater Section upon request.

ACHD may approve an Idaho Licensed Design Professional's alternative format to the spreadsheet if the volume and peak flow calculations are summarized for each storage facility and the calculations meet or exceed the ACHD calculated minimum values. Computer software printouts that are not summarized by storage facility will not be accepted.

8202.3 Design Example

A 2.5 acre farm will be developed into single family housing. Calculate the volume and flow from the site for the pre and post project conditions

assuming a Coefficient of Runoff C=0.2 for pre project and that the owner operator of a drain through the site would only accept predevelopment flows from a 25-year storm. See Appendix B for completion of the design example.

8202.4 Operation and Maintenance (O&M) Plan Outline

The outline provided in Appendix D shall be used for Operation and Maintenance plans.

8202.5 Facility Revegetation and Irrigation

Native grasses and drought-tolerant plant species are recommended for use in surface stormwater facilities for water quality treatment, slope stabilization and erosion control. Native plant species should be specified over non-native species except for native trees which may not be well suited to stormwater facilities. Salt resistant vegetation should be used in locations with probable adjacent salt application.

ACHD stormwater ponds shall be landscaped according to the "Ada County Highway District Stormwater Management Pond Revegetation Guidance Manual" (April 2014).

Facilities maintained by a Homeowner's Association are subject to ACHD review and approval of design and landscaping through plan review and approval of a License Agreement.

Non-draining materials like rocks and cobbles are prohibited over the infiltration areas. If turf grass is used, only washed sod or sod grown on sandy soils shall be allowed on the areas designed to infiltrate and barriers shall be used to protect the infiltration areas from other sodded areas until the vegetation is established.

Provide irrigation for native plant establishment (2-3 years), and supplemental irrigation during periods of prolonged drought. Reclaimed water shall not be used for irrigation in stormwater facilities.

8202.6 Inspection Checklists

ACHD has developed a checklist for inspection of stormwater ponds. This checklist is in Appendix E and is available for download from the ACHD website or by contacting the Stormwater Section.

8202.7 Design Details

The following miscellaneous design details shall be used for stormwater design plans. They are included in Appendix G.

Detail 1 Beehive Overflow Detail 2 Inlet Protection Apron and Flow Spreader
Detail 3 Anti-Seep Collar
Detail 4 Flow Spreader for Ponds and Swales
Detail 5 Access Roads and Turnaround Detail
Detail 6 Groundwater Observation Well Drill

Detail 7 Stormwater Pond Standards
Detail 8 Borrow Ditch
Detail 9 Shallow Inlet – Detached Walk
Detail 10 Shallow Inlet – Attached Walk
Detail 11 Drop Inlet Layout Tolerances
Detail 12 Seepage Bed/Water Service Conflict Options

8202.8 List of Approved Stormwater BMPs

This section lists ACHD's approved Best Management Practices (BMPs). The title of each BMP has a description of the functions for which the BMP is approved including Pretreatment, Treatment, and Storage.

Infiltration facilities with landscape based treatment are recommended over detention facilities and manufactured systems.

Facilities that infiltrate to groundwater must comply with Idaho Groundwater Standards and IDWR Rules for Waste Disposal and Injection Wells. Facilities that discharge to surface water must comply with water quality protection criteria based on Idaho Water Quality Standards and applicable water quality plans.

8202.9 BMP Alternatives

The District may require more stringent requirements than would normally be required under these standards depending on special conditions and/or environmental constraints for a given site. ACHD has the option of accepting alternative BMPs to these standards if the proposed alternatives meet or exceed the adopted performance standards.

ACHD encourages the development of innovative practices that meet the intent of ACHD's stormwater policy and design standards. If new practices meet or exceed these standards in the future, ACHD may adopt the practice for general use.

Stormwater facilities and controls other than those identified in this MANUAL may be proposed (or as recommended by the Engineering Deputy Director) where site constraints make it difficult to achieve the stormwater management standards with conventional systems where a new technology may provide a higher level of treatment or performance.

8202.9.1 When a new technology is proposed, the applicant shall submit the following additional information to ACHD a description of the alternative technology or product including:

a. Size
b. Technical description including mechanism used for pollutant removal
c. Capital costs
d. Design life
e. Installation process and costs (describe consequences if installed improperly, etc.)

f. Minimum and recommended operation and maintenance (O&M) requirements and costs

8202.9.2 Data on the effectiveness of the alternative technology:

a. Data from laboratory testing and pilot or full scale operation, and calculation of pollutant removal rates for pollutants of concern (POC) sediment (TSS), total phosphorus (TP), dissolved ortho-phosphorus (DOP), and bacteria (E. coli)
b. Operational details on any full scale installations, including any special licensing, hauling, or access requirements, and safety issues associated with the operation and maintenance of the product

8202.9.3 Validation Information:

a. Articles from peer review, scientific, or engineering journals
b. Any approvals or permits from other authorities
c. A monitoring plan to demonstrate BMP effectiveness or clear representations of the specific pollutant removal efficiencies for the device in a typical mode of use and under conditions that would be expected normally within the jurisdiction.
d. References and examples of actual installations of the product

ACHD staff will assess proprietary system pollutant removal based on the manufacturer's test data at the design flow rate and at the median concentration for the POCs (TSS, TP, DOP, *E.coli*) typically found for this region or similar regions.

8202.10 Design Criteria for Manufactured Systems

All use of manufactured or prefabricated stormwater treatment systems is subject to review and prior approval by the District. ACHD approval is dependent on the product being used and tested in other areas with a proven record of effectiveness and maintainability.

8202.11 Other Resources

ACHD may consider BMPs listed on the following agency websites for pretreatment or primary treatment.

Washington Department of Ecology
http://www.ecy.wa.gov/programs/wq/stormwater/newtech/technologies.html
General BMPs and proprietary manufactured systems.

International Stormwater BMP Database
http://www.bmpdatabase.org/
General BMPs and proprietary manufactured systems.

WERF
http://www.werf.org/
General BMPs.

New Jersey Stormwater
http://www.njstormwater.org
Proprietary manufactured systems.

Idaho Department of Environmental Quality
http://www.deq.idaho.gov/water-quality/wastewater/stormwater.aspx
Landscape based treatment BMPs.

8202.12 BMP 01 Sand and Grease Trap (Pretreatment)

Description

BMP01 includes two alternatives for the Sand and Grease Trap: 1-Standard 1000 & 1500 Gallon Sand and Grease Trap Vault, 2-750 Gallon Catch Basin/Sediment Box (Combo Box).

Note: The use of item 2-Catch Basin/Sediment Box (Combo Box) is only allowed where a standard inlet with Sand and Grease Trap conflicts with utilities. The use of a Catch Basin/Sediment Box requires ACHD approval.

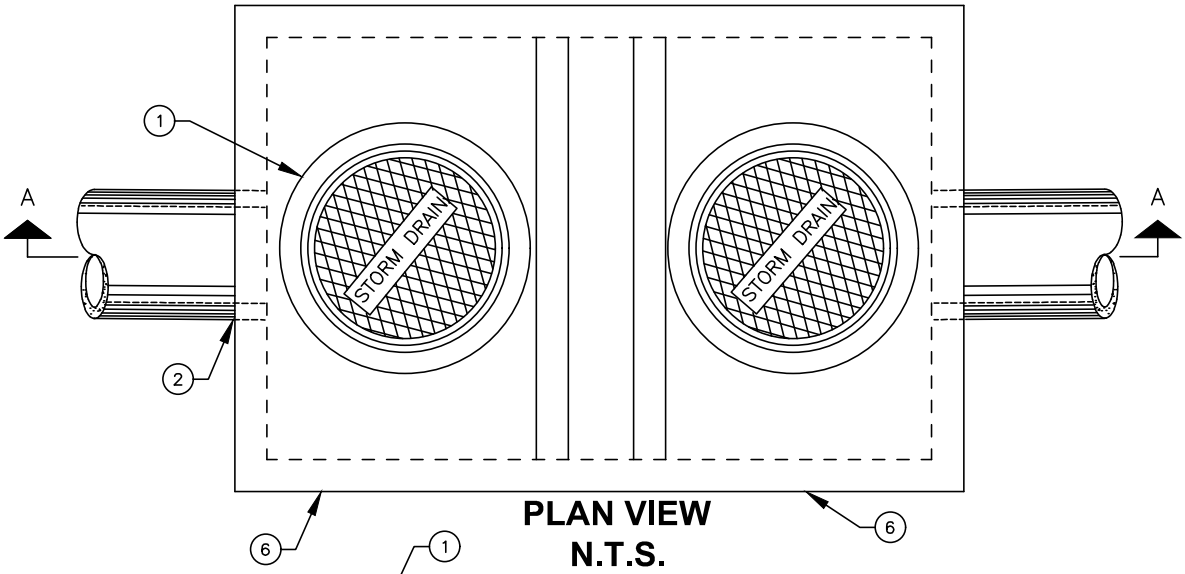
Sand and Grease Traps are approved for use only as pretreatment for seepage beds.

Design

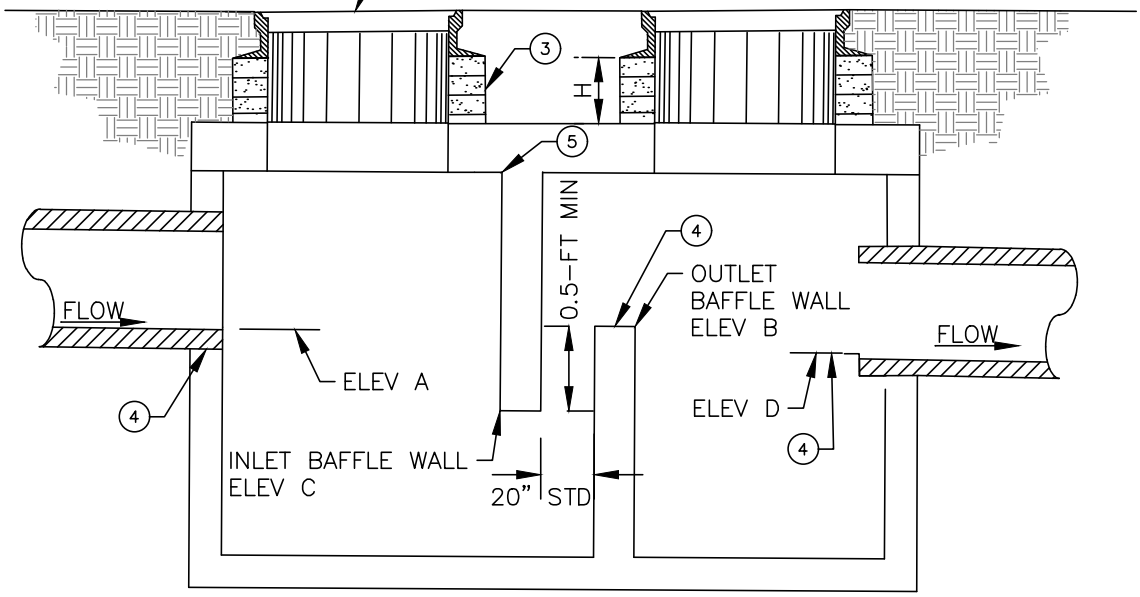
Storm conveyance systems shall be designed so the Sand and Grease Trap flows are less than or equal to 0.5-feet per second. A diversion manhole upstream of the sand and grease trap tank shall divert the high flow around the sand/grease trap.

If the total Q is less than 3.33 cfs, one online 1000 gallon tank may be used without a high flow bypass pipe.

Unit	**Max Q**
1000 Gallon Tank, approx. inside dimension 4'x8'x6' (20" Baffle Spacing)	3.33 cfs
1500 Gallon Tank, approx. inside dimension 5'x7'x7' (20" Baffle Spacing)	4.15 cfs
Catch Basin/Sediment Box, approx. inside dimensions 5.33'x7.5'x3' (8-inch Baffle Spacing)	1.77 cfs



PLAN VIEW
N.T.S.

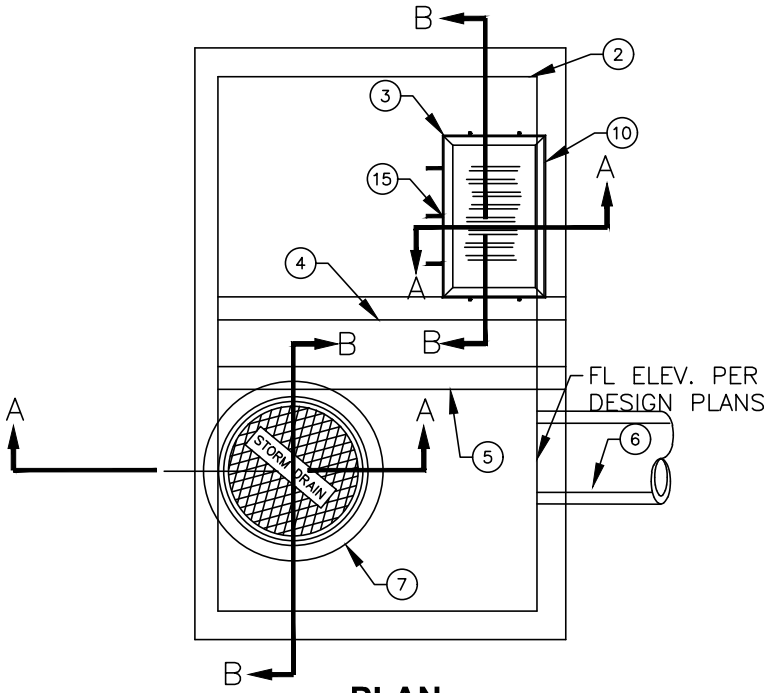


SECTION A-A
N.T.S.

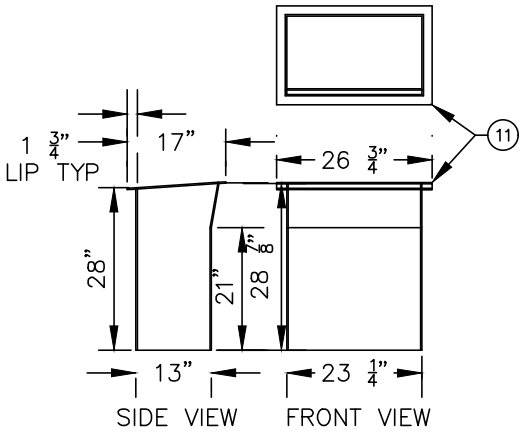
NOTES
1. SAND AND GREASE TRAP USED FOR SUBSURFACE FACILITIES ONLY

LEGEND:
(1) MANHOLE FRAME AND COVER PER SD-617 (TYPICAL)
(2) LOCATION AND FL ELEV. PER DESIGN PLANS (TYPICAL)
(3) H 1-FT USE GRADE RINGS (TYPICAL)
1-FT < H <= 2-FT USE 24" DIA RCP RISER
2-FT < H <= 10-FT USE MANHOLE CONE & 48" DIA RISERS
(4) EL. A > EL. B BY 0.10' MIN
EL. D < EL. B BY 0.10' MIN
EL. C < EL. B BY 0.50' MIN. UNLESS OTHERWISE APPROVED BY ACHD
(5) WATERTIGHT SEAL
(6) PRECAST BOX MANUFACTURER SHALL MARK FLOW DIRECTION AND LABEL INLET OR OUTLET ON SIDE OF BOX

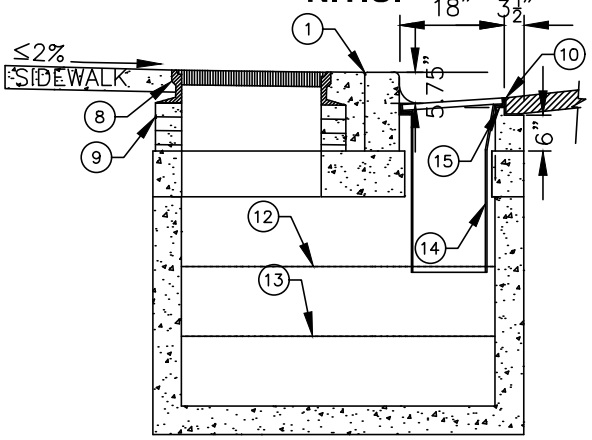
2015 ACHD STORMWATER DESIGN GUIDELINES	SAND AND GREASE TRAP	STANDARD DRAWING BMP 01 1 OF 2



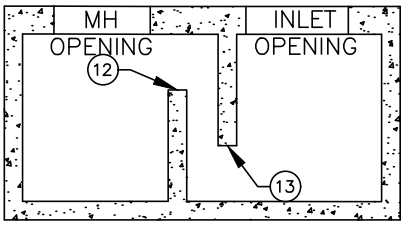
PLAN
N.T.S.



SECTION REMOVABLE
FUNNEL
N.T.S.



SECTION A-A
N.T.S.



SECTION B-B
N.T.S.

LEGEND:

1. BACK OF CURB LINE
2. LIP OF GUTTER
3. STANDARD GRATE AND GRATE FRAME. SEE SD-609, SD-610 AND SD-610A
4. BAFFLE WALL "A"
5. BAFFLE WALL "B"
6. PIPE OUTLET
7. SPECIAL DIAMOND FINISH MANHOLE COVER WITH "STORM DRAIN" CAST IN COVER PER SD-616
8. STANDARD RING
9. CONCRETE RISER RINGS
10. 3" X 3" X 1/4" STEEL ANGLE w/ (3) 3/8"x3" ANCHORS
11. 1 3/4" LIP TO SIT INSIDE GRATE FRAME BELOW GRATE
12. TOP OF OUTLET BAFFLE WALL "B"
13. BOTTOM OF INLET BAFFLE WALL "C"
14. 12GA SHEET METAL FABRICATED REMOVABLE FUNNEL
15. 2" X 2" X 1/4" STEEL ANGLE w/ (3) 3/8"x3" ANCHORS

NOTES:

1. DESIGN LOAD: AASHTO HS-25 HIGHWAY LOADING OR GREATER
2. ALL REINFORCING STEEL TO BE GRADE 60
3. DETAILED DRAWING OF A PRECAST BOX OR A CAST-IN-PLACE BOX DESIGN MUST BE APPROVED BY ACHD PRIOR TO CONSTRUCTION
4. CONSTRUCT CATCH BASIN PORTION ABOVE BOX LIKE INLET CATCH BASIN, TYPE I FOR CURB APPLICATIONS
5. STEEL ANGLE GRATE AND GRATE FRAME PER SD-609, SD-610, AND SD-610A
6. TANK CAPACITY IS APPROXIMATELY 750 GALLONS OR 100 CUBIC FEET
7. BEFORE THESE BOXES ARE USED THE APPLICATION MUST BE APPROVED BY ACHD.
8. DESIGN MAY BE REVERSED FOR APPLICATION WITH MANHOLE AND CATCH BASIN OPENINGS IN OPPOSITE DIRECTIONS

2015 ACHD STORMWATER DESIGN GUIDELINES	SAND AND GREASE TRAP (COMBO BOX)	STANDARD DRAWING BMP 01 2 OF 2

8202.13 BMP 02 Treatment and Conveyance Swale (Pretreatment)

Description
This BMP is approved for pretreatment of stormwater runoff.

Design
For conveyance swales, a hydraulic residence time of 9-minutes is required. Water velocity, as determined by Manning's "n", should not exceed 0.9 feet/second. The maximum depth of flow through a conveyance swale shall be 4-inches.

Swale side slopes shall be no steeper than 3:1.

For surface flow on streets with curb/gutter, flow shall enter the swale through a Shallow Inlet per Details 9 and 10.

Provide for energy dissipation and flow spread using Flow Spreaders, per Detail 4.

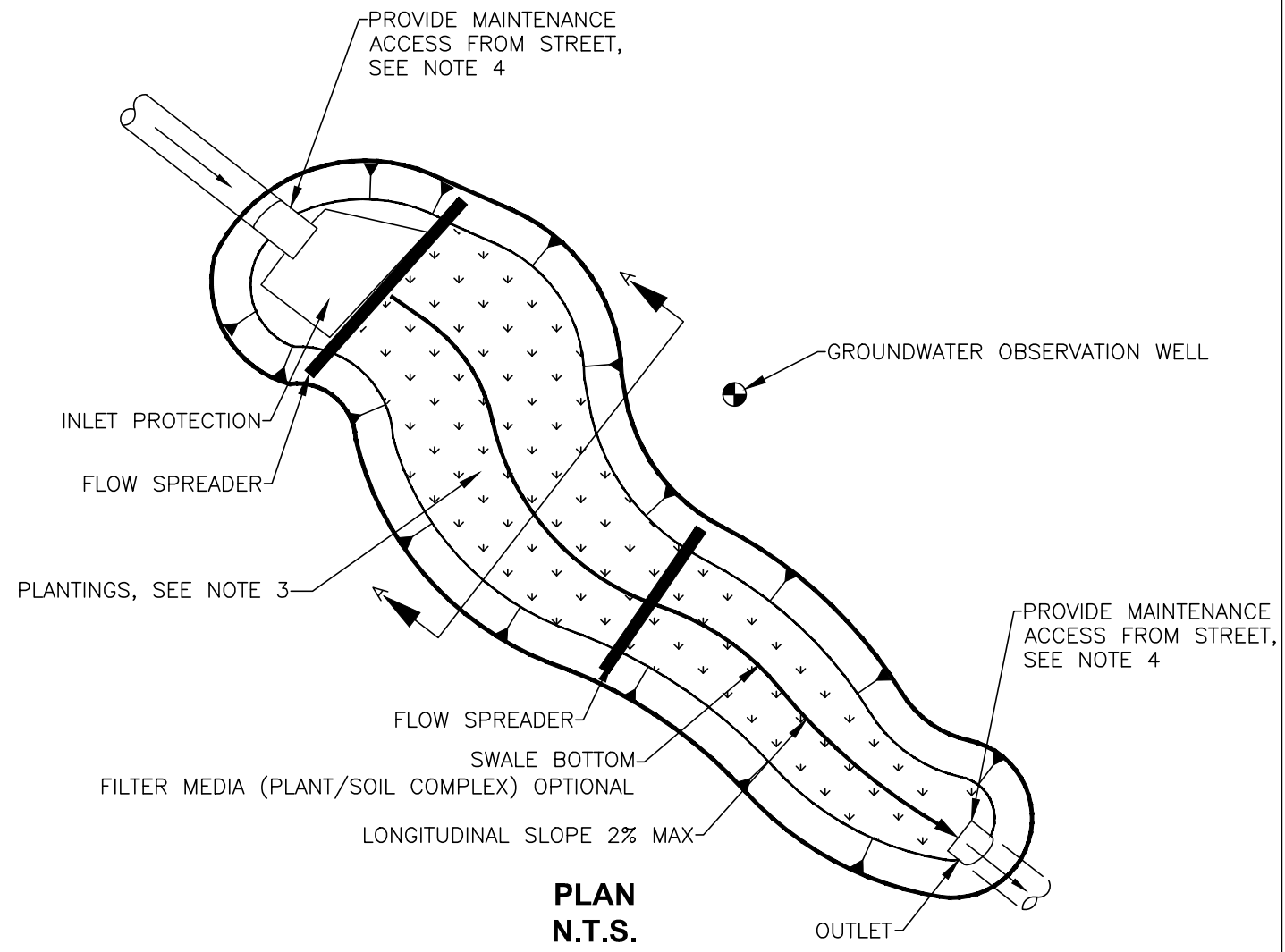
The length of swale required for pretreatment:

Length = Runoff Reduction Volume/A_{swale} x 540
Where 9 min residence time x 60 sec/min=540
A_{swale} = Cross sectional area of swale

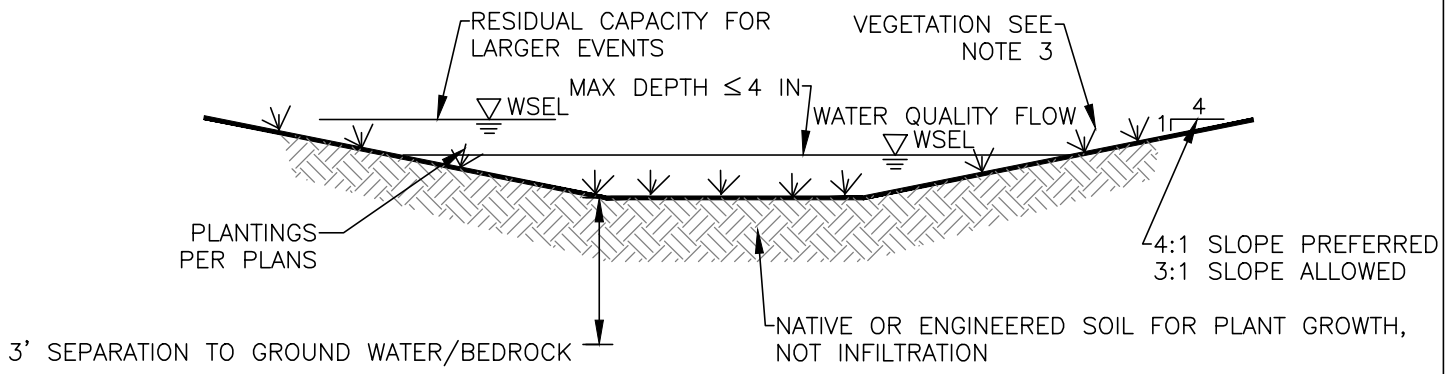
The average recommended flow depth is four (4) inches.

Longitudinal slope shall be 1% to 2% between berms.

Light maintenance of this BMP, when approved for use by the District, shall be performed by the developer or a homeowner's association unless it is an ACHD owned facility.



PLAN
N.T.S.



SECTION A-A
N.T.S.

NOTES:
1. SWALE IS DESIGNED FOR CONVEYANCE AND TREATMENT THROUGH PLANT FILTERING. STORMWATER CAN FLOW LONGITUDINALLY IN SWALE. GRADE TO BE 1% TO A MAXIMUM OF 2%.
2. USE BMP 30 IF INFILTRATION IS DESIRED
3. DROUGHT TOLERANT PLANT SPECIES OR WASHED TURF GRASS
4. PROVIDE MAINTENANCE ACCESS TO ALL PIPES AND STRUCTURES FROM THE STREET

2015 ACHD STORMWATER DESIGN GUIDELINES	CONVEYANCE/TREATMENT SWALE	STANDARD DRAWING BMP 02

8202.14 BMP 03 Grass Buffer Strip (Pretreatment)

Description

This BMP is approved for pretreatment if flows from roadside runoff are not concentrated in gutter flow or a pipe network. Storage facilities such as a swale or borrow ditch must be provided.

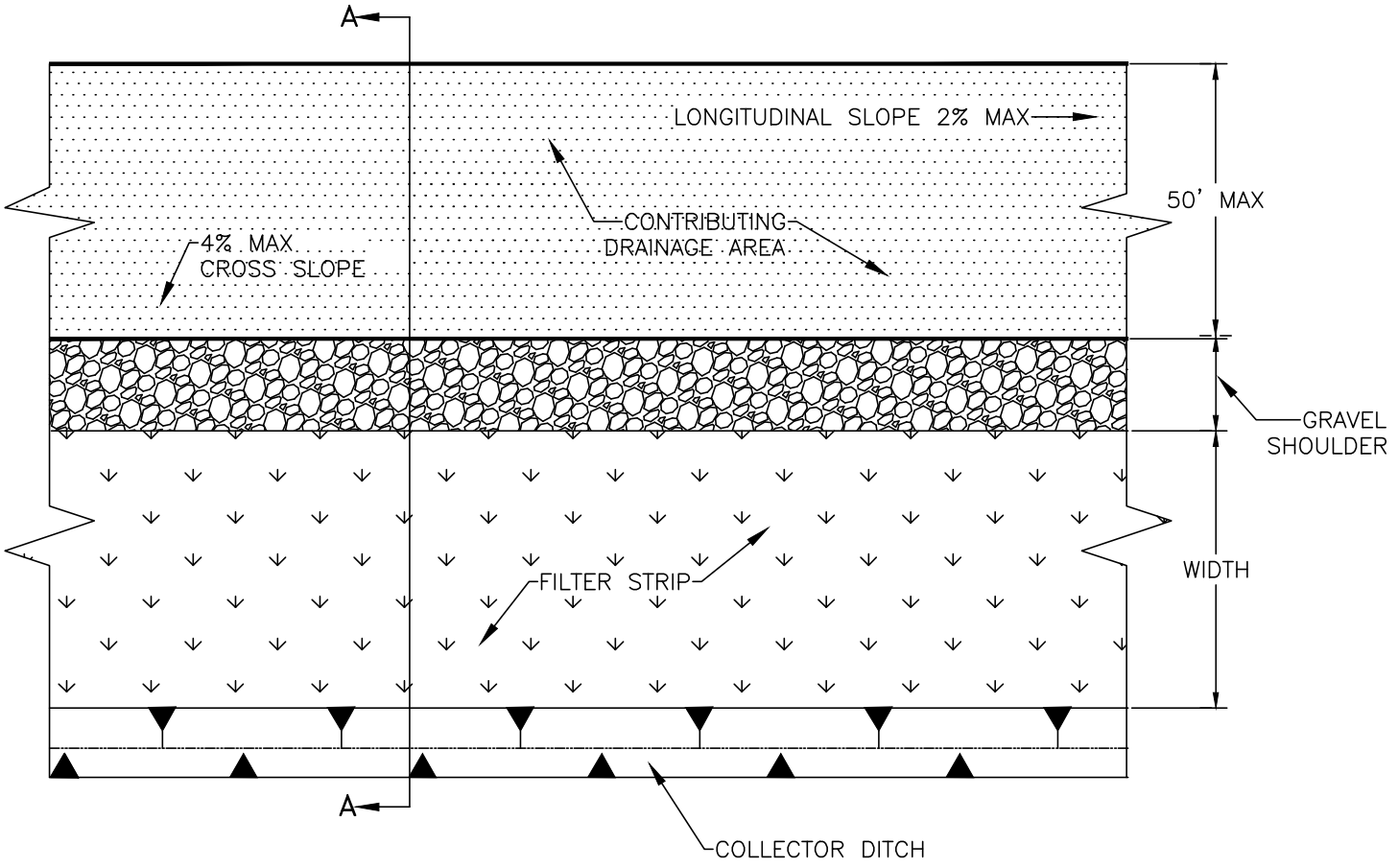
Design

The longest flow path from the area contributing sheet flow to the filter strip shall not exceed 150 feet. The maximum depth of flow through the filter strip for optimum water quality shall be 1.0 inch.

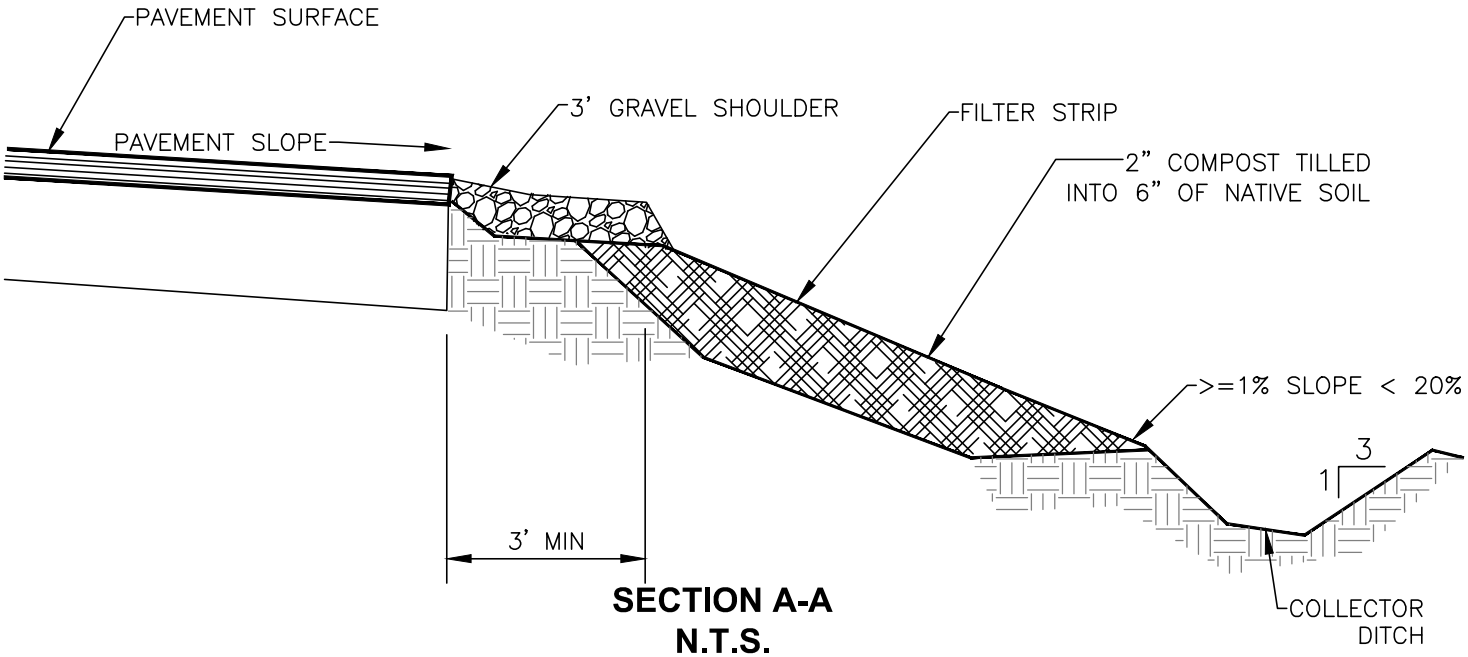
The maximum allowable flow velocity shall be 0.5-feet per second.

Grass buffer strips shall not be used when the contributing drainage areas has a longitudinal grade steeper than 5 percent. Energy dissipation and flow spreading should be provided upslope of the upper edge of the filter strip to achieve flow characteristics equivalent to those meeting the above criteria.

Light maintenance of this BMP, when approved for use by the District, shall be performed by the developer or a homeowner's association unless it is an ACHD owned facility.



PLAN
N.T.S.



SECTION A-A
N.T.S.

2015 ACHD STORMWATER DESIGN GUIDELINES	GRASS BUFFER STRIP	STANDARD DRAWING BMP 03

8202.15 BMP 04 Manufactured Systems (Pretreatment)

Description
These are approved as a pretreatment BMP only.

Design
See Manufacturer's website for design information.

No details are provided for this BMP.

MANUFACTURED SYSTEMS
PROPRIETARY PRODUCTS
NO DETAILS PROVIDED
REQUIRES ACHD APPROVAL PRIOR TO DESIGN

(BMPs 5-9 Reserved)

8202.16 REQUIREMENTS FOR PONDS

Following are standards to be used in the design of stormwater ponds.

8202.16.1 Side Slopes

Side slopes should be 4:1 (horizontal: vertical), but no greater than 3:1 unless specifically approved by ACHD and the pond is fenced for safety.

8202.16.2 Freeboard

For facilities less than, or equal to, 3-feet in depth from the pond bottom to high water mark, a minimum freeboard of 0.5-feet shall be required. For facilities with a pool depth greater than 3-feet, a minimum freeboard of 1-foot shall be required.

8202.16.3 Outfall Pipe Armoring

Pipe outfalls shall be armored with riprap or an approved flow spreader for energy dissipation and erosion protection. Detail 2 in the Design Manual (Appendix G) shows armoring options.

8202.16.4 Forebays & Primary Storage Basin

All ponds shall have a sediment forebay unless otherwise approved by ACHD. Exceptions for the forebay and high-flow bypass requirements may be made for ponds where the total bottom footprint is less than 1500 square feet.

A pretreatment BMP to capture sediment and floatables shall be used if the pond is not designed with a forebay.

The forebay shall be separated from the primary storage basin by an earthen berm barrier with side slopes no steeper than 3:1 unless specifically approved by ACHD. Forebays with a bottom footprint of greater than 1500 square feet shall be designed with a maintenance access ramp with not greater than 15% slope. For a 24-hour, 25-year design storm, stormwater in the forebay may spill over an armored berm into the primary basin.

The forebay shall have a minimum 3-foot separation to groundwater or an impervious liner. If an impervious liner is used, a 12-inch outlet pipe with removable plastic end cap with 3-inch minimum diameter hole shall be installed at the forebay invert to drain it (see Outlets for Detention Facilities). A sand filter with under drain similar to BMP 12 Sand Filter Extended Detention Pond may also be used.

Stormwater ponds shall drain 90% of the design volume in ~~24~~ 48-hours unless designed as a wet pond.

8202.16.5 Dams and Embankments

The Idaho Department of Water Resources (IDWR) may categorize a pond as a dam if the vertical distance between the high water mark and the downstream flow line exceeds 10-feet or the pond impounds more than 50 acre-feet of water. If a pond meets either criterion, then a permit may be required from the IDWR. Contact IDWR for more information.

An Anti-Seep Collar, per Detail 3 in this Design Manual, or other seepage control methods are to be installed around outlet pipes within embankments.

8202.16.6 Emergency Overflows/Flood Routing

The Idaho Licensed Design Professional shall demonstrate the ability to safely pass the 24 hour, 100-year runoff event. The streets can be used to convey or store stormwater runoff with limits on the street carrying capacity based on the classification of the street related to emergency usage during flood events in accordance with Section 8011.5.2.

8202.16.7 Design Requirements for Detention Ponds

Detention ponds shall be designed to lengthen the flow path, thereby increasing detention time from inlet to outlet. The recommended length to width ratio should be 3:1 or more. Shallow ponds with large surface areas also provide better removal efficiencies than small deep ponds.

The design of a detention facility requires designing the discharge to not adversely impact downstream areas and leave the hydrology the same as existed before development.

Balancing these requirements is done through the development of three items: an inflow hydrograph, a depth-storage relationship, and a depth-outflow relationship. These items are combined in a routing routine to determine the outflow rate, depth of stored water, and volume of storage at any specific time, as the flood passes through the detention facility. The inflow/storage/outflow relationships shall be based on a storm duration that identifies a peak detention pond volume for the storm interval required. The design considerations and procedures are discussed in the following sections.

8202.16.7.1 Maximum Outflow Rate for Detention Ponds
The maximum outflow rate should not exceed the pre-development flow rate. The receiving system must be shown to be capable of accommodating the design flow and written approval from the owner/operator of the downstream facility is required.

8202.16.7.2 Outlets for Detention Facilities

1. To minimize the chance of clogging and to facilitate cleaning, outlet pipes shall be at least 12-inches in diameter. If riser pipes are used, they shall be at least 1-1/2 times the cross-sectional area of the outfall pipe. Trash racks and anti-vortex devices shall be required. All pipe joints are to be watertight.

2. Outflows shall be staged to not exceed pre-development discharge rates for the 2, 25, and 100-year design flows. Rectangular openings or V-notch weirs are preferred over small round orifices for maintenance purposes. If small orifices are used, the minimum orifice opening shall be 3-inches in diameter to help resist clogging.
3. Outlet structures shall be reinforced concrete. All construction joints are to be watertight.
4. Suitable slope protection approved by the District shall be placed upstream and downstream of principal outlets as necessary to prevent scour and erosion. High velocity discharges require energy dissipaters.

8202.16.8 General Landscape Guidelines for Stormwater Ponds

Vegetation shall be established around the perimeter slopes of the pond for erosion control and pollutant removal. Native grasses and drought tolerant plant species are recommended for use in stormwater facilities for slope stabilization and erosion control. ACHD stormwater ponds shall be landscaped according to the “Ada County Highway District Stormwater Management Pond Revegetation Guidance Manual (April 2014).

Ponds maintained by a Homeowner's Association are subject to ACHD review and approval of design and landscaping through plan review and approval of a License Agreement.

Ponds owned and maintained by ACHD shall be fenced with minimum 4-foot tall black poly coated chain link fence with a top rail, unless determined by ACHD to not be necessary. Fence shall have 22 mil vinyl thickness and 12 gauge thickness for the steel.

Detail 7 in this Design Manual shows the standards for ACHD owned ponds. Ponds owned and maintained by a Homeowner's Association may be similar to these standards but may not require a fence.

Non-draining materials like rocks, cobbles, and sod are prohibited over the infiltration areas.

Washed turf or turf with an approved sandy topsoil mix is allowed over infiltration areas for shared use facilities like ball fields. The design should spread the stormwater out over a large area so the design storm water depth is shallow. ACHD must approve multi-use facilities through a License Agreement.

8202.16.9 License Agreement

As a condition of final plat or plan approval, the Developer is required to obtain a License Agreement for landscaping within ACHD right-of-way and easements. Because stormwater easements are exclusive to ACHD, a License Agreement is required to install landscaping within the exclusive easement (see ACHD Policy Section 4000 for more information).

Stormwater ponds can be shared use facilities such as parks or ball fields with a License Agreement. Shared use facilities are encouraged as long as the primary use for stormwater storage, treatment, and maintenance access are not negatively impacted by the secondary use.

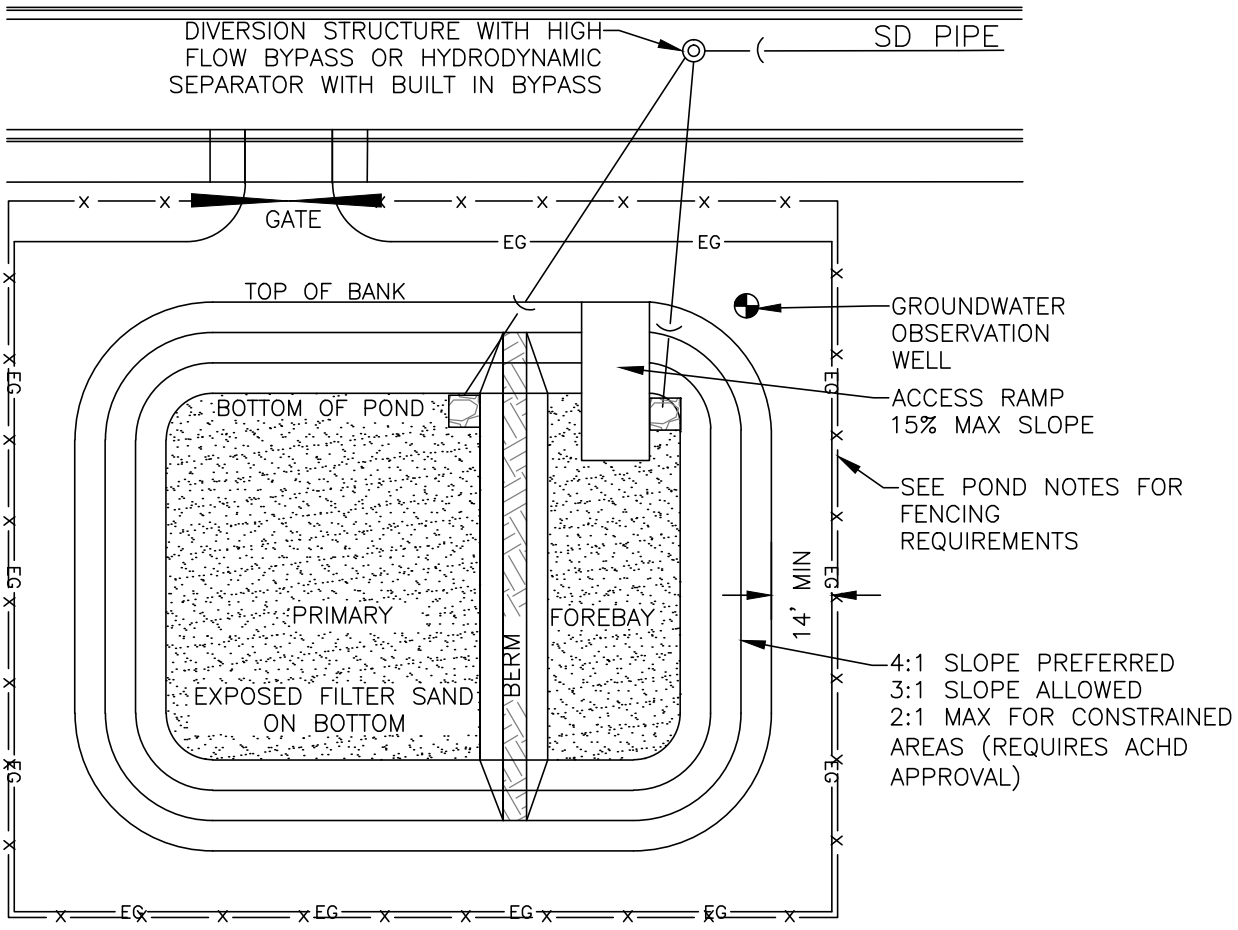
8202.17 BMP 10 Infiltration Basin With Forebay (Treatment & Storage)

Description
This BMP is approved for treatment and storage.

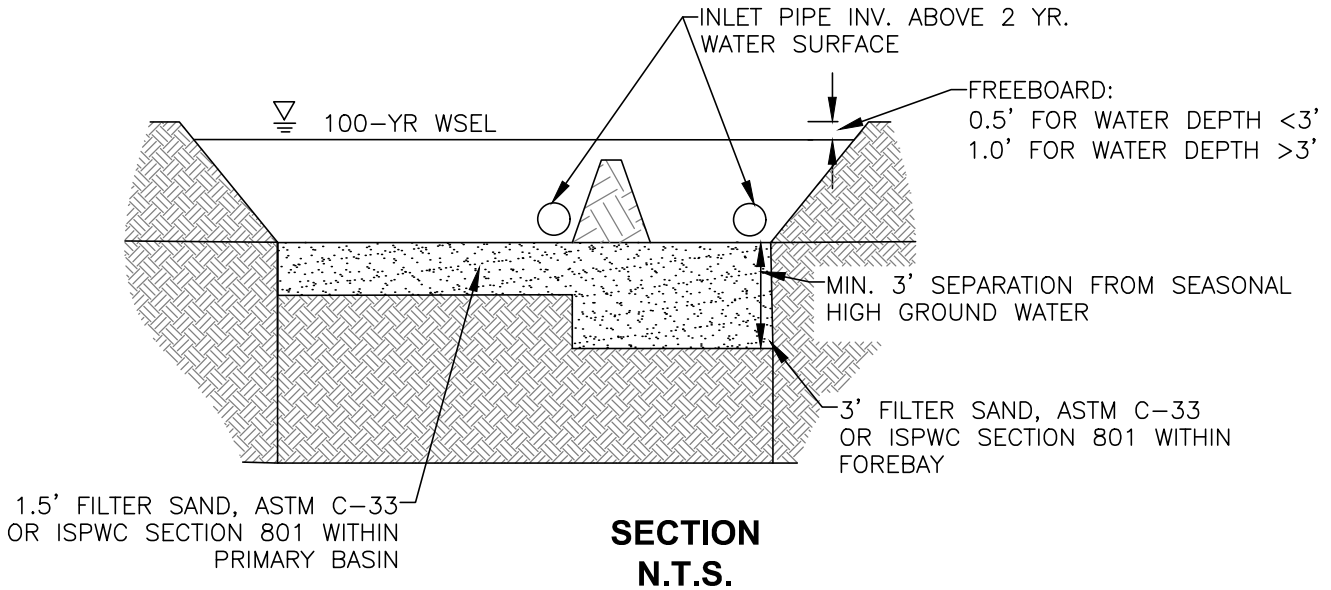
A conventional infiltration pond stores the design storm, treats and infiltrates stormwater with no discharge from the site.

Light maintenance of this facility, when approved for use by the District, shall be performed by the developer or a homeowner's association unless it is an ACHD owned facility.

Design
Ponds shall drain 90% of the design storm in 48-hours.



PLAN VIEW
N.T.S.



SECTION
N.T.S.

NOTES:
1. SEE DETAIL 7 FOR POND STANDARDS.
2. FOREBAY SHALL HAVE 3-FT DEPTH OF FILTER SAND. PRIMARY BASIN MAY HAVE 1.5-FT OF FILTER SAND.

2015 ACHD STORMWATER DESIGN GUIDELINES	INFILTRATION BASIN WITH FOREBAY	STANDARD DRAWING BMP 10

8202.18 BMP 11 Detention Pond With Forebay (Treatment & Storage)

Description
This BMP is approved for treatment and storage.

A conventional detention pond stores the peak design storm, treats and discharges stormwater at a controlled rate to downstream receiving facilities.

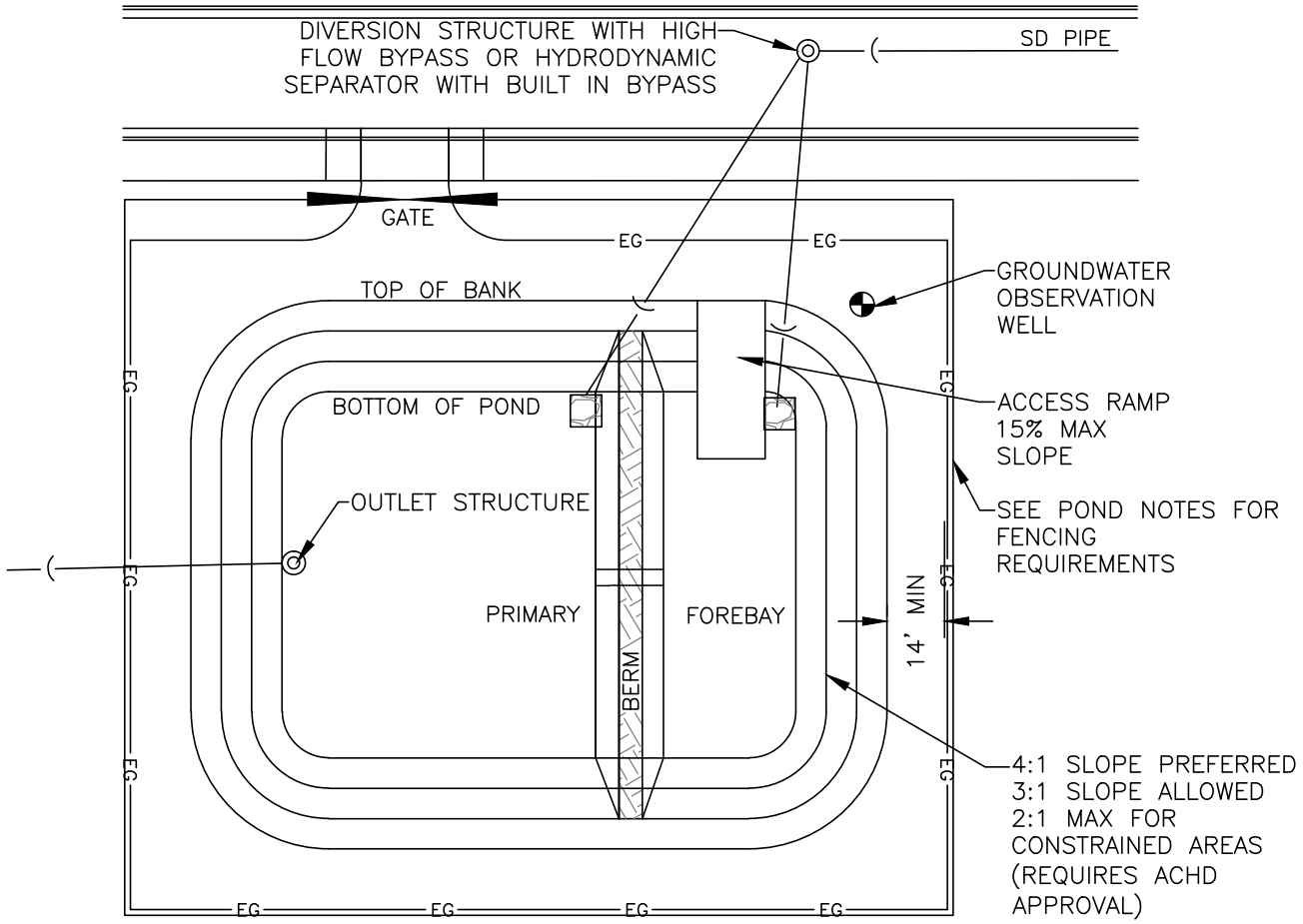
Light maintenance of this BMP, when approved for use by the District, shall be performed by the developer or a homeowner's association unless it is an ACHD owned facility.

Design
Ponds shall drain 90% of the design storm in 48-hours.

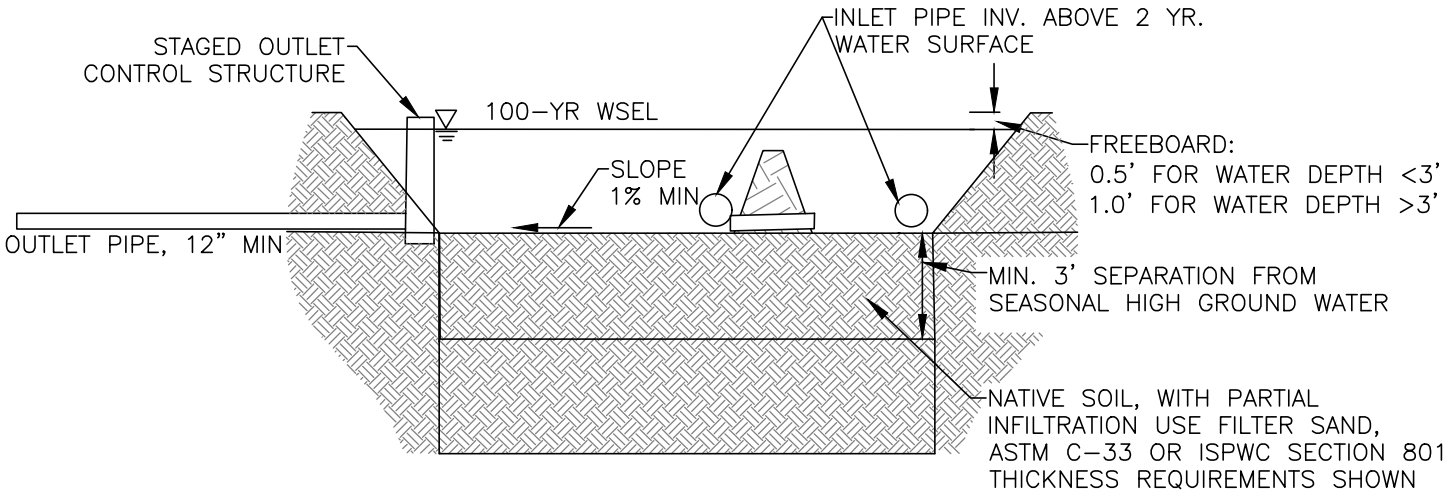
Where the 3-foot separation to groundwater is not maintained an impervious liner shall be used. The following specifications are the minimum requirements for a rigid pond liner to help meet groundwater separation requirements or to retain water in a wet pond with porous soils. Type D or C Soils, Clay or other impervious liners may also be used upon request.

PVC Liner

Property	Test Method	English
Profile Thickness	ASTM D-1593	30 mil
Specific Gravity	ASTM D792	1.20
Breaking Factor (lbs/in width)(1" wide)	ASTM D-882 Method A or B	73
Elongation at Break (%) (2" jaw separation)	ASTM D-882 Method A or B	350
Modulus (force) at 100% Elongation (lbs/in width)	ASTM D-882 Method A or B	34
Tear Resistance (lbs, min)	ASTM D-1004 (Die C)	8.5
Low Temperature, °C	ASTM 1790	-29
Water Extraction (% loss max)	ASTM D-1204 (as modified by NSF)	0.15
Dimensional Stability (each direction, % change max)	ASTM D-1204	± 3
Volatility Loss (% loss max)	ASTM 1203 Method A	0.7
Breaking Factor	ASTM D-3083 (as modified by NSF)	± 5
Elongation at Break	ASTM D-3083 (as modified by NSF)	± 20
Modulus at 100% Elongation	ASTM D-3083 (as modified by NSF)	± 20
Hydrostatic Resistance (psi min)	ASTM D-751 Method A	100



PLAN VIEW
N.T.S.



SECTION
N.T.S.

NOTES:
1. SEE DETAIL 7 FOR POND STANDARDS

2015 ACHD STORMWATER DESIGN GUIDELINES	DETENTION POND WITH FOREBAY	STANDARD DRAWING BMP 11

8202.19 BMP 12 Sand Filter Extended Detention Pond (Pretreatment, Treatment & Storage)

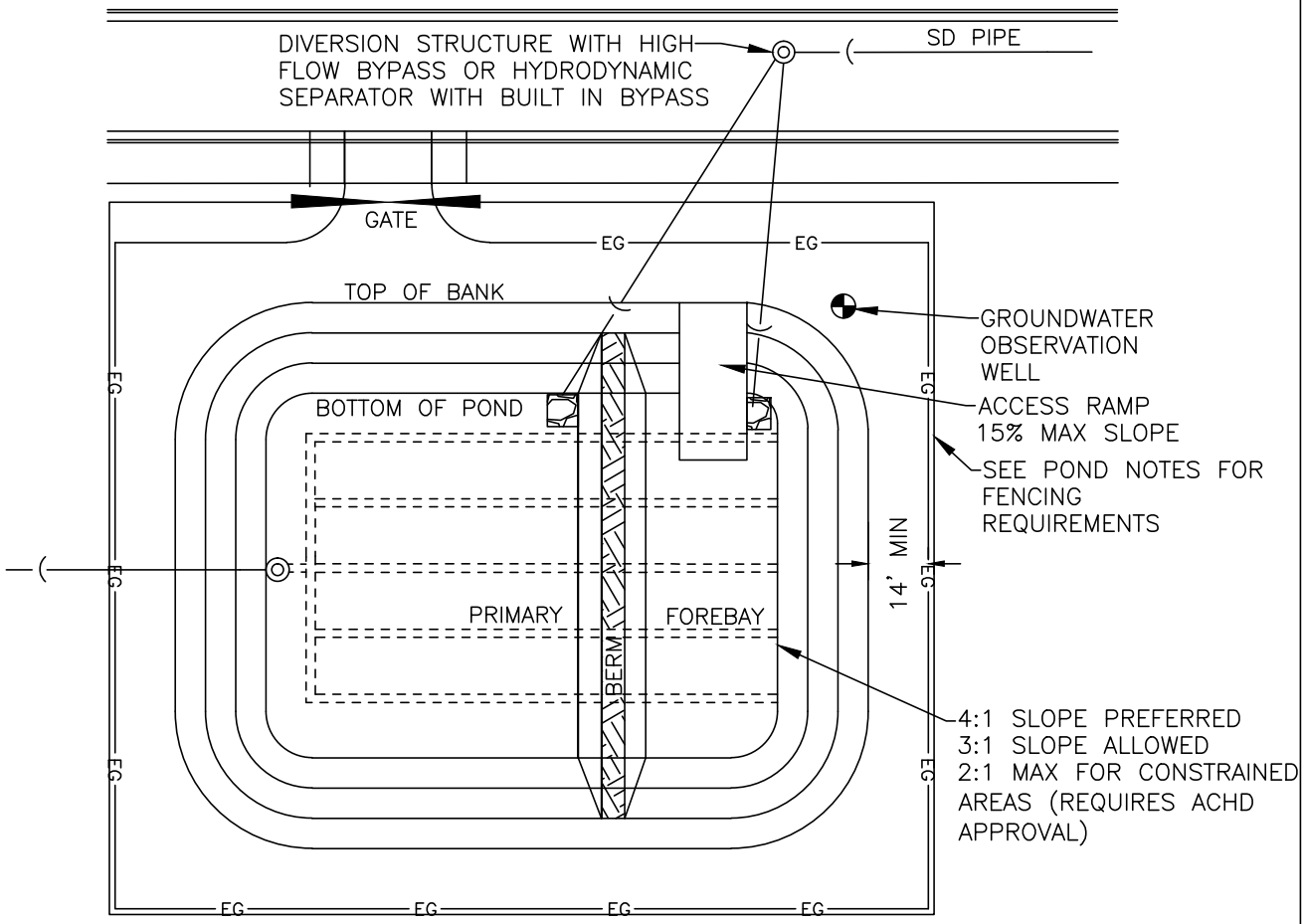
Description
This BMP is approved for pretreatment, treatment and storage.

Filtration for this BMP consists of a sand bed with an under drain.

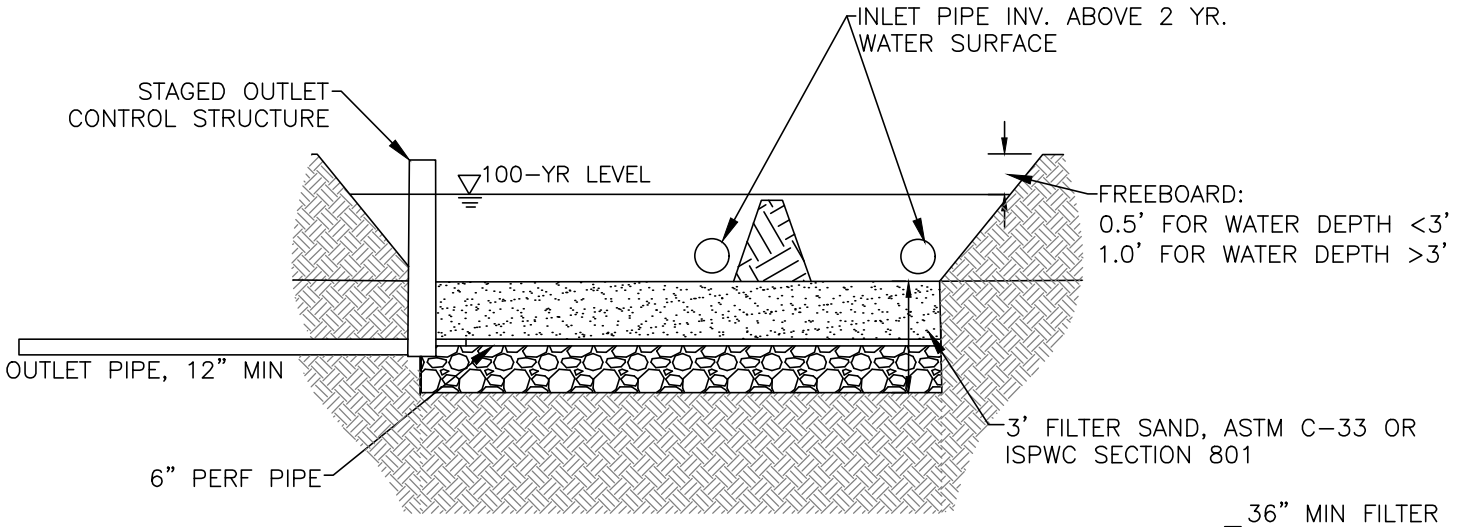
Light maintenance of this BMP, when approved for use by the District, shall be performed by the developer or a homeowner's association unless it is an ACHD owned facility.

The perforated under drain pipe shall be 6-inch minimum diameter with a thick wall.

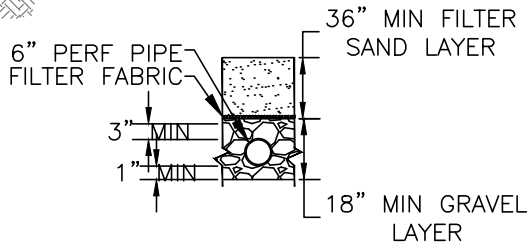
Design
Forebays shall be sized to drain 90% of the design storm in 48-hours.



PLAN
N.T.S.



SECTION
N.T.S.



NOTES:
1. SEE DETAIL 7 FOR POND STANDARDS.

2015 ACHD STORMWATER DESIGN GUIDELINES	SAND FILTER EXTENDED DETENTION POND	STANDARD DRAWING BMP 12

8202.20 BMP 13 Wet Retention or Detention Pond (Treatment & Storage)

Description

This BMP is approved for treatment and storage.

A wet extended detention pond incorporates a permanent pool to detain a volume of water to allow for the settling of particles and associated pollutants.

Wet ponds must be allowed by the lead land use agency and must be approved by ACHD prior to starting the design. Wet ponds shall be incorporated as an amenity to the development. Water shall be aerated and/or have a source of fresh water circulating through the system to prevent the permanent pool of water from becoming stagnant. Aeration and/or circulation systems shall have an operations and maintenance plan and identify long-term maintenance responsibilities. The District SHALL NOT be responsible or liable for aeration and circulation systems.

Stormwater and irrigation may be combined at retention ponds only. The CC&R's shall establish that the public drainage storage is secondary to the primary function of irrigation. The Home Owner's Association (HOA) shall have primary maintenance responsibility over the Primary Treatment/Storage Facility. ACHD shall perform heavy maintenance duties on the forebay only.

Design

Forebays shall be sized to drain 90% of the design storm in 48-hours unless approved as a wet forebay.

Detention pond outlets shall be designed to pass a flow rate necessary for extended quantity attenuation, normally 48 to 72 hours. The outlet design shall incorporate a multi-stage riser to allow water to be drained over an extended period.

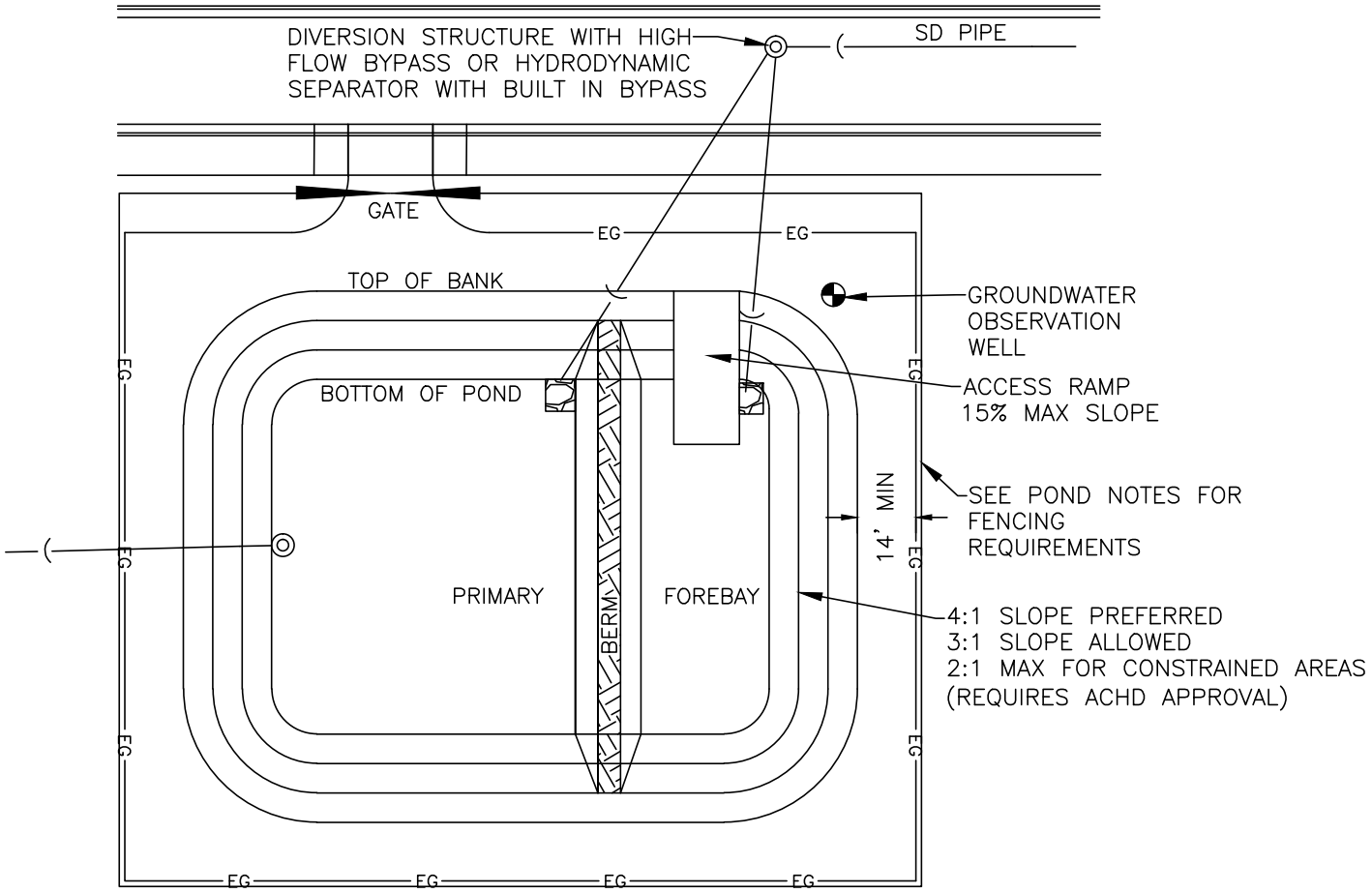
Wet ponds shall be excavated to a minimum depth of 15-feet, adequate to intercept groundwater or shall be lined to retain water. Rigid impervious liners shall meet the specifications identified in BMP 11.

Wet ponds shall be stabilized with vegetation to control dust and improve pond aesthetics. A landscaping plan for a pond and surrounding area should be prepared to indicate how aquatic and terrestrial areas will be stabilized, established, and maintained. Wetland plants shall be used in a pond design, along the aquatic bench and within shallow areas of the pool.

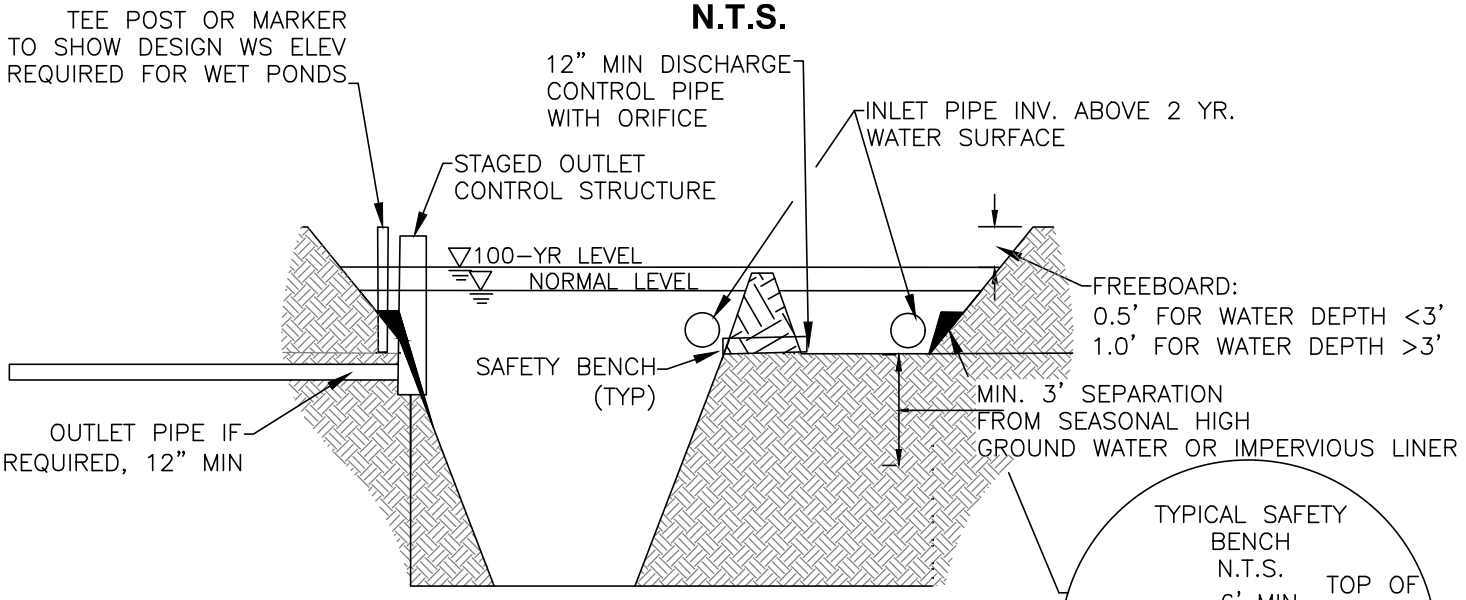
Wet ponds shall be constructed with safety benches meeting the following criteria:

The perimeter of all deep permanent pool areas shall have a minimum 6-foot wide flat bench 1.5-feet below the normal pool water surface elevation. Pond slope between the top of the bank and bench shall not exceed 4:1.

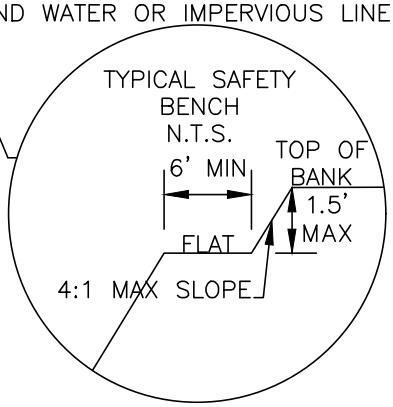
A Tee post shall be installed with the design operating water level clearly identified on the post.



PLAN
N.T.S.



SECTION
N.T.S.



NOTES:
1. SEE DETAIL 7 FOR POND STANDARDS
2. WET PONDS REQUIRE AN AERATION SYSTEM TO CIRCULATE WATER

2015 ACHD STORMWATER DESIGN GUIDELINES	WET RETENTION OR DETENTION POND	STANDARD DRAWING BMP 13

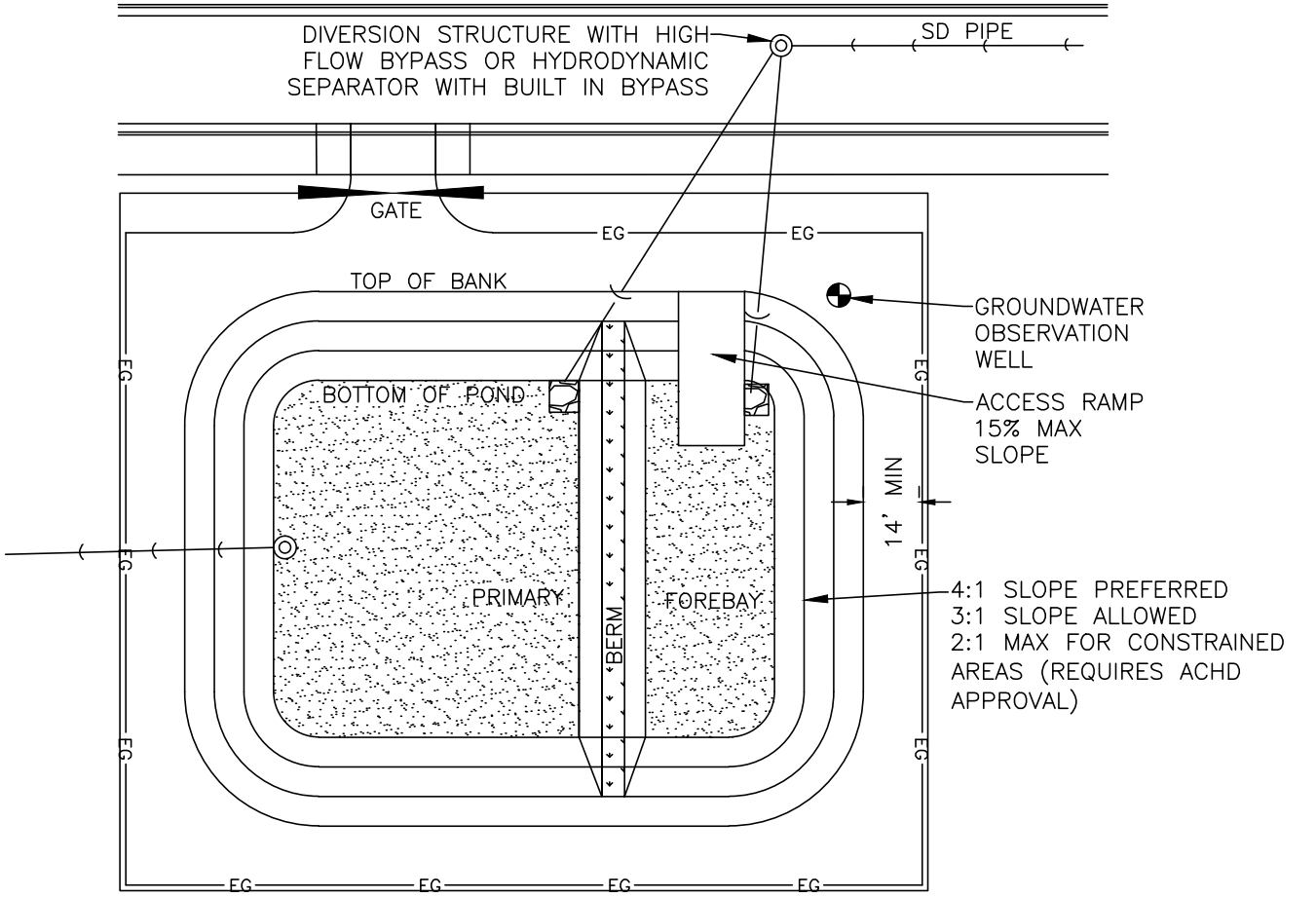
8202.21 BMP 14 Constructed Wetland Basin (Treatment & Storage)

Description
This BMP is approved for treatment and storage.

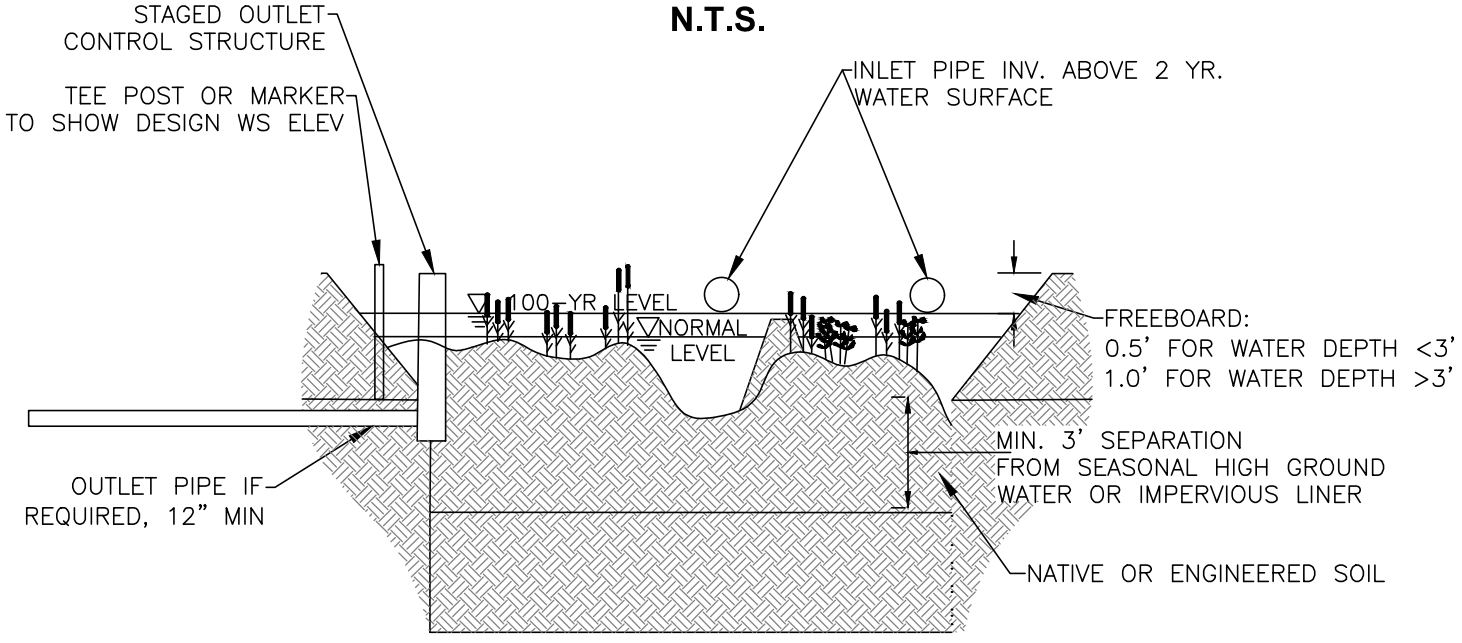
A constructed wetland pond is a shallow retention pond, which requires a perennial base flow to permit the growth of vegetation and allow time for sedimentation, filtering, and biological uptake from stormwater.

Design
Forebays shall be sized to drain 90% of the design storm in 48-hours.

Light maintenance of this BMP, when approved for use by the District, shall be performed by the developer or a homeowner's association unless it is an ACHD owned facility.



PLAN
N.T.S.



SECTION
N.T.S.

NOTES:
1. SEE DETAIL 7 FOR POND STANDARDS

2015 ACHD STORMWATER DESIGN GUIDELINES	CONSTRUCTED WETLAND BASIN	STANDARD DRAWING BMP 14

(BMPs 15-19 Reserved)

8202.22 BMP 20 Seepage Bed With Optional Chambers (Treatment & Storage)

Description

This is approved as for treatment and storage if preceded by another approved pretreatment BMP.

A seepage bed stores stormwater runoff in a trench backfilled with uniformly sized drain rock and infiltrates the water into the ground.

Flows shall be pretreated upstream using approved pretreatment BMPs. The system may also include underground storage chambers for additional storage.

Design

Seepage beds and underground stormwater chambers shall be sized to store the entire 100-year design storm of one-hour duration assuming no infiltration, unless it can be safely conveyed or detained in the right-of-way or stormwater easement without flooding the sidewalk and impacting private property. In this case, the facility can be sized for the one-year, 25-year design storm. Facilities must infiltrate 90% of the design storm in 48-hours through the area of the sand filter. Volume shall be increased by 15% to account for sediment.

A stone aggregate of clean, washed drain rock, 1.5 to 2 inches in diameter should be used for storage. Crushed aggregates to interlock are required for storage chambers. Follow Manufacturer's recommendations. Other materials may be used to create voids per the table below. Void volumes for the specific materials used must be lab verified and clean with less than 2 percent passing a 200 sieve.

Void Volume of Typical Materials	
Material	Void Volume %
2" Max Blasted Rock	30
(1-½" to 2") Uniform Size Gravel	40
¾" Uniform Size Crushed Chips	40
Crushed Glass	30

Crushed aggregates shall have a minimum 50% crushed or fractured face (at least on one side and meet the following gradation:

Crushed Aggregate	
Sieve Size	Percent Passing
3 inch	100%
1 inch	25-60%
3/8 inch	0-4%
No. 200	0-2%

The Design Professional may determine void volumes for other materials by laboratory analysis and submit them to the District for review.

The 18-inch perforated pipe shall have 3/8-inch perforations within the corrugation valleys per the schedule in this standard detail.

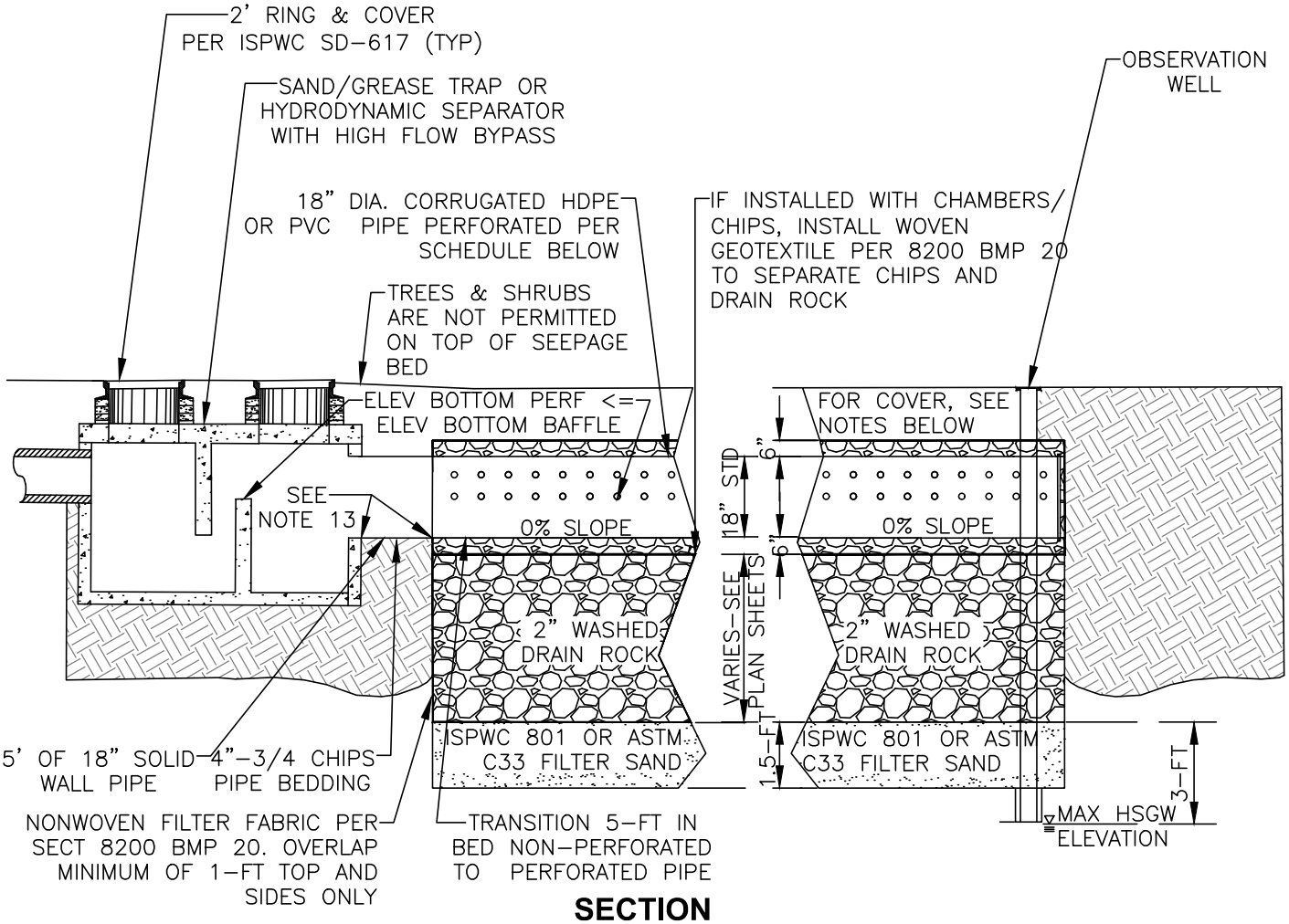
Following are the requirements for drainage geotextiles. Nonwoven or monofilament woven geotextiles are required. Slit film or slit tape geotextiles are not approved for drainage applications.

Non-Woven Filter Fabric

Property	Test Method	English
Tensile Strength (Grab)	ASTM D-4632	120 lbs
Elongation	ASTM D-4632	50%
Puncture	ASTM D-4833	65 lbs
Trapezoidal Tear Strength	ASTM D-4533	50 lbs
UV Resistance	ASTM D-4355	70%
Apparent Opening Size (AOS)	ASTM D-4751	70 US Std. Sieve
Permittivity	ASTM D-4491	1.50 sec-1
Water Flow Rate	ASTM D-4491	120 gpm/ft2

Woven Fabric

Property	Test Method	English
Tensile Strength (Grab)	ASTM D-4632	Min 250 lbs
Puncture Strength or CBR Puncture	ASTM D-4833 or ASTM D-6241	Min 125 lbs or Min 950 lbs
UV Resistance	ASTM D-4355	Min 80%
Apparent Opening Size (AOS)	ASTM D-4751	70 US Std. Sieve
Water Flow Rate	ASTM D-4491	Min 18 gpm/ft^2
Percent Open Area	CW-02215	Min 4%



SECTION
N.T.S.

NOTES:

1. CONTACT DESIGN PROFESSIONAL FOR SEEPAGE BED REDESIGN IF GROUNDWATER IS ENCOUNTERED ABOVE MAX HSGW ELEVATION
2. ALL VAULTS, MANHOLES, & SAND AND GREASE TRAPS SHALL BE HS25 OR GREATER LOAD RATED
3. SEEPAGE BED SHALL BE SHOWN ON BOTH PLAN AND PROFILE VIEWS
4. OPTIONAL CHAMBERS PER MANUFACTURERS SPECIFICATIONS
5. ALL GEOTEXTILE SEAMS SHALL OVERLAP 1 FOOT MINIMUM
6. EL. IN >= EL. BOTTOM PERFORATIONS IN 18" PERF PIPE
7. MAXIMUM BED LENGTH IS 400-FT BETWEEN MANHOLES
8. BED WIDTH SHALL REMAIN CONSTANT
9. 1.5-FT FILTER SAND ALLOWED FOR THIS BMP ONLY.
11. THE DESIGN PROFESSIONAL IS SOLELY RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE OF THE SUBGRADE SOILS AND DETERMINING THE DEPTH OF FOUNDATION STONE
12. SEE BMP 01 FOR SAND/GREASE TRAP DETAILS
13. WATERTIGHT CONNECTION

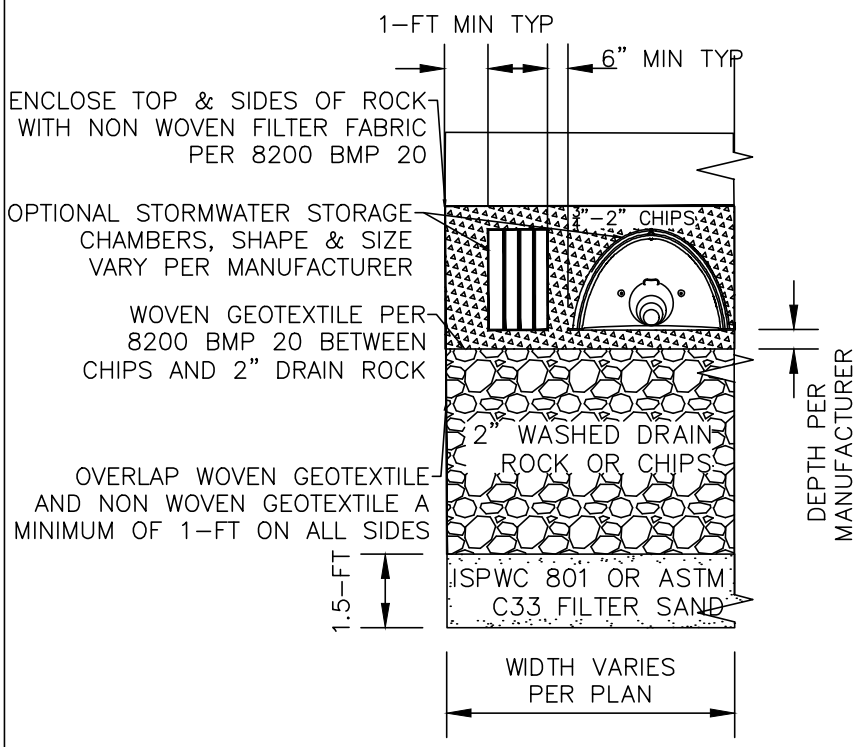
FOR SEEPAGE BEDS IN PUBLIC RIGHT-OF-WAY

1. A MINIMUM 1-FT COVER FROM TOP OF BED TO ROAD SUBGRADE IS REQUIRED
   --BACKFILL OVER BED TO SUBGRADE WITH 6"-8" MINUS PITRUN
   --WOVEN GEOTEXTILE FABRIC REQUIRED OVER TOP OF BED
2. IF < 1-FT COVER FROM TOP OF BED TO SUBGRADE, ANGULAR ¾" TO 2" ROCK IS REQUIRED WITH MINIMUM 50% SINGLE FRACTURED FACE IN PLACE OF 2" DRAIN ROCK.
3. FULL ROADWAY SECTION IS REQUIRED OVER SEEPAGE BEDS. SEEPAGE BEDS SHALL NOT EXTEND ABOVE SUBGRADE

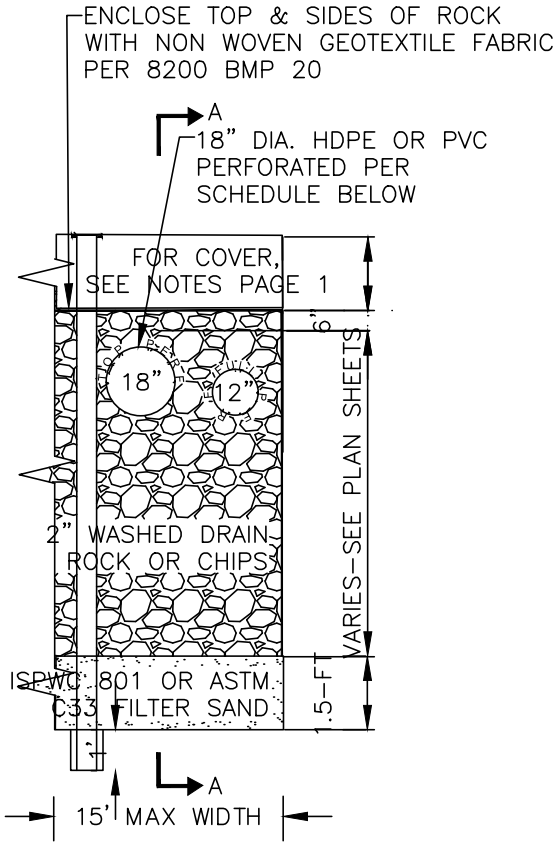
FOR SEEPAGE BEDS OUTSIDE PUBLIC RIGHT-OF-WAY

1. A MINIMUM 1.5-FT COVER FROM TOP OF BED TO FINISH GRADE IS REQUIRED

2015 ACHD STORMWATER DESIGN GUIDELINES	SEEPAGE BED WITH OPTIONAL CHAMBERS	STANDARD DRAWING BMP 20 1 OF 3

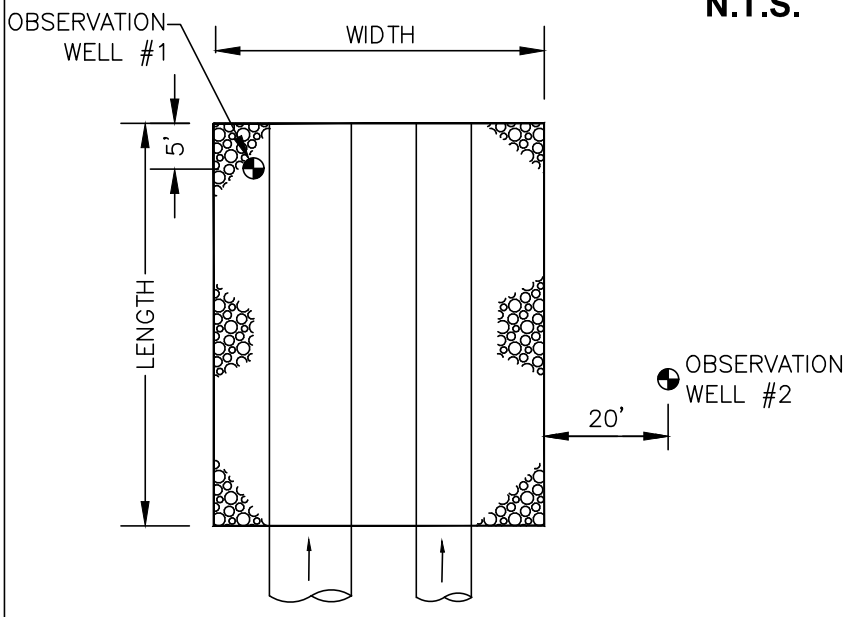


OPTIONAL CHAMBER



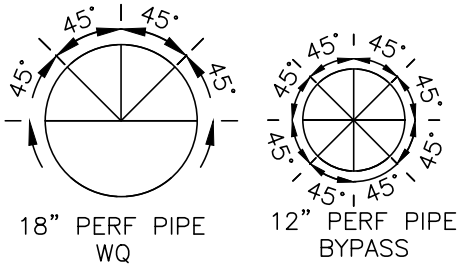
STANDARD

SECTION
N.T.S.



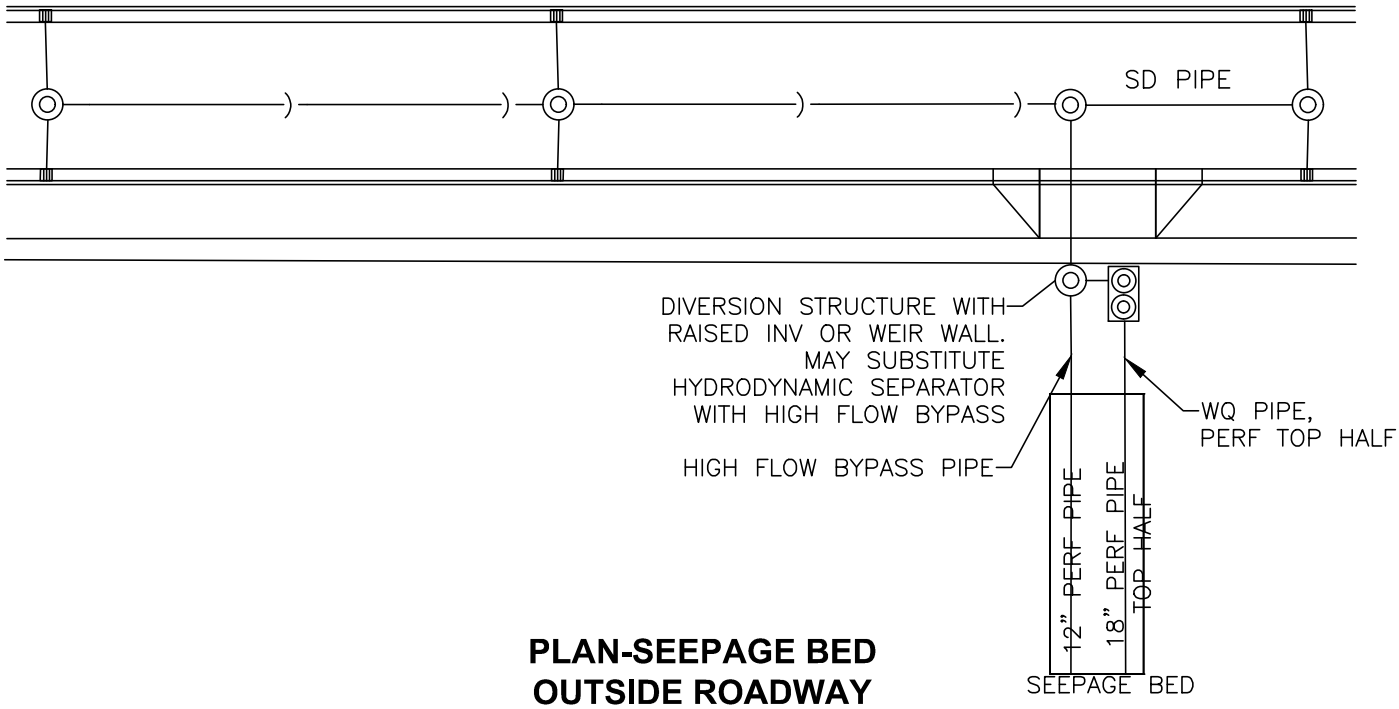
OBSERVATION WELLS: 2 REQUIRED PER BED

PLAN
N.T.S.

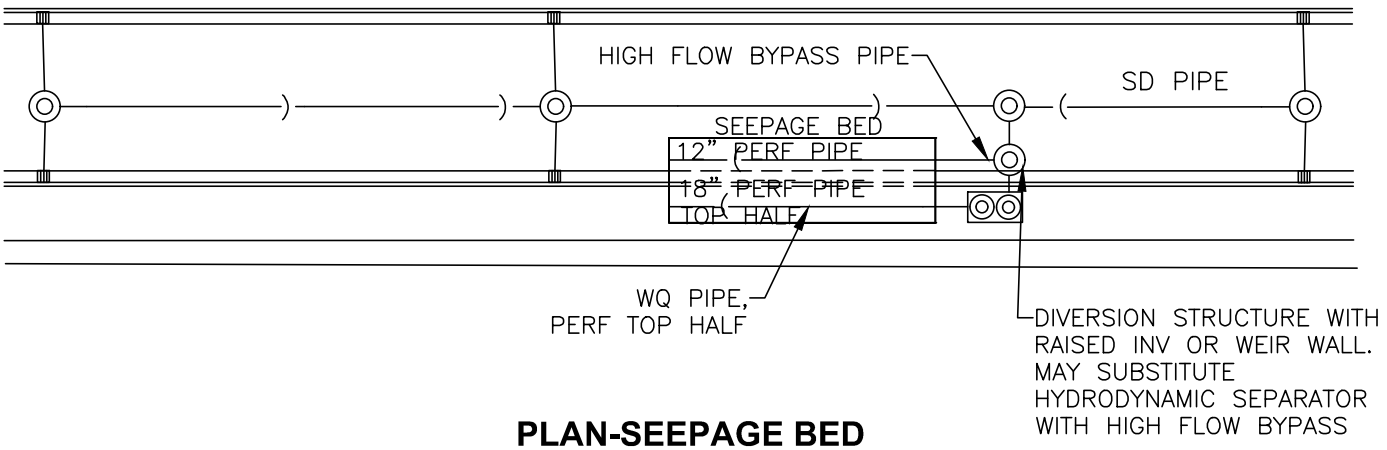


PERFORATION SCHEDULE
3/8" PERFORATIONS IN VALLEYS OF CORRUGATED PIPE. 5 EA ON 18", 8 EA ON 12"

2015 ACHD STORMWATER DESIGN GUIDELINES	SEEPAGE BED WITH OPTIONAL CHAMBERS	STANDARD DRAWING BMP 20 2 OF 3



PLAN-SEEPAGE BED
OUTSIDE ROADWAY
N.T.S.



PLAN-SEEPAGE BED
IN ROADWAY
N.T.S.

2015 ACHD STORMWATER DESIGN GUIDELINES	SEEPAGE BED WITH OPTIONAL CHAMBERS	STANDARD DRAWING BMP 20 3 OF 3

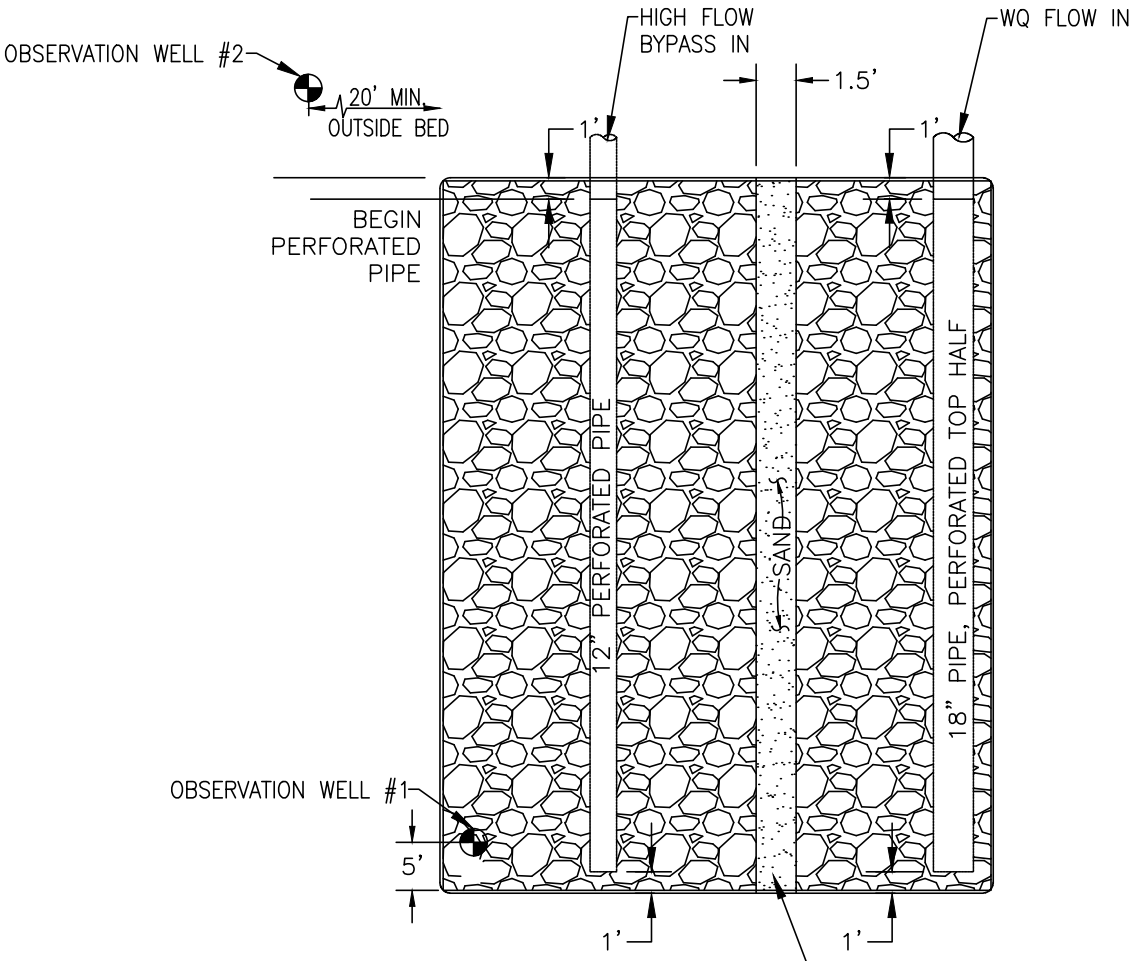
8202.23 BMP 21 Horizontal Sand Filter

Description

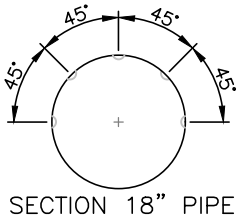
This is approved for treatment and storage if preceded by another approved pretreatment BMP.

This BMP may only be used where 3-foot separation to high groundwater is not possible. Use of this BMP requires written approval from ACHD.

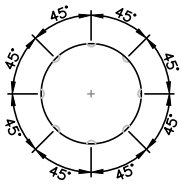
See BMP 20 Seepage Bed for description and design.



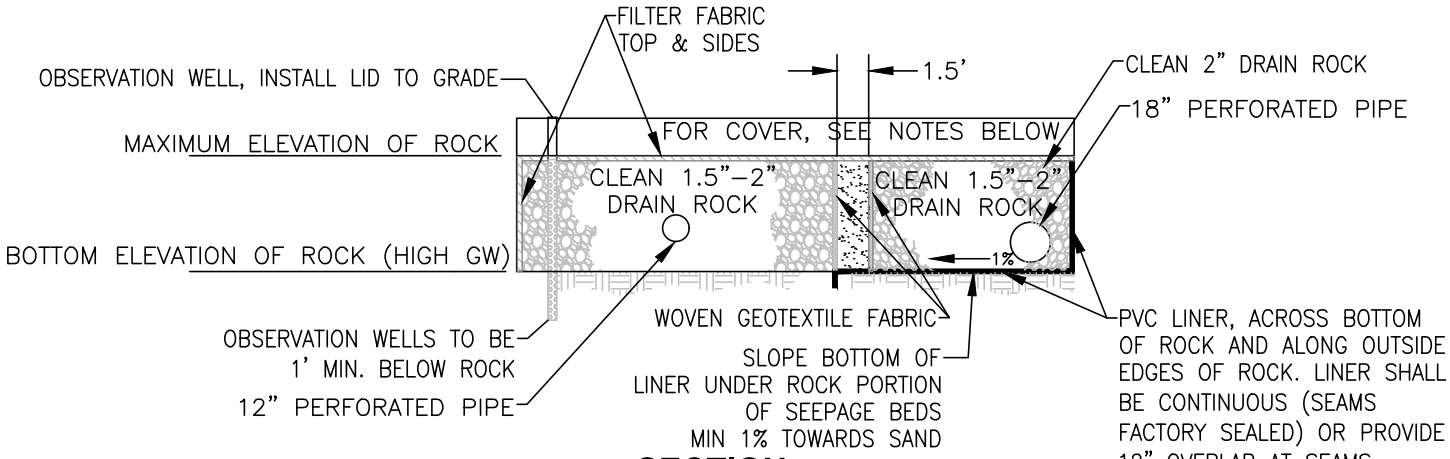
PLAN
N.T.S.



SECTION 18" PIPE
PERFORATION
DETAIL
N.T.S.



SECTION 12" PIPE
PERFORATION
DETAIL
N.T.S.



SECTION
N.T.S.

NOTES:
1. THIS BMP MUST BE APPROVED FOR USE BY ACHD AND IS ONLY ALLOWED WHERE 3-FT SEPARATION TO HSGW IS NOT POSSIBLE
2. SEE BMP 20 FOR NOTES

2015 ACHD STORMWATER DESIGN GUIDELINES	HORIZONTAL SAND FILTER	STANDARD DRAWING BMP 21

8202.24 BMP 22 Underground Sand Filter (Pretreatment, Treatment)

Description

This is approved as a pretreatment BMP if the sand filter is sized to treat the runoff reduction volume. If the sand filter is sized to treat the entire 25-year design storm then this BMP can provide primary treatment. Storage facilities or an approved discharge are required for the design storm.

The Underground Sand Filter Vault consists of a chamber to hold sediment, a filter sand surface for capture of pollutants over the top of perforated under drain pipes in a gravel bed.

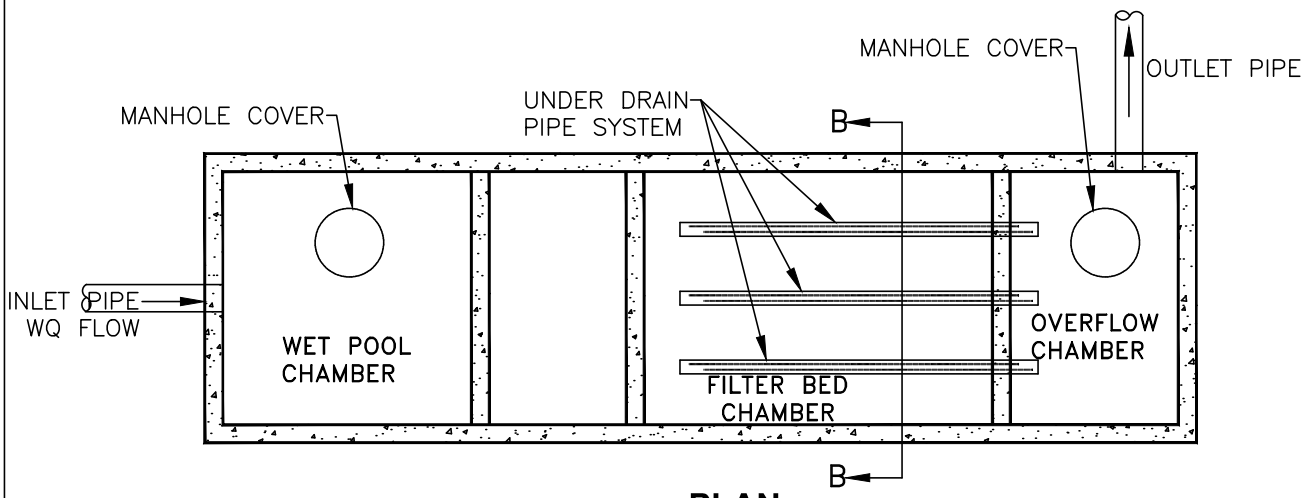
Design

The perforated under drain pipe shall be a minimum 6-inch diameter. A precast vault, 1500 Gallon Sand/Grease Trap or similar, with two manhole accesses shall be used.

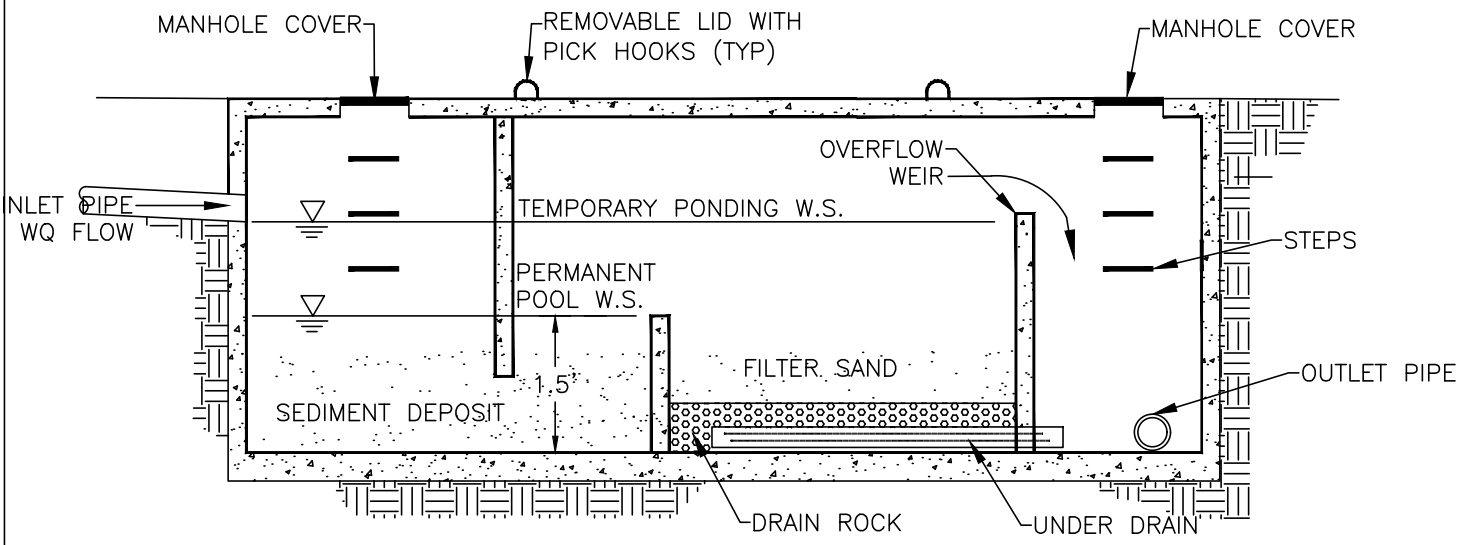
Due to the limited infiltration rate through the filter sand, sand filters can only accommodate a small peak discharge as shown below without additional storage.

Unit	**Max Q**
1500 Gallon Tank w/Sand Bed, Approx. inside dimension 5'x7'x7'	0.39 cfs

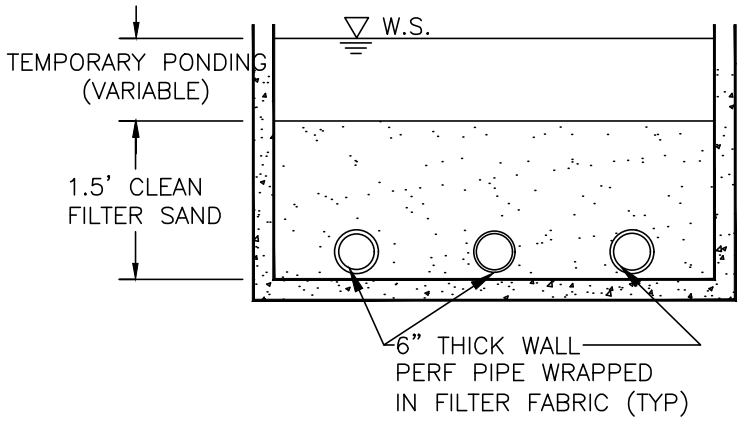
Manufactured additives can be added to the sand media for additional treatment of pollutants of concern like phosphorus.



PLAN
N.T.S.



SECTION
N.T.S.



SECTION B-B
N.T.S.

NOTES:

1. FOR USE OUTSIDE OF THE ROADWAY PRISM
2. ALL REINFORCING STEEL SHALL BE GRADE 60
3. CAST–IN–PLACE BOX DESIGN MUST BE APPROVED BY ACHD PRIOR TO CONSTRUCTION
4. HEIGHT OF OUTLET BAFFLE WALL AND LENGTH OF INLET BAFFLE WALL DETERMINED BY TANK CAPACITY AND FLOW RATE
5. BEFORE THESE BOXES ARE USED THE APPLICATION MUST BE APPROVED BY ACHD
6. MANHOLE FRAME, COLLAR AND COVER SHALL BE PER SD–616 AND SD–617
7. PROVIDE STEPS WHEN THE DISTANCE FROM TOP OF MANHOLE FRAME TO TOP OF BOX EXCEEDS 2–FT
8. SORBTIVE MEDIA, PHOSPHOSORB OR APPROVED EQUAL. ADDITIVE MAY BE REQUIRED FOR PHOSPHORUS REMOVAL. OTHER ADDITIVES MAY BE REQUIRED TO ADDRESS POLLUTANTS OF CONCERN

2015 ACHD STORMWATER DESIGN GUIDELINES	UNDERGROUND SAND FILTER	STANDARD DRAWING BMP 22

BMPs 24-29 Reserved

8202.25 REQUIREMENTS FOR BIORETENTION FACILITIES

8202.25.1 Description

A bioretention facility is an infiltration device consisting of an excavated area that is back-filled with a Bioretention Soil Media (BSM) and planted with vegetation. Bioretention facilities include Swales (BMP 30), Planters (BMP 31), and Curb Extensions (BMP 32).

8202.25.2 Siting

Sloped areas immediately adjacent to the bioretention device shall be less than 2% but greater than 0.5% for pavement and greater than 1% for vegetated areas to ensure positive flow towards the device.

The area draining to the bioretention device shall not exceed 2 acres. The drainage area shall not contain significant sources of soil erosion.

Requirements in the ACHD Policy Manual for infiltration facilities shall apply.

If an impermeable liner and an underdrain are used, no setback is needed from buildings. Otherwise, the 10 foot setback shall apply. Where an impermeable liner is included between facility and adjacent infrastructure (street, parking lot), a 30 MIL HDPE or PVC material shall be used. No setbacks are required for lined flow-through planters where the height above finished grade is 30 inches or less.

8202.25.3 General Design Criteria

All AASHTO Roadside Design Guide Requirements shall be met when developing bioretention facilities.

A parking step-out zone of 24” measured from face of curb shall be provided for bioretention facilities adjacent to parking lanes.

Pedestrian crossings of continuous bioretention facilities adjacent to curb are required as below.

- One 6’ concrete crossing between each street tree and 35 foot maximum spacing in high-volume pedestrian areas
- One 6’ crossing every other tree and 70 foot maximum spacing in other areas consistent with surrounding area (paved, grass, or mulched).

Access is required to all bioretention areas for maintenance.

Inlets shall include a rock pad, concrete or other erosion protection device in the channel entrance to dissipate energy. The flow entrance shall drop 2 to 3

inches from curb line and provide an area for settling and periodic removal of sediment.

Pretreatment shall be provided and may include shallow catch basins, a pea gravel trench, stone splash pad, or filter strip.

8202.25.4 Flow Regulation

The flow at the inlet to the bioretention device shall be controlled to prevent erosion and achieve uniform distribution across the surface of the soil planting bed.

Provide aggregate (6" depth, 3"-6" rounded), washed cobble or concrete splash pads at inlets.

An overflow structure is required for on-line systems without an overflow bypass and shall connect to approved discharge point or another downstream bioretention area. Overflow structures shall be sized to safely convey larger storm events.

When a standpipe with a trash guard is used to regulate the maximum ponding depth, the invert elevation of the overflow structure shall be equal to the maximum ponding depth of the bioretention device. Vertical stand pipes can be connected to under-drain systems, horizontal drainage pipes, or armored overflow channels installed at the designed maximum ponding elevations.

Maximum surface pool drawdown time shall be 48 hours.

Storage Layer

A 6-inch thick filter layer of ¾" (No. 4) open-graded aggregate and a 12-inch gravel drainage layer (No. 57) shall be used for subsoil infiltration rates less than 0.5 inches/hour. The swale shall be sized to capture and store 100% of the design volume within the filter media (BSM, sand, and underdrain stone). The bottom of the infiltration swale shall be separated at least 2 feet vertically from the bedrock layer or seasonal high water table, measured from the bottom of the aggregate.

Where an aggregate layer is used and trees are specified, replace aggregate with increased BSM depth in tree planting locations.

8202.25.5 Bioretention Soil Media (BSM)

The Bioretention Soil Media (BSM) is specified in Appendix F. All bioretention facilities shall include a minimum of 24 inches of Bioretention Soil Mix (BSM). The bottom of the facility (below BSM) shall be at least two feet above the seasonal high water table and bedrock as determined by the geotechnical investigation. Deeper BSM profiles may be required in areas with high groundwater, high infiltration rates or underdrains. BSM depth should also be adjusted to accommodate expected rooting depths of vegetation.

The Contractor shall not place BSM until the Inspector has reviewed and confirmed the following:

- Soil mix delivery ticket(s). Delivery tickets shall show that the full delivered amount of soil matches the product type, volume and Manufacturer named in the submittals.
- Visual match with submitted samples. Delivered product will be compared to the submitted sample, to verify that it matches the submitted sample.
- The Inspector may inspect any loads of soil and stop placement if it is determined that the delivered soil does not appear to match the submittals; and require sampling and testing of the delivered soil, before authorizing soil placement. All testing costs shall be the responsibility of the Contractor.

Place BSM in 6-inch lifts; compact each lift by lightly wetting and allow BSM to dry overnight before planting.

8202.25.6 Vegetation/Mulch

The entire facility area shall be planted with vegetation. Native plant species are preferred over non-native species. Salt resistant vegetation should be used in locations with probable adjacent salt application.

Erosive conditions shall be prevented during germination and establishment of vegetation. The use of temporary or permanent stabilization fabrics or materials is required.

Provide irrigation for plant establishment (2-3 years), and supplemental irrigation during periods of prolonged drought. Provide separate zone for connection to water supply.

Washed pea gravel, river rock mulch or compost mulch is recommended for planters. Any other mulch must be aged, stabilized, non-floating mulch, such as a specified compost mulch.

Tree dams, using tree mounds, can be used and should be no higher than 6-9 inches above the bottom (invert) of the channel.

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.

8202.26 BMP 30 Bioretention Swale (Treatment & Storage)

Description

This BMP is approved for pretreatment, or treatment and storage. Infiltration swales can be used on arterials and collectors, in subdivision common areas including medians; and as retrofits to provide pollutant reduction on existing development that is currently untreated by any BMP or is inadequately treated by an existing BMP. It can also include conversion, enhancements or restoration of older BMPs to boost their performance.

Design

Bioretention swales must meet the requirements of Section 7200 for lots one-acre and larger or be located on collector or arterial roadways behind vertical curb. Use of this BMP requires written approval from ACHD.

When a swale is intended to be used for infiltration, the site evaluation requirements for infiltration facilities shall apply.

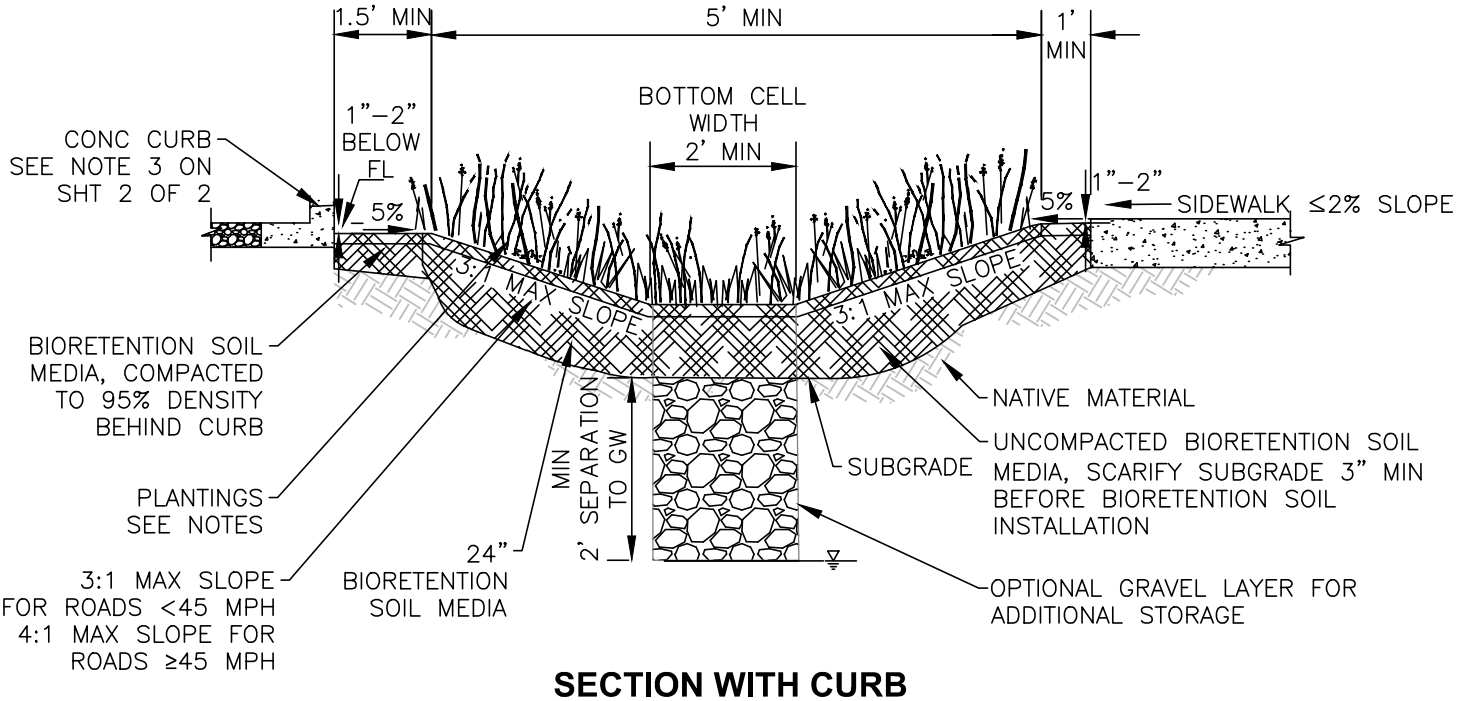
Infiltration swales shall include a minimum of 24 inches of Bioretention Soil Mix (BSM) on the bottom of the swale. BSM is not required on the slopes but is recommended.

A 2’ minimum flat bottom width shall be required for a bioretention swale. Side slopes shall be 4:1 or flatter.

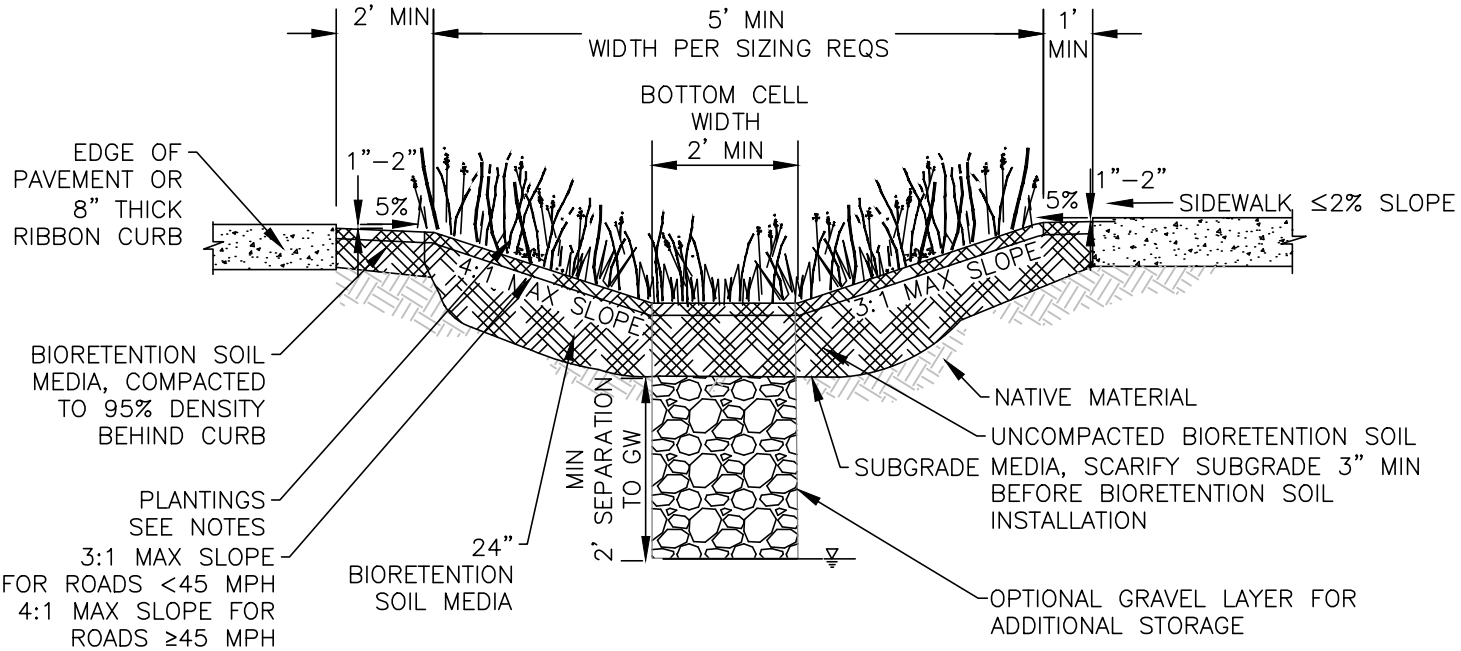
Maximum longitudinal bottom slope shall be 6%. Longitudinal slope shall be 2 percent maximum between berms. Provide check dams to increase detention time and infiltration capability on sloped sites and to reduce flow velocity and potential erosion.

The facilities should be heavily vegetated with grasses, and may also be landscaped to enhance their function and appearance. Swales can be planted with turf grass, native grasses, decorative herbaceous cover, or trees on the dams).

If turf grass is used, only washed sod or sod grown on sandy soils shall be allowed on the areas designed to infiltrate and the sides of the facility. Barriers shall be used to protect the infiltration areas from other sodded areas until the vegetation is established. Minimum vegetation height of 4 inches is recommended.



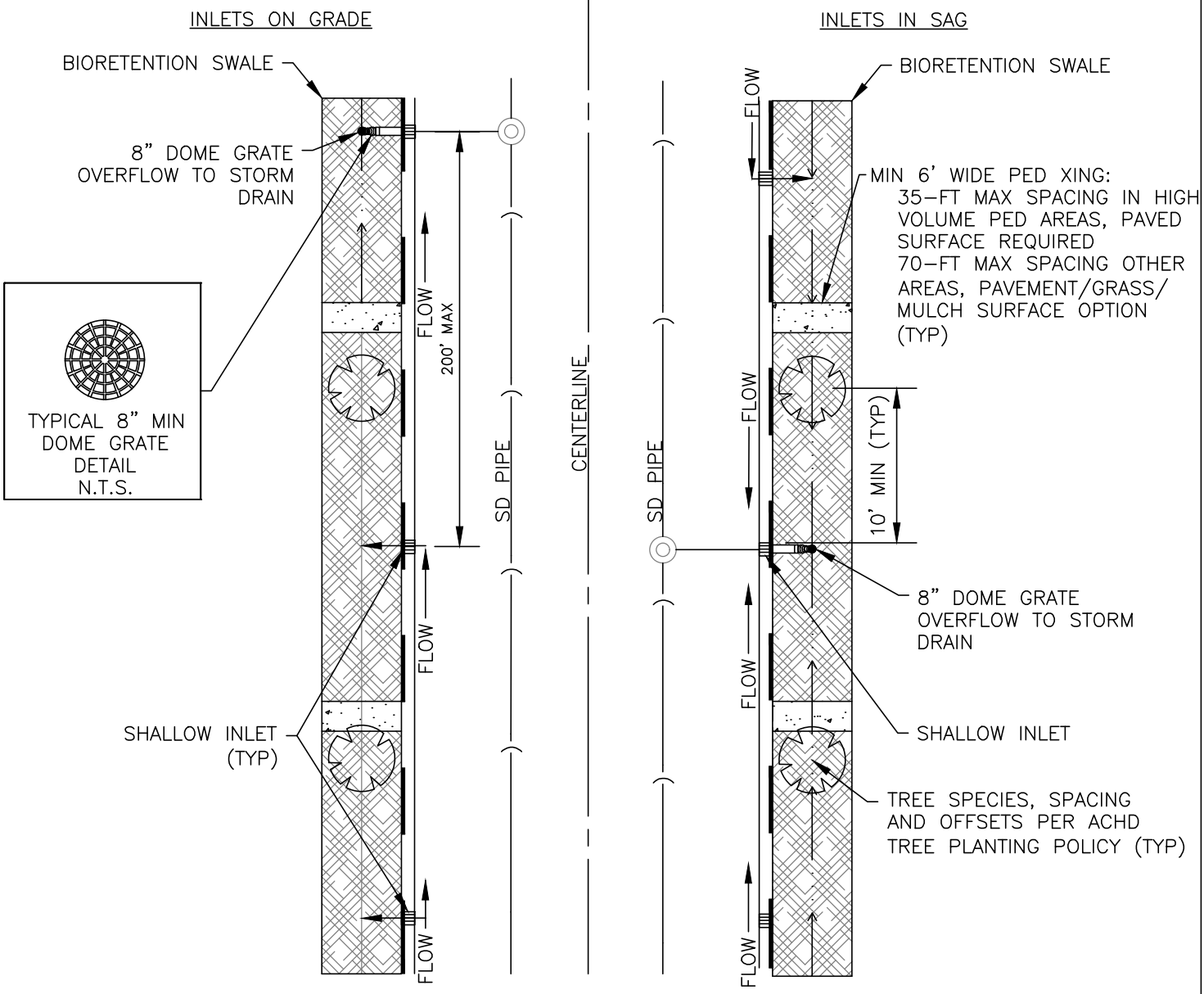
SECTION WITH CURB
N.T.S.



SECTION WITHOUT CURB
N.T.S.

NOTES:
1. SEE NOTES ON SHEET 2 OF 3

2015 ACHD STORMWATER DESIGN GUIDELINES	BIORETENTION SWALE	STANDARD DRAWING BMP 30 SHEET 1 OF 3

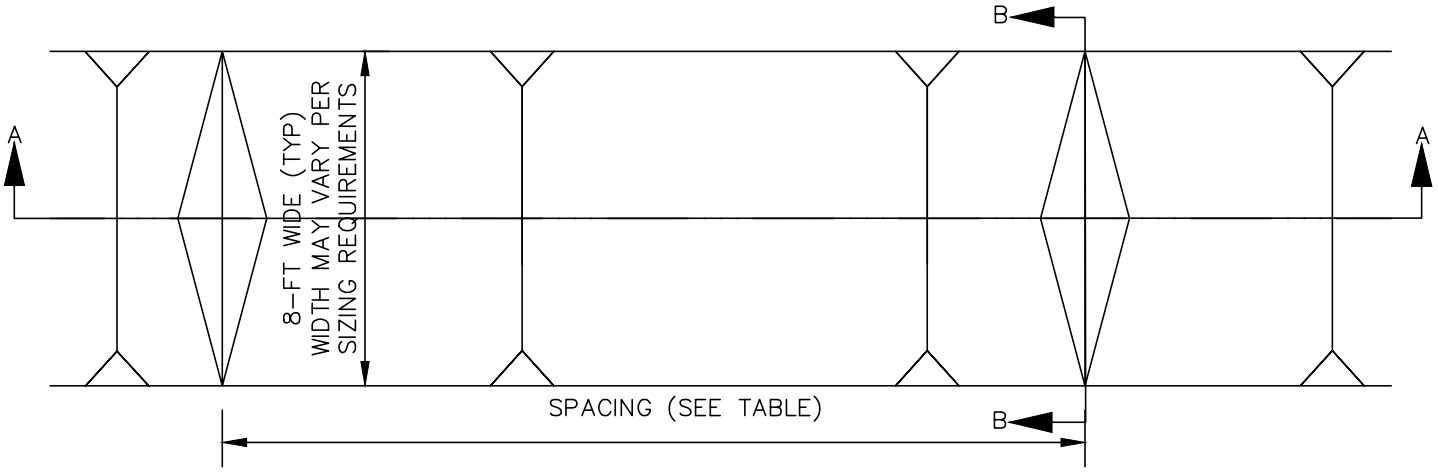


URBAN SECTION WITH SD OVERFLOW
N.T.S.

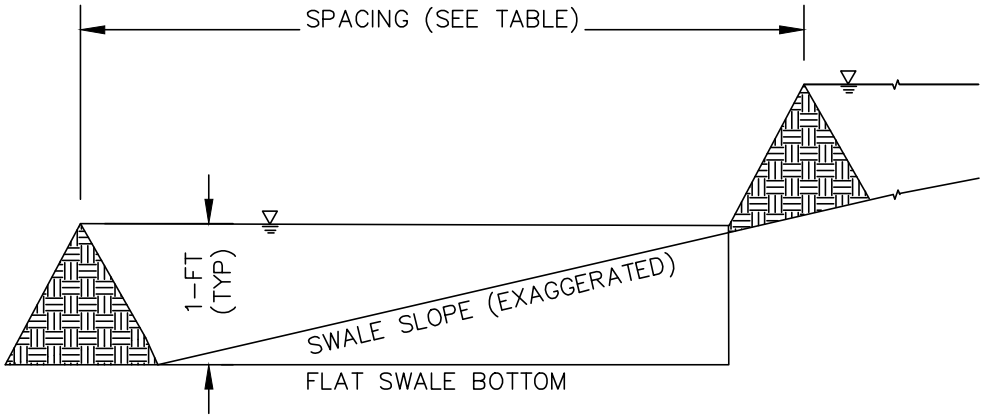
NOTES:

1. THE USE OF SWALES MUST BE APPROVED BY ACHD PRIOR TO DESIGN. SWALES ARE NOT ALLOWED ON RESIDENTIAL STREETS FOR NEW DEVELOPMENT EXCEPT RURAL LOTS ≥ 1 ACRE
2. SEE SPECIFICATIONS FOR BIORETENTION SOIL MEDIA (BSM)
3. SIDE SLOPES SHALL COMPLY WITH AASHTO CLEAR ZONE GUIDELINES: 3:1 MAX SLOPE < 45 MPH, 4:1 MAX SLOPE ≥ 45 MPH
4. SHALLOW INLET REQUIRED FOR URBAN SECTIONS WITH CURB. SEE SECT 8200
5. FOR DENSE URBAN DETAIL, OPTIONAL OVERFLOW PIPE AND RISER TO BE USED IF ADDITIONAL CAPACITY IS NEEDED
6. STEP OUT ZONE REQUIRED WHEN PARALLEL PARKING IS PROVIDED. FINISHED SURFACE MAY BE CONCRETE SIDEWALK, SOD, MULCH OR PAVEMENT BASED ON SURROUNDING CONDITIONS. MEET CURRENT ADA REQUIREMENTS
7. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS
8. INFILTRATION RATE OF NATIVE SOILS AT SUBGRADE SHALL BE MIN 0.5 IN/HR
9. BIORETENTION CELLS ALLOW PLACEMENT OF AN AGGREGATE SUBBASE FOR ADDITIONAL VOLUMETRIC STORAGE IF NEEDED
10. DROUGHT TOLERANT PLANT SPECIES OR WASHED TURF GRASS
11. IRRIGATION TO BE DESIGNED FOR SPECIFIC APPLICATION

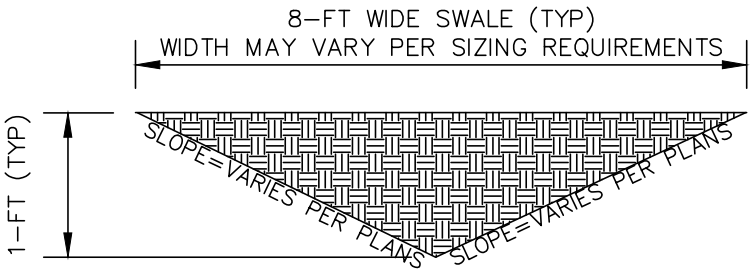
2015 ACHD STORMWATER DESIGN GUIDELINES	BIORETENTION SWALE	STANDARD DRAWING BMP 30 SHEET 2 OF 3



PLAN
N.T.S.



SECTION A-A
N.T.S.



SECTION B-B SWALE CHECK DAM
N.T.S.

PERCENT SLOPE	DIST BETWEEN CHECK DAMS (FT)
1%	100
2%	50
3%	33
4%	25
>=5%, 10% MAX	20

NOTES:
1. CHECK DAMS TO BE CONSTRUCTED OF CLAY SOIL TO MINIMIZE SEEPAGE OR COBBLES FOR CONVEYANCE SWALES. OTHER MATERIALS MAY BE USED FOR CHECK DAMS WITH ACHD WRITTEN APPROVAL
2. SIDE SLOPES AND CHECK DAMS SHALL COMPLY WITH AASHTO CLEAR ZONE GUIDELINES

2015 ACHD STORMWATER DESIGN GUIDELINES	BIORETENTION SWALE CHECK DAMS	STANDARD DRAWING BMP 30 3 OF 3

8202.27 BMP 31 Bioretention Planter

Planters shall have a 4” minimum height wall adjacent to sidewalk for pedestrian safety.

Planter walls shall be made of stone, concrete, brick, or other durable material. Chemically treated wood can contaminate stormwater and shall not be used.

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

The depth of the planter is measured from adjacent pedestrian walking surface to facility finished elevation/planting surface) based on desired ponding plus freeboard, but also relates to planter width.

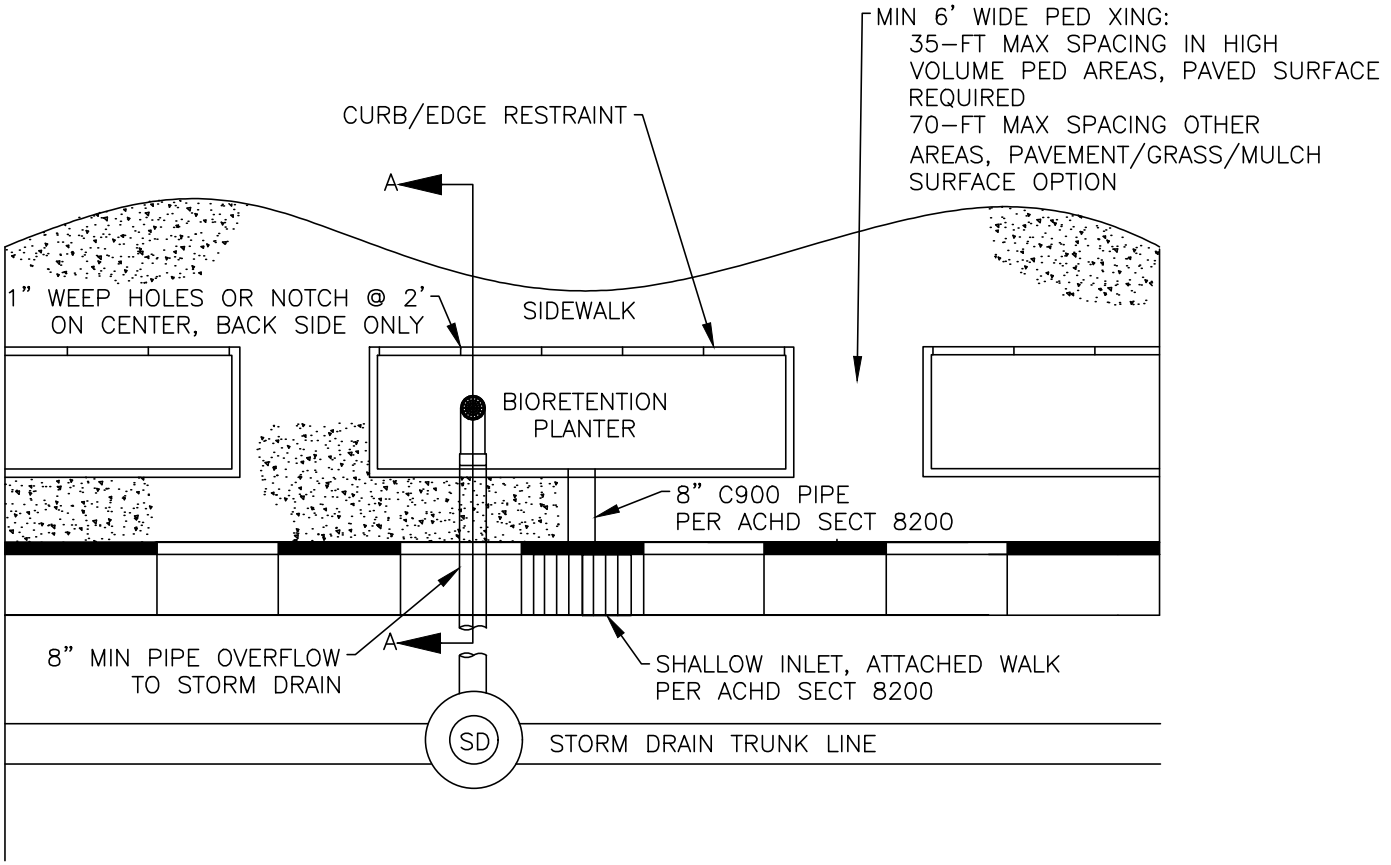
Planters can be deeper if they are wider, and need to be shallower as they narrow. This is a pedestrian perception and safety issue. Some recommended width to depth guidelines are:

PLANTER WIDTH	MAX. PLANTER DEPTH
>5’	16”
4’-5’	12”
3’-4’	10”
2’-3’	8”

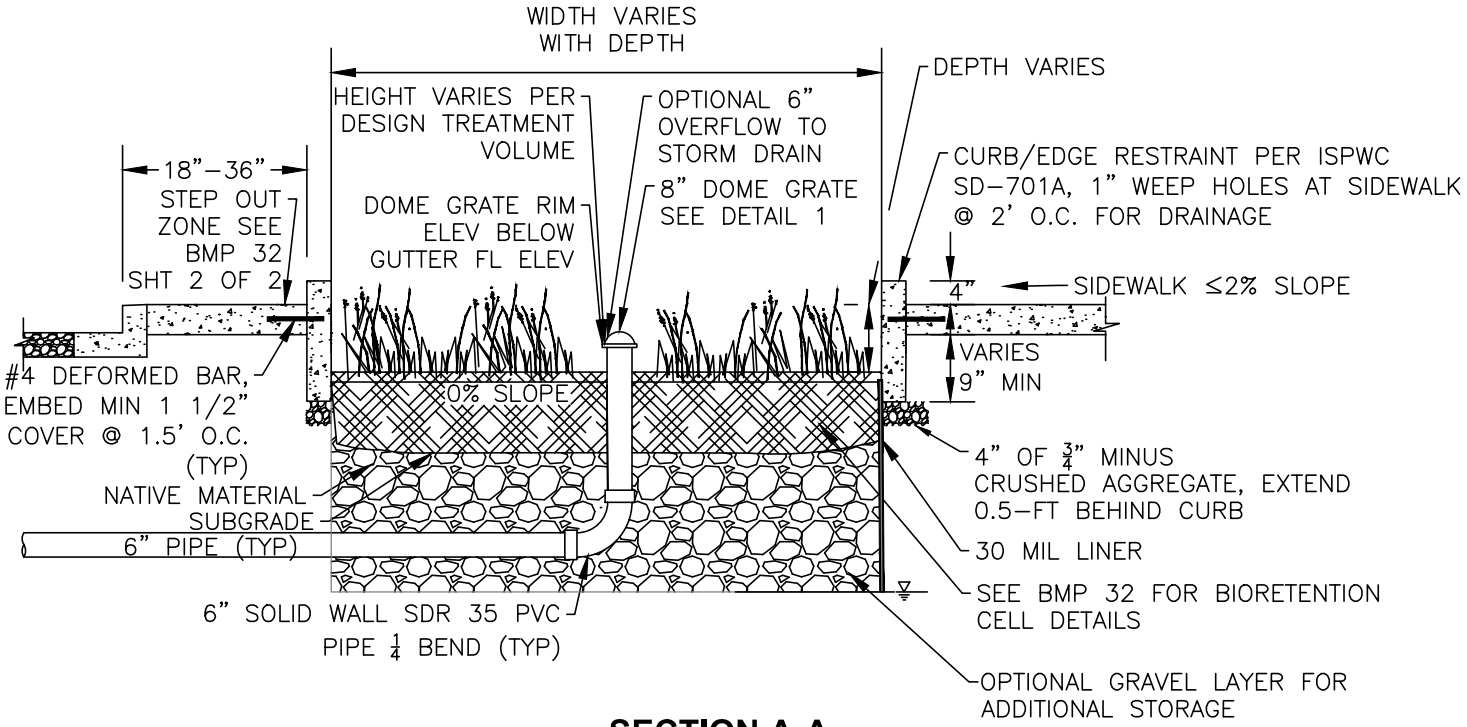
Planters are flat facilities that shall not slope more than 0.5 percent in any direction. A minimum of two inches of freeboard (vertical distance between the design water surface elevation and overtopping elevation) shall be provided.

When the sidewalk drains to the planter, provide 4”-6” wide notch openings in wall, 1: below sidewalk sloping to the facility.

Provide minimum 2” cover between notch and structural dowels in curbs/walls.



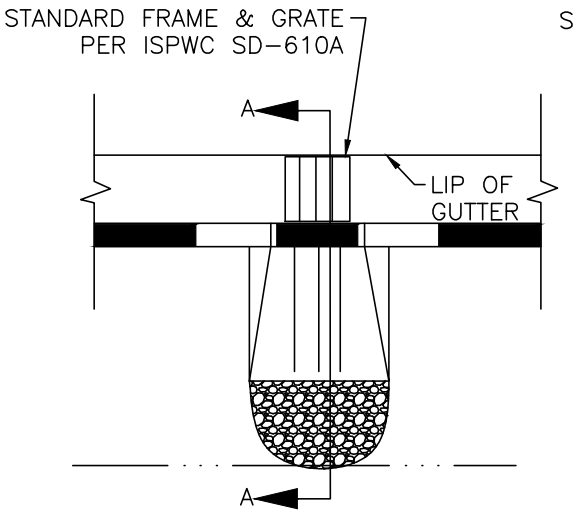
PLAN
N.T.S.



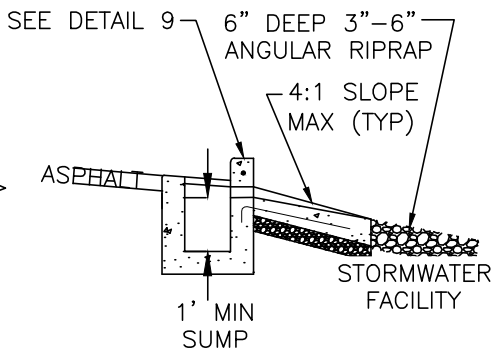
SECTION A-A
N.T.S.

NOTES:
1. SEE NOTES ON BMP 30, SHEET 2 OF 3
2. IRRIGATION TO BE DESIGNED FOR SPECIFIC APPLICATION

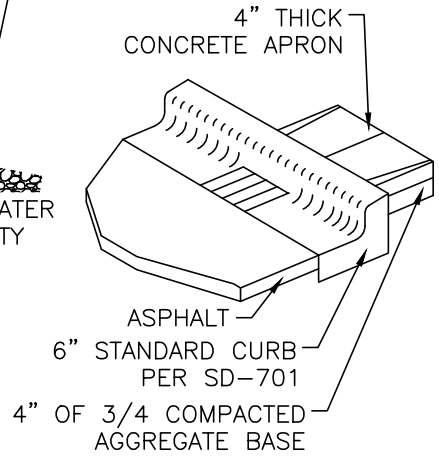
2015 ACHD STORMWATER DESIGN GUIDELINES	BIORETENTION PLANTER	STANDARD DRAWING BMP 31 SHEET 1 OF 2



PLAN
N.T.S.

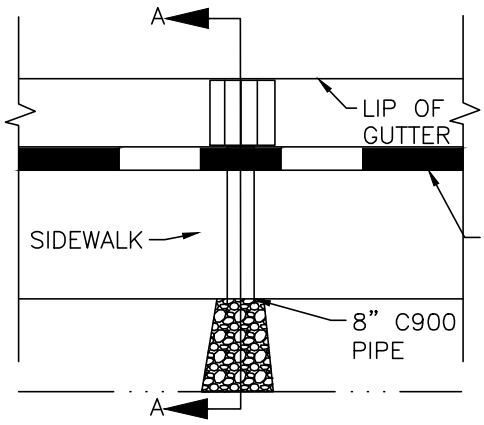


SECTION A-A
N.T.S.

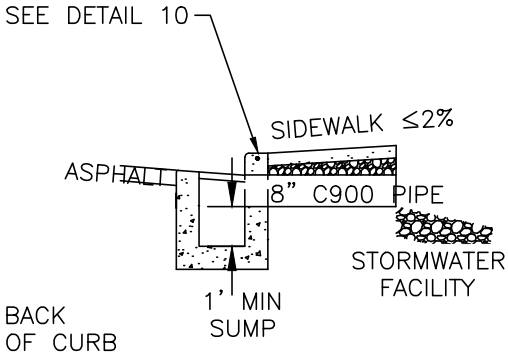


PERSPECTIVE VIEW
N.T.S.

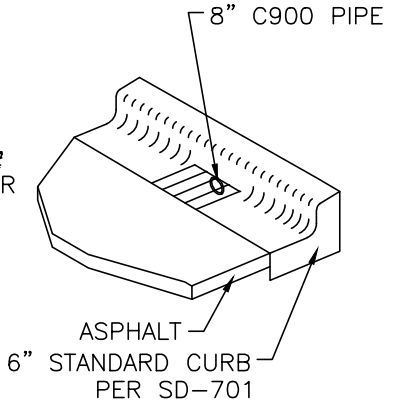
SHALLOW INLET TO BIORETENTION SWALE, DETACHED SIDEWALK



PLAN
N.T.S.



SECTION A-A
N.T.S.



PERSPECTIVE VIEW
N.T.S.

SHALLOW INLET TO BIORETENTION, ATTACHED SIDEWALK

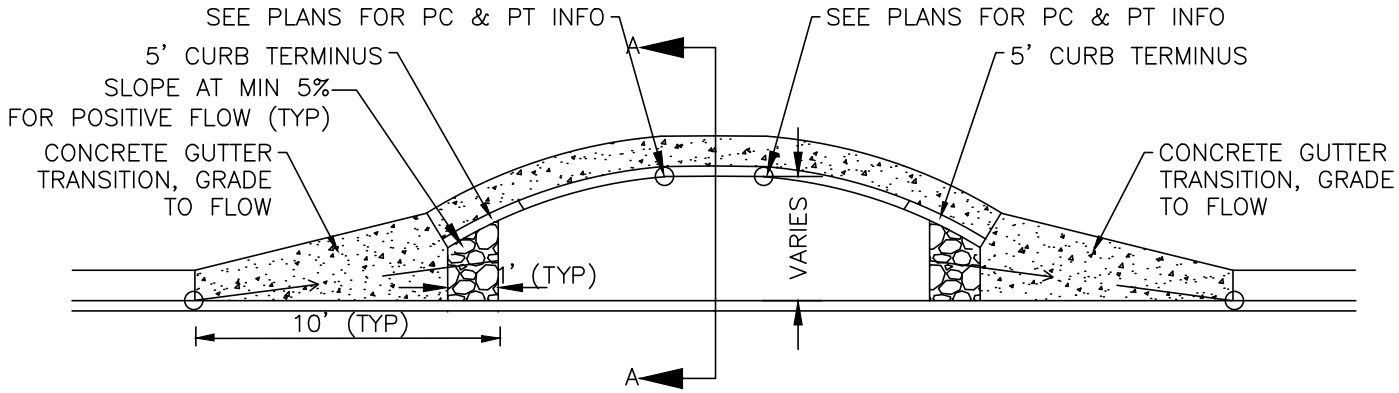
NOTES:
1. SEE NOTES ON BMP 32, SHEET 2 OF 2

2015 ACHD STORMWATER DESIGN GUIDELINES	BIORETENTION INLET OPTIONS	STANDARD DRAWING BMP 31 SHEET 2 OF 2

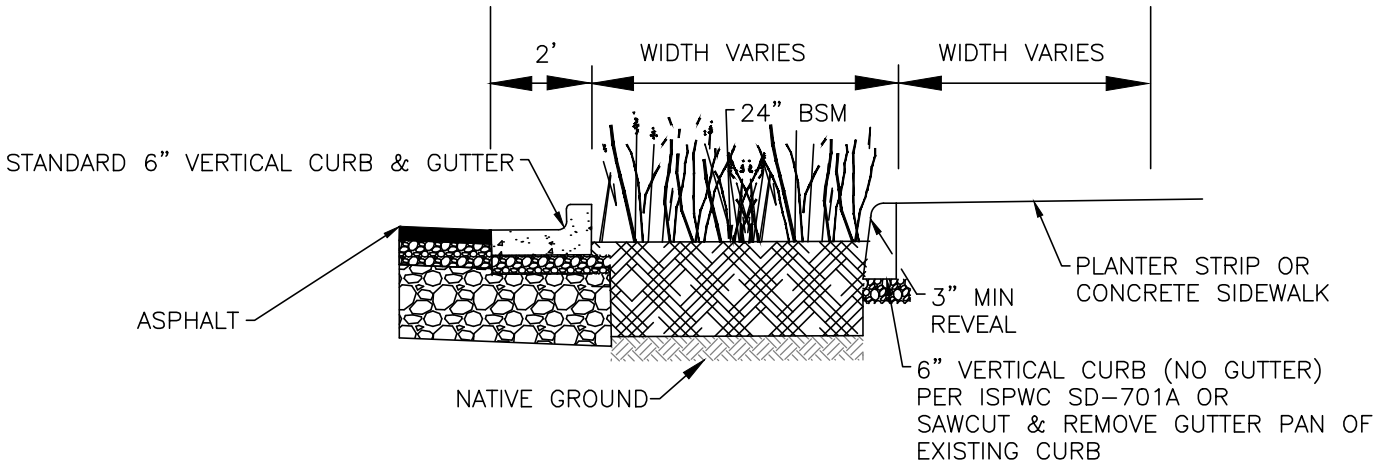
8202.28 BMP 32 Bioretention Curb Extension (Treatment & Storage)

Description

Stormwater curb extensions, also called vegetated curb extensions, are landscaped areas within the parking zone of a street that capture stormwater runoff in a depressed planting bed. The landscaped area can be designed similar to a swale, utilizing infiltration and evapotranspiration for stormwater management. Vegetated curb extensions can be used at a roadway intersection, midblock, or along the length or block of the roadway, and can be combined with pedestrian crosswalks to increase safety along a roadway. Additionally, vegetated curb extensions provide traffic calming opportunities along with stormwater management opportunities.



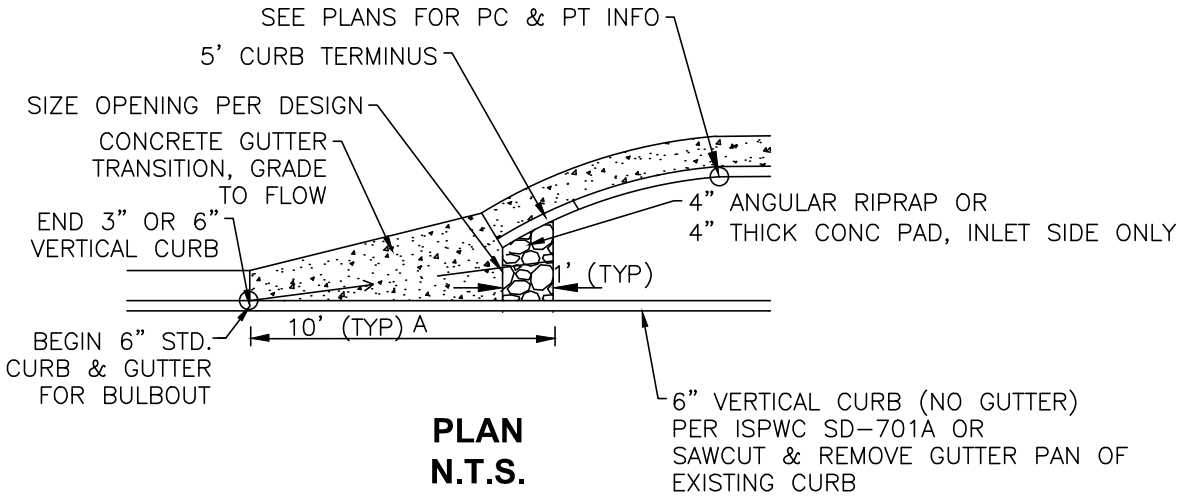
PLAN
N.T.S.



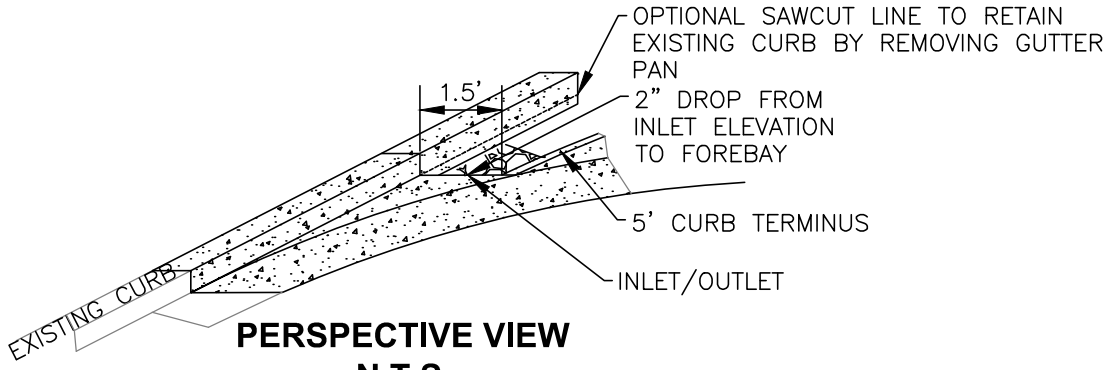
SECTION A-A
N.T.S.

NOTES:
1. SEE NOTES ON SHEET 2 OF 2

2015 ACHD STORMWATER DESIGN GUIDELINES	BIORETENTION CURB EXTENSION	STANDARD DRAWING BMP 32 SHEET 1 OF 2



PLAN
N.T.S.



PERSPECTIVE VIEW
N.T.S.

NOTES:

1. SEE SPECIFICATIONS FOR BIORETENTION SOIL MEDIA (BSM)
2. DROUGHT TOLERANT PLANT SPECIES OR WASHED TURF GRASS OVER BSM
3. DEPTH OF INFILTRATION SUMP AS SHOWN ON DESIGN PLANS SHOULD BE SIZED TO ADDRESS STORMWATER MANAGEMENT REQUIREMENTS
4. INFILTRATION RATE OF NATIVE SOILS AT SUBGRADE SHALL BE MIN 0.5 IN/HR
5. BIORETENTION CELLS ALLOW PLACEMENT OF AN AGGREGATE SUBBASE FOR ADDITIONAL VOLUMETRIC STORAGE IF NEEDED.
6. SCARIFY SUBGRADE 3" MINIMUM BEFORE INSTALLATION

2015 ACHD STORMWATER DESIGN GUIDELINES	BIORETENTION CURB EXTENSION	STANDARD DRAWING BMP 32 SHEET 2 OF 2

8202.29 BMP 33 Stormwater Tree Cells

Description

This BMP is approved for treatment and storage. Soil cells are a pre-engineered modular structural system designed to be filled with a soil mix for tree rooting and support of vehicle loaded pavements. Each soil cell or stack of soil cells shall be structurally independent of all adjacent soil cell stacks such that a single stack or group of stacks can be removed after the completion of installation to facilitate future utility installation and repair.

The structural design of each soil cell unit shall facilitate the movement of roots and water between each cell and between the edges of the cell system and the surrounding soils. The design shall facilitate the installation, compaction and in-situ soil compaction testing; installation and maintenance of utilities within and under the soil cells; the movement and expansion of roots; and the lateral capillary movement of water.

Design

The structural system shall be designed to be filled with a soil mix for tree rooting and support of vehicle loaded pavements meeting the following requirements:

- The structure shall be designed to support loads up to and including AASHTO H-20 when used in conjunction with approved pavement profiles.
- Each cell stack shall be structurally independent of all adjacent stacks such that the cell layout can achieve maximum layout flexibility.
- The structural openings must allow all of the soil to be checked for compaction and complete filling of all cell areas.
- The soil cell deck shall be perforated to allow the free flow of water through the deck.
- The soil cells shall have been specifically designed and tested for the purpose of growing tree roots, and rainwater filtering, detention and retention.
- The soil cells shall permit the structure to be built around, over, under and through existing and proposed utilities.

For each type of product, submit manufacturer's product literature with technical data sufficient to demonstrate that the product meets these specifications including:

- Manufacturer's certified analysis for standard products
- Soil cell manufacturer's letter of review and approval of the project, plans, details and specifications for compliance with product installation requirements.

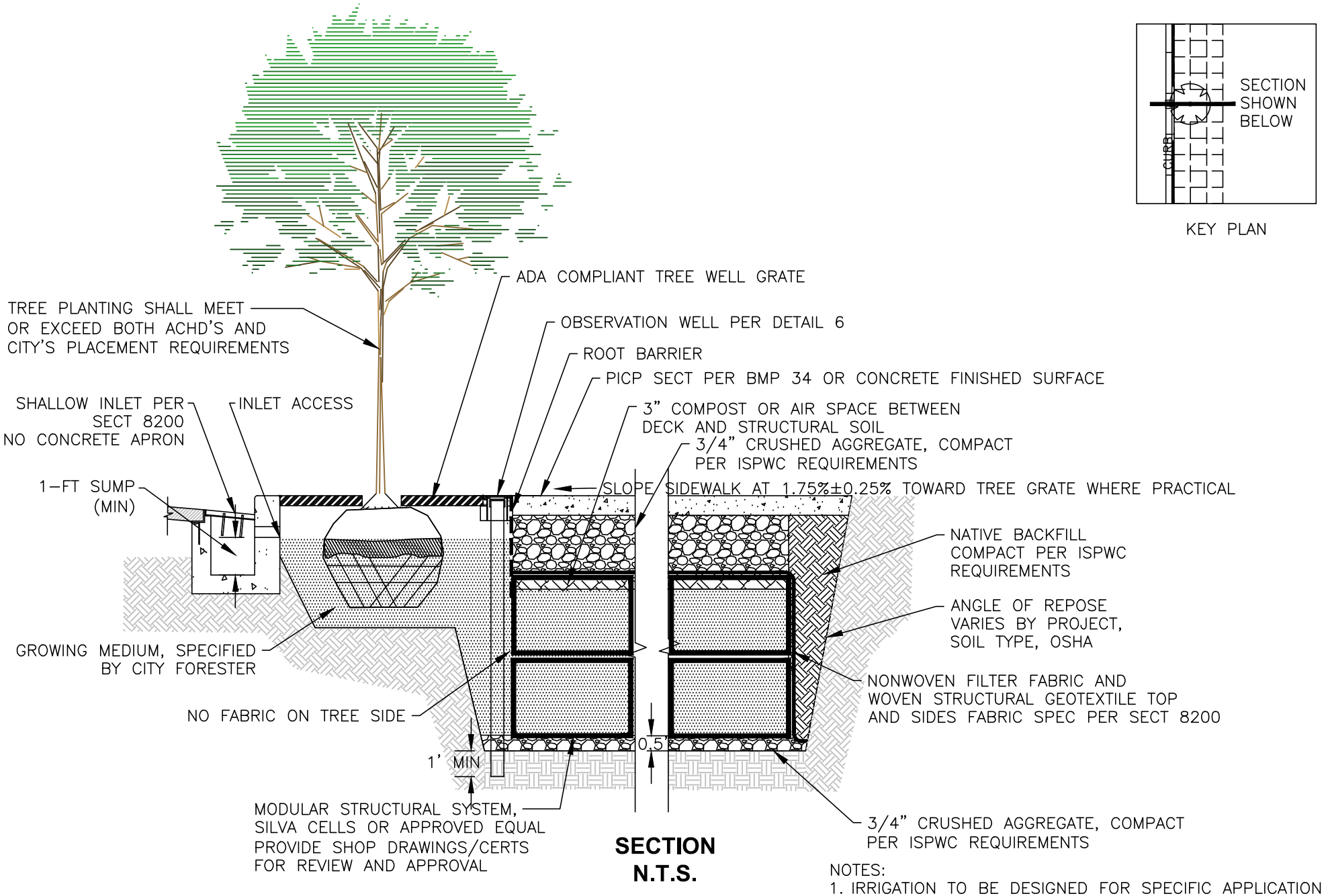
Soil cells and related products shall be installed by a qualified installer whose work has resulted in successful installation of planting soils and planter drainage systems, underground piping, chambers and vault structures.

Installer is required to maintain an experienced full-time supervisor on project site when work is in progress. Installer will be required to take part in a half-day training session provided by the manufacturer. Training session to be attended by all foremen and key personnel involved in installation.

Refer to manufacturer’s instructions for installation of soils cells, planting soil, geo-grid and backfill.

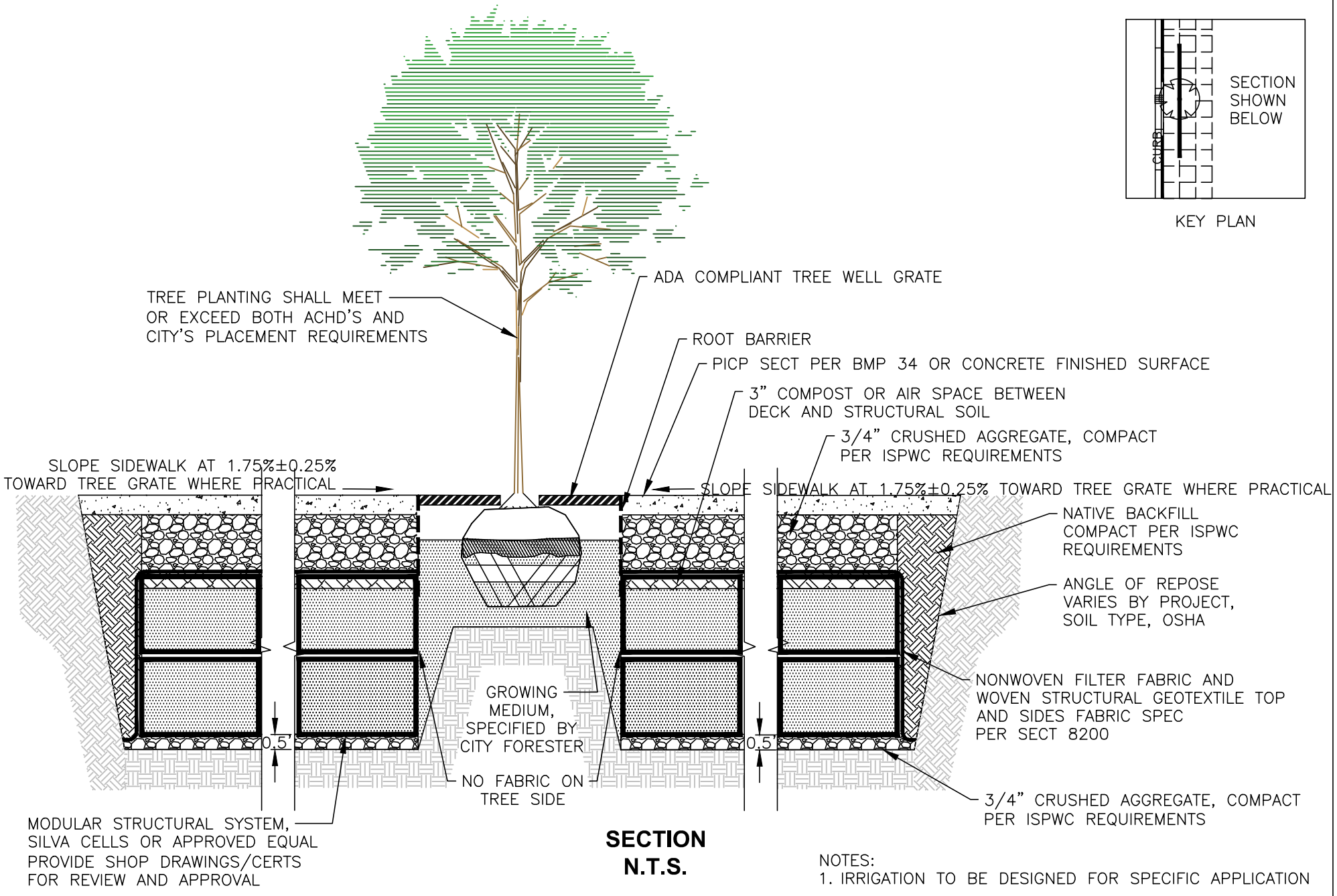
Where needed and approved, utility lines may be installed through the spaces within the soil cell frames.

An observation well shall be provided as an inspection riser for drainage. Install a minimum of one inspection riser for each four trees above the soil cells.



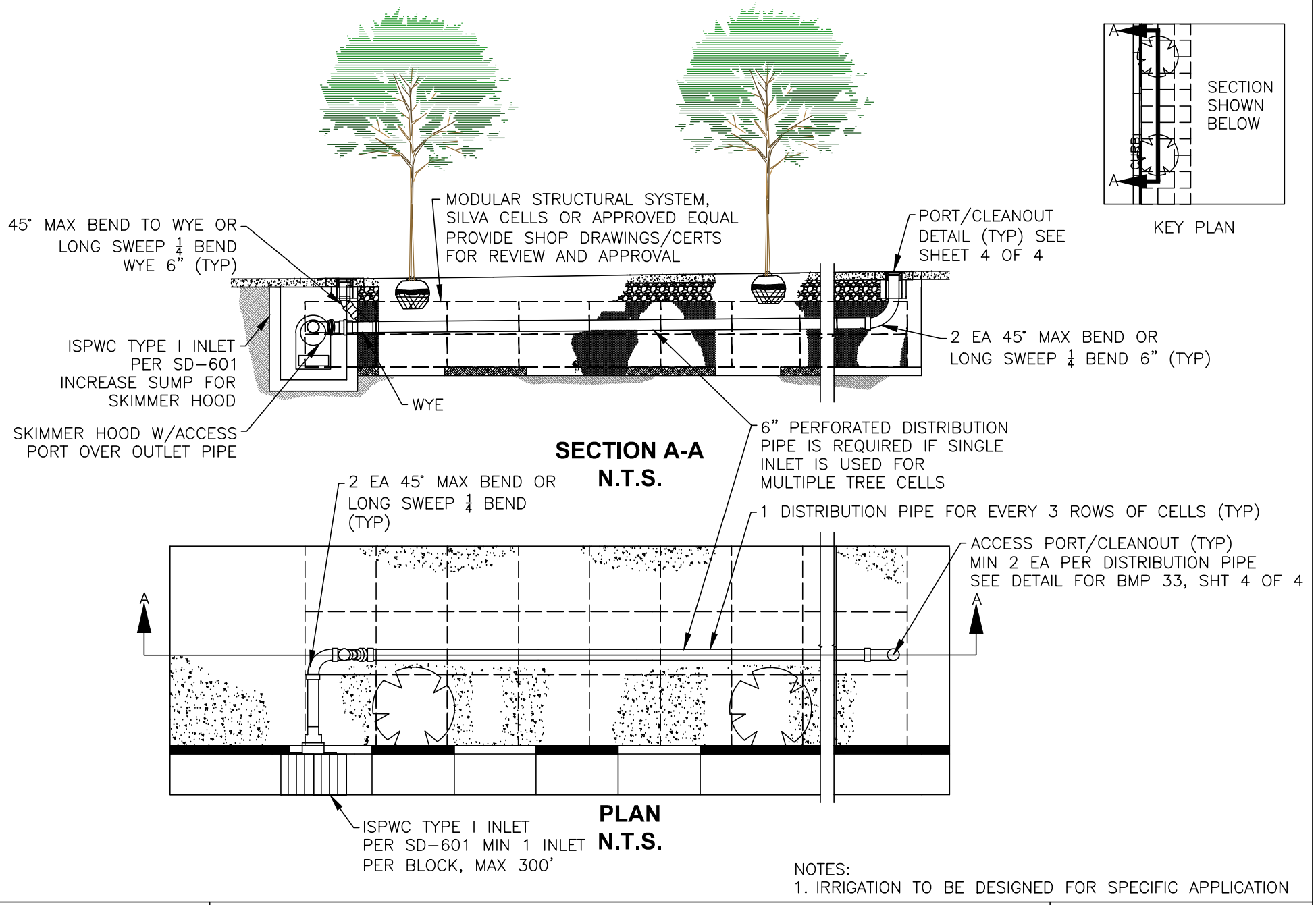
NOTES:
1. IRRIGATION TO BE DESIGNED FOR SPECIFIC APPLICATION

2015 ACHD STORMWATER DESIGN GUIDELINES	TREE STORMWATER CELLS	STANDARD DRAWING BMP 33 SHEET 1 OF 4



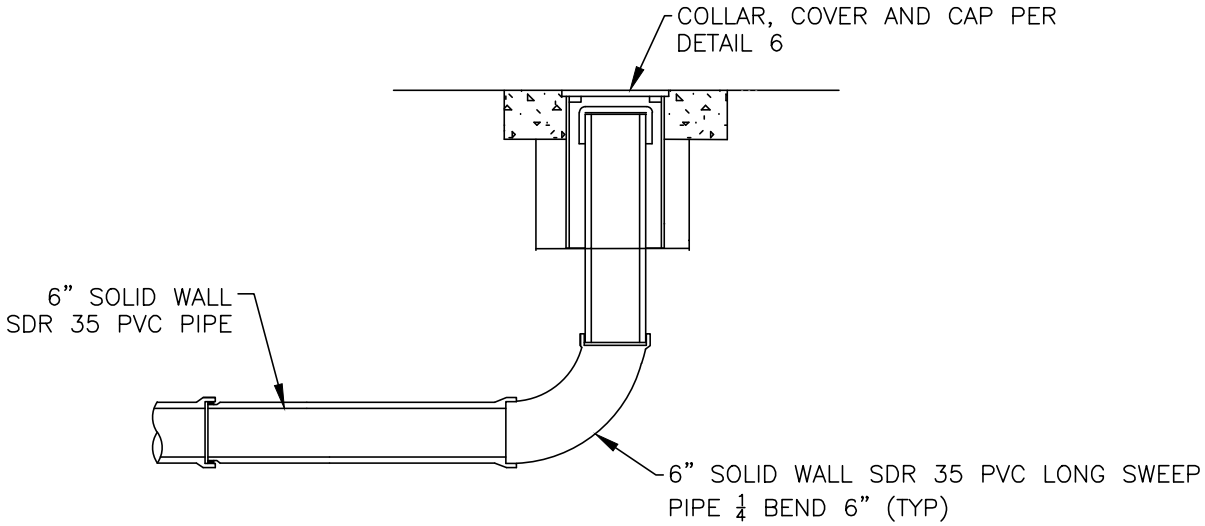
SECTION
N.T.S.

NOTES:
1. IRRIGATION TO BE DESIGNED FOR SPECIFIC APPLICATION

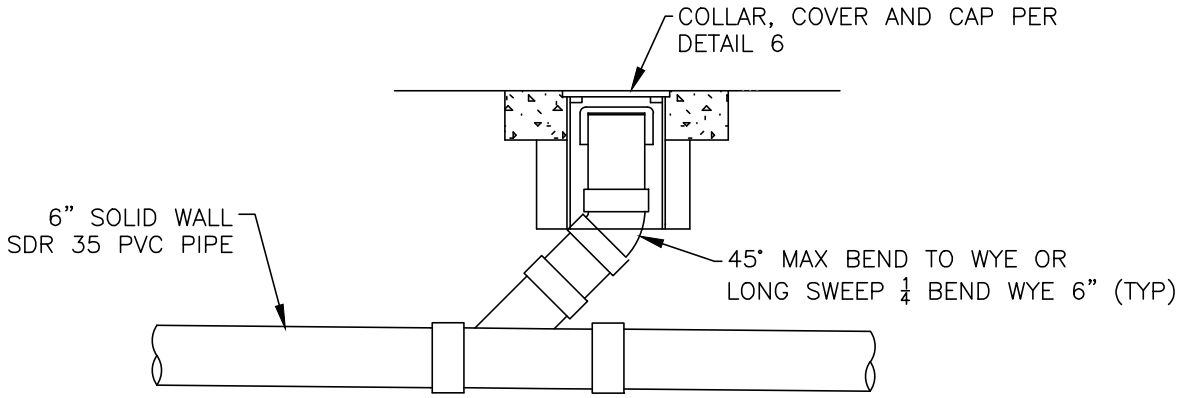


NOTES:
1. IRRIGATION TO BE DESIGNED FOR SPECIFIC APPLICATION

2015 ACHD STORMWATER DESIGN GUIDELINES	TREE STORMWATER CELLS	STANDARD DRAWING BMP 33 SHEET 3 OF 4



INSPECTION PORT/CLEANOUT DETAIL
END OF PIPE



INSPECTION PORT/CLEANOUT DETAIL
AT WYE

8202.30 BMP 34 Permeable Pavers (Treatment & Storage)

Description

This BMP is approved for treatment and storage. Permeable Interlocking Concrete Pavements (PICP) provide an alternative to conventional pavement systems in lower-speed vehicle areas that permit stormwater to infiltrate between precast concrete pavers for temporary storage, infiltration into subsurface soils, or discharge to another location once stormwater passes through the pavement structure. PICPs are the only permeable pavement systems currently approved for use. PICPs can be used in parking lanes and and alleys in commercial areas. All other applications require prior approval from ACHD staff.

Concrete Block Pavers

1. The surfacing materials for pedestrian and vehicular uses shall consist of concrete paving units that conform to ASTM C936 including an average 8,000 psi compressive strength.
2. Pavers shall be designed to allow joint spaces between blocks of 5% to 15 % of the total pavement surface.

Subgrade

PICP subgrade shall be tested and approved by a qualified geotechnical engineer. Properties and conditions to be evaluated include but are not limited to:

1. Soil classification as per ASTM D2487
2. Soil subgrade strength
3. Infiltration rate (permeability testing as per ASTM D3385)

Aggregates

1. PICP aggregate shall be crushed with 90% fractured faces and a minimum Los Angeles Abrasion factor of less than 40 per ASTM C131 and C535.
2. Gap aggregate shall conform to ASTM sizes No. 8, 89 or 9 stone.
3. Open graded bedding course (2 inch minimum thickness) shall conform to ASTM No. 8 stone.
4. Open graded base reservoir (4 inch minimum thickness) shall conform to ASTM No. 57 stone (1 to 1.5 inch crushed stone).
5. Open graded subbase reservoir shall conform to ASTM No. 2,3, or 4 stone (2 to 3 inch)
6. Aggregate base materials shall be used.

General Design Criteria

1. PICP shall be designed by a registered professional.
2. All Section 8000 Infiltration Requirements apply.
3. A survey shall be submitted showing calculations of the exact dimensions of all existing impervious surfaces and of the project site before and after completion of the project.
4. One-hundred (100) percent of the total area covered by PICP shall be considered a pervious or permeable surface.
5. PICP surfaces shall have a slope between 0.5% to 6%.
6. PICP should not be used if located next to ground slopes in excess of 20%.

7. The surface of the soil subgrade shall have a slope of less than or equal to 0.5%. Terraces and baffles may be installed to achieve flat subgrades under sloping pavement surfaces.
8. PICP section design will be governed by the deepest section required for either structural performance or stormwater capacity.
9. Structural design method shall be in conformance to the AASHTO Flexible Pavement Design Method or ASCE Standard 58-10 / Structural Design of Interlocking Concrete Pavement for Municipal Streets and Roadways.
10. Void ratio for base aggregates is 0.4 (40% void space). For design purposes, only the base and subbase courses can be used as storage volume.
11. Subgrade surface shall drain within 48 hours (for single storm events).
12. All manufacturer requirements, product standards, and industry guidelines shall be followed to ensure lasting effectiveness of PICP systems.
13. For Type B, C, and D soils, the surface of the soil subgrade under infiltrating permeable pavement should be scarified, ripped, or trenched immediately prior to aggregate base placement to maintain the pre-construction subgrade infiltration rate.
14. Permeable pavement systems designed for infiltration shall treat the design storm. Permeable pavement systems designed for detention shall be designed to meet runoff reduction requirements and provide safe conveyance for storms of larger magnitude.
15. Permeable pavement may be designed to receive runoff from adjacent built upon areas (BUAs) such as roofs and conventional pavement (if the soils under the permeable pavement have adequate capacity to infiltrate the additional runoff). The design shall provide storage for the entire runoff volume. In addition, there shall be a well-designed system to convey the runoff from the adjacent BUAs to the permeable pavement.
16. Runoff from concentrated flow, such as roof drains, must be discharged onto the top of the PICP surface. If possible, run on flows shall be dispersed (sheet flow conditions) prior to discharge to the PICP surface. Stormwater discharge directly into the PICP base materials is not permitted.
17. Maximum allowable run on (from adjacent impermeable surfaces to PICP surfaces) ratio is 3:1. Run on rates of up to 5:1 may be considered on a case by case basis.
18. Runoff from adjoining pervious areas, such as grassed slopes and landscaping shall be prevented by grading the landscape away from the permeable pavement.
19. Permeable pavement shall not be installed until the upslope and adjoining areas are stabilized. After installations, barriers shall be installed to prevent construction traffic from driving on the pavement.
20. The soil subgrade for the permeable pavement shall be graded when dry. The aggregate base and permeable surface course shall be completed as quickly as possible to reduce risk of soil subgrade compaction.
21. Permeable pavement may be placed on fill material as long as the material is at least as permeable as the in-situ soil after it is placed and prepared. Design shall be based upon the most restrictive soil.

22. A minimum of one observation well shall be provided at the low point in the system unless the subgrade is terraced; in that case, there shall be one well for each terrace.
23. Edge restraints shall be provided around the perimeter of permeable interlocking grid pavers as well as anywhere PICP is adjacent to conventional asphalt. Edge restraints shall consist of concrete curbing or a ribbon curb having a minimum width of one foot and a minimum depth of eight inches.

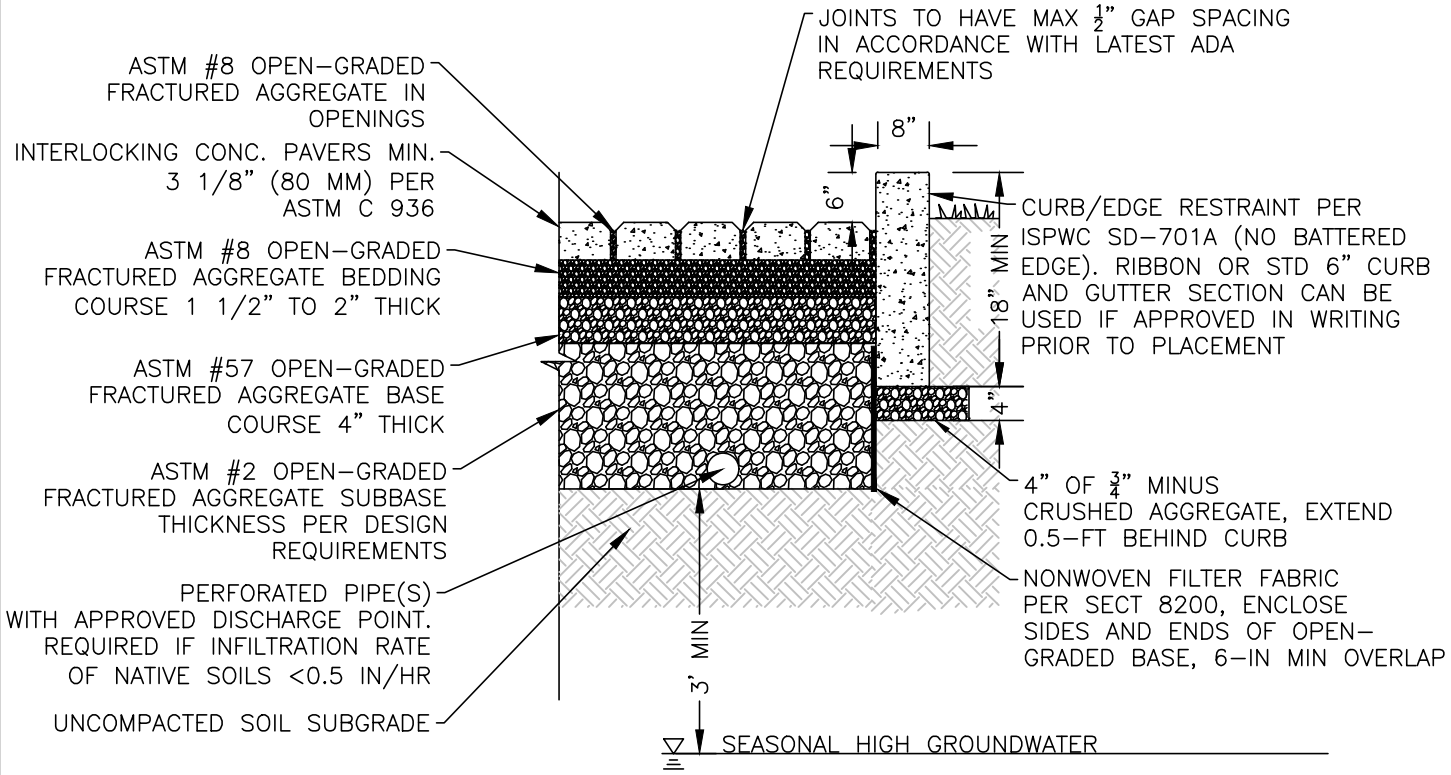
Installation Requirements

1. PICP systems shall be installed by a contractor that has an Interlocking Concrete Pavement Institute (ICPI) Concrete Paver Installation Certification. Documentation of certified installers shall be provided prior to approval of the drainage plan.
2. Certified installer shall be onsite to oversee each installation crew during all PICP construction.

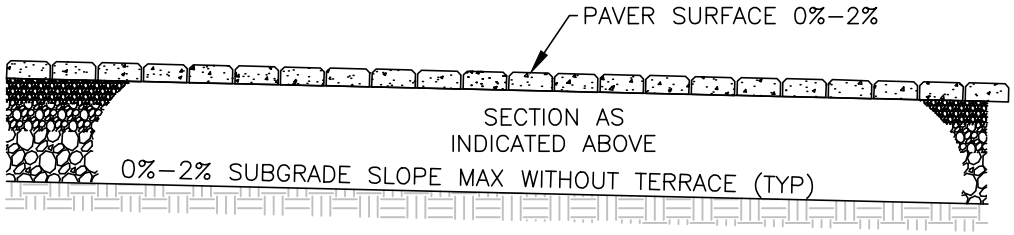
Operation and Maintenance

Sand and deicers shall not to be applied to PICP. For traction control, apply No. 8 aggregate when required.

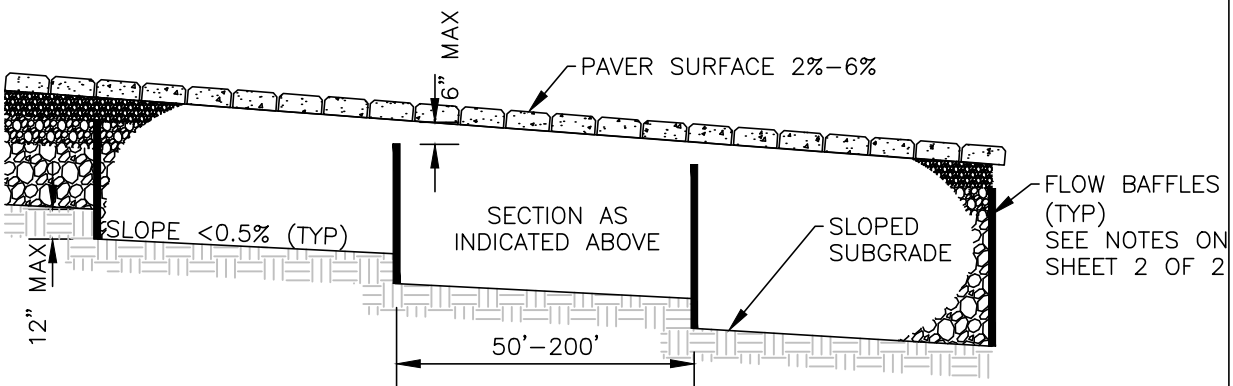
Permeable pavement signage shall be clearly and permanently posted to prevent use by inappropriate vehicles, and the deposition and storage of particulate matter.



SECTION
N.T.S.



SECTION: SURFACE SLOPE 0%–2%
N.T.S.



SECTION: SURFACE SLOPE 2%–6% TERRACE & BAFFLES
N.T.S.

2014 ACHD STORMWATER DESIGN GUIDELINES	PERMEABLE INTERLOCKING CONCRETE PAVERS (PICP)	STANDARD DRAWING NO. BMP 34 SHEET 1 OF 2

NOTES:

1. USE OF PERMEABLE INTERLOCKING CONCRETE PAVERS (PICP) IN PUBLIC STREETS IS NOT ALLOWED WITHOUT ACHD APPROVAL PRIOR TO DESIGN. AGREEMENT FOR PROTECTION AND MAINTENANCE OF PICP IS REQUIRED

2. INTERLOCKING CONCRETE PAVEMENT INSTITUTE (ICPI) CERTIFIED INSTALLER IS REQUIRED. INSTALLER TO PROVIDE CERTIFICATIONS PRIOR TO PLACEMENT

3. PICP SHALL MEET REQUIREMENTS OF ACHD SECTION 8010 INFILTRATION REQUIREMENTS

4. 0% CROSS SLOPE ON PAVER SURFACE AND SUBGRADE

5. SUBGRADE LONGITUDINAL SLOPE >2% REQUIRES TERRACING OR TERRACING WITH FLOW BAFFLES. SEE TERRACING DETAILS
   A. FLOW BAFFLES SHALL BE 30 MIL PVC POND LINER PER ACHD SECT 8200 OR 4" THICK CONCRETE

6. AGGREGATES SHALL MEET ASTM STANDARDS AND ICPI PERMEABLE INTERLOCKING CONCRETE PAVEMENT (PICP) MANUAL, CURRENT EDITIONS

7. A MINIMUM OF ONE OBSERVATION WELL IS REQUIRED AT THE LOW POINT. SEE ACHD SECTION 8200

8. PICP SECTION FOR SIDEWALKS IS THE SAME AS THE ROADWAY SECTIONS PROVIDED. CURB TYPE PER DESIGN PLANS. PICP IS NOT APPROVED FOR USE IN PEDESTRIAN CROSSWALKS.

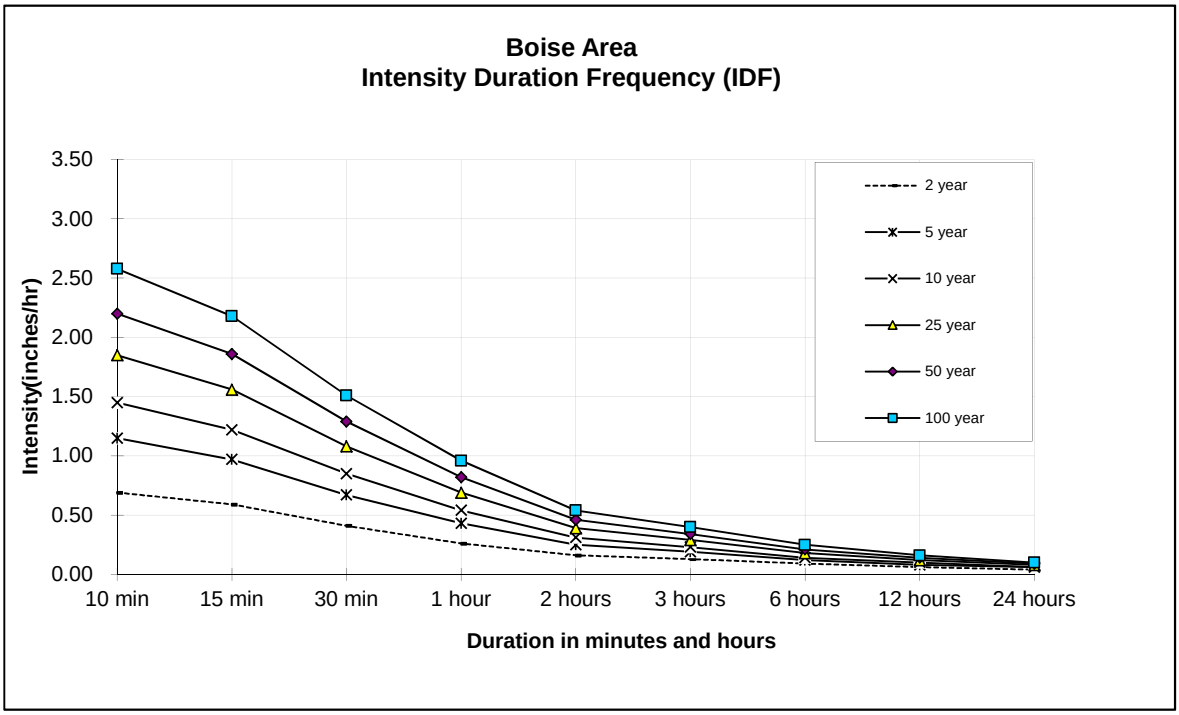
APPENDIX A

Ada County IDF Curve

Boise Area Intensity-Duration-Frequency (IDF)

Intensity (inches per hour)

	Design Storm	2	5	10	25	50	100
Tc (Hr)	Tc (Min)	==========					
0.17	10 min	0.69	1.15	1.45	1.85	2.20	2.58
0.25	15 min	0.59	0.97	1.22	1.56	1.86	2.18
0.33	20 min	0.49	0.81	1.01	1.30	1.54	1.81
0.42	25 min	0.43	0.71	0.89	1.14	1.35	1.58
0.50	30 min	0.41	0.67	0.85	1.08	1.29	1.51
0.58	35 min	0.34	0.56	0.70	0.90	1.07	1.25
0.67	40 min	0.31	0.51	0.64	0.82	0.98	1.15
0.75	45 min	0.29	0.48	0.60	0.77	0.91	1.07
0.83	50 min	0.27	0.45	0.56	0.72	0.85	1.00
0.92	55 min	0.26	0.43	0.54	0.69	0.82	0.96
1.00	1 hour	0.26	0.43	0.54	0.69	0.82	0.96
2.00	2 hours	0.16	0.25	0.31	0.39	0.46	0.54
3.00	3 hours	0.13	0.19	0.23	0.29	0.34	0.40
6.00	6 hours	0.09	0.12	0.14	0.18	0.21	0.25
12.00	12 hours	0.06	0.08	0.10	0.12	0.14	0.16
24.00	24 hours	0.04	0.06	0.06	0.08	0.09	0.10



APPENDIX B

Design Example

ACHD Calculation Sheet for Finding Peak Discharge/Volume - Rational Method

NOTE: This worksheet is intended to be a guideline to standardize ACHD checking of drainage calculations and shall not replace the Engineer's calculation methodology. These calculations shall establish a minimum requirement. The Engineer's methodology must result in facilities that meet or exceed these calculations in order to be accepted.

Steps for Peak Discharge Rate using the Rational Method calculated for post-development
Calculate Post-Development Flows (for pre-development flows, increase number of storage facilities to create new tab)
User input in yellow cells. To accept default value type = in yellow cell and point to computed cell

1 **Project Name** **Design Example, PRE**

2 Is area drainage basin map provided? **YES**
(map must be included with stormwater calculations)

3 Enter Design Storm For Volume (100-year per ACHD policy) **25**

4 Enter number of storage facilities (25 max)

Click to Show More Subbasins ☑

		Subbasin 1	Subbasin 2	Subbasin 3	Subbasin 4	Subbasin 5	Subbasin 6	Subbasin 7	Subbasin 8	Subbasin 9	Subbasin 10
5 Area of Drainage Subbasin (SF or Acres)	SF	43,560	21,780	43,560							
	Acres	2.50									
6 Determine the Weighted Runoff Coefficient (C)		0.20	0.20	0.20							
C=[(C1xA1)+(C2xA2)+(CnxAn)]/A	Weighted Avg	0.20									

7 Calculate Overland Flow Time of Concentration in Minutes (Tc) or use default 10 min — User Calculate: 10 Min.

8 Determine the average rainfall intensity (i) from IDF Curve based on	i	1.85		in/hr
9 Calculate the Post-Development peak discharge (QPeak)	Q_{peak}	0.93		cfs
10 Calculate total runoff vol (V) (for sizing primary storage)	V	1,242		ft^3
V = Ci (Tc=60)Ax3600				
11 Calculate Vrr (Volume of Runoff Reduction)				
Enter Percentile Storm (95th percentile = 0.60 in)		95th	0.60	in
Enter Runoff Reduction Vol (95th Percentile 0.60-in x Area)	V_{rr}	1,242		ft^3
12 Detention: Approved Discharge Rate to Surface Waters (if applicable)				cfs
13 Volume Summary				
Surface Storage: Pond				
WQ Pond Forebay (2-Year Storm)	V	468		ft^3
Primary Treatment/Storage Basin	V	774		ft^3
Subsurface Storage: Seepage Bed				
Volume Without Sediment Factor	V	1,242		ft^3
See BMP04 Seepage Bed for Design Volume With Sediment				

Estimated Runoff Coefficients for Various Surfaces

Type of Surface	Runoff Coefficients "C"			
Business				
Downtown areas	0.70 - 0.95			
Urban neighborhood areas	0.50 - 0.70			
Residential				
Single-family	0.35 - 0.50			
Multi-family	0.60 - 0.75			
Residential (rural)	0.25 - 0.40			
Apartment dwelling areas	0.70			
Industrial and Commercial				
Light areas	0.80			
Heavy areas	0.90			
Parks, cemeteries	0.10 - 0.25			
Playgrounds	0.20 - 0.35			
Railroad yard areas	0.20 - 0.40			
Unimproved areas	0.10 - 0.30			
Streets				
Asphalt	0.95			
Concrete	0.95			
Brick	0.85			
Roofs	0.95			
Fields: Sandy soil	Soil Type			
Slope	A	B	C	D
Flat 0-2%	0.04	0.07	0.11	0.15
Average 2-6%	0.09	0.12	0.15	0.20
Steep >6%	0.13	0.18	0.23	0.28

Adapted from ASCE

APPENDIX C

Infiltration Testing Methods

A. In-Situ Small-Scale Pilot Infiltration Test Method

Small-scale Pilot Infiltration Tests (PITs) shall be used for measuring the saturated hydraulic conductivity of the soil profile beneath facilities in areas with homogeneous soils where the required separation distance from groundwater and bedrock can be achieved.

1. Test Procedure

The test method is the following:

a. Excavate the test pit to the estimated infiltration elevation of the proposed facility.

b. The horizontal surface area of the bottom of the test pit should be twelve to thirty-two (12-32 SF) square feet. The pit may be circular or rectangular, but accurately document the size and geometry of the test pit.

c. Install a vertical measuring rod adequate to measure the full ponded water depth and marked in half-inch increments in the center of the pit bottom.

d. Use a rigid pipe with a splash plate on the bottom to convey water to the pit and reduce side-wall erosion or excessive disturbance of the infiltration surface. Excessive erosion and bottom disturbance will result in clogging of the infiltration receptor and yield lower than actual infiltration rates

e. Pre-soak period: add water to the pit so there is standing water for at least six (6) hours. Maintain the pre-soak water level at least twelve (12”) inches above the bottom of the pit.

f. At the end of the pre-soak period, add water to the pit at a rate that will maintain a six to twelve (6- 12”) inch water level above the bottom of the pit over a full hour. The specific depth should be the same as the maximum designed ponding depth.

g. Every fifteen (15) minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point on the measuring rod.

h. After one (1) hour, turn off the water and record the rate of infiltration in inches per hour from the measuring rod data until the pit is empty.

i. At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by an Idaho registered geologist, professional engineer, or professional soil scientist with experience in hydrogeologic investigations.

2. Data Analysis

a. Calculate and record the saturated hydraulic conductivity in inches per hour in thirty (30) minute or one (1) hour increments until one (1) hour after the flow has stabilized.

b. Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.

c. Apply appropriate factor of safety (FOS) to determine the site-specific design infiltration rate with a minimum FOS of two (2).

B. In-Situ Large-Scale Pilot Infiltration Test (PIT) method

Large-scale in-situ PITs shall be used for measuring the saturated hydraulic conductivity of the soil profile beneath facilities in areas where conditions are not uniform.

1. Test Procedure

The test method is the following:

a. Excavate the test pit to the estimated elevation of the proposed infiltration surface. Lay back the slopes sufficiently to avoid caving and erosion during the test.

b. The horizontal surface area of the bottom of the test pit should be at least one-half (1/2) the size of the proposed facility. Accurately document the size and geometry of the test pit.

c. Install a vertical measuring rod in the center of the pit bottom.

d. Use a rigid six (6”) inch diameter pipe with a splash plate on the bottom to convey water to the pit and reduce side wall erosion or excessive disturbance of the pond bottom.

e. Add water to the pit at a rate that will maintain a water level between six and twelve (6 and -12”) inches above the bottom of the pit.

f. Every fifteen to thirty (15-30) minutes, record the cumulative volume and instantaneous flow rate in gallons per minute necessary to maintain the water level at the same point on the measuring rod.

g. Keep adding water to the pit until one (1) hour after the flow rate into the pit has stabilized while maintaining the same water level. A stabilized flow rate should have a variation of five (5%) percent or less in the total flow. The total of the pre-soak time plus the one (1) hour after the flow rate has stabilized should be no less than six (6) hours.

h. After the flow rate has stabilized for at least one (1) hour, turn off the water and record the rate of infiltration in inches per hour per hour from the measuring rod data, until the pit is empty. Consider running this falling head phase of the test several times to estimate the dependency of infiltration rate with head.

i. At the conclusion of testing, over-excavate the pit to see if the test water is mounded on shallow restrictive layers or if it has continued to flow deep into the subsurface. The depth of excavation varies depending on soil type and depth to hydraulic restricting layer, and is determined by an Idaho registered geologist, professional engineer, or professional soil scientist with experience in hydrogeologic investigations. Mounding is an indication that a mounding analysis is necessary.

2. Data Analysis:

a. Calculate and record the saturated hydraulic conductivity in inches per hour in thirty (30) minutes or one (1) hour increments until one (1) hour after the flow has stabilized.

b. Use statistical/trend analysis to obtain the hourly flow rate when the flow stabilizes. This would be the lowest hourly flow rate.

c. Apply appropriate factor of safety (FOS) to determine the site-specific design infiltration rate with a minimum FOS of two (2).

C. Basin Flooding Tests

Basin flooding tests shall be used to establish the permeability rates of bedrock beneath facilities in accordance to the procedures below.

1. Test Procedure

The test method is the following:

a. A test basin meeting the following requirements shall be excavated within or immediately adjacent to the area of concern.

b. The bottom area of the basin shall be the same size as the proposed facility infiltration area.

c. The bottom of the basin should be made as level as possible so that high areas of rock do not project above the water level when the basin is flooded as prescribed below.

d. If groundwater is observed within the test basin, the basin flooding test shall not be used.

e. The test area shall be protected with non-woven filter fabric and one (1) foot of clean sand.

f. Fill the test basin with exactly 12 inches of water above the top of the sand and record the time. Allow the basin to drain completely below the top of the sand. If the time required for the basin to drain completely is greater than 24 hours, the test shall be terminated and the limiting zone in question shall be considered to be a massive rock substratum.

g. If the basin drains completely within 24 hours after the first flooding, immediately refill the basin to a depth of 12 inches above the top of the sand

and record the time. If the basin drains completely within 24 hours of the second filling, the limiting zone in question shall be considered to be fractured rock substratum. If water remains in the basin after 24 hours the limiting zone in question shall be considered to be a massive rock substratum.

2. Permeability Rate Determination

A design permeability rate shall only be used if the basin drains completely within 12 hours while performing 1.g. described above.

D. Other Allowable Methods

Other in-situ methods have been developed for determining field saturated hydraulic conductivity within the unsaturated zone of the soil. The following allowable methods may be used at the discretion of an Idaho registered geologist, professional engineer, or professional soil scientist provided they are appropriate for the site conditions.

- Double Ring Infiltrometer Test (ASTM D3385-03)
- Single Ring Infiltrometer Test (ASTM 3385-09)
- Well Permeameter Method (USBR Procedure 7300-89)
- Encased Borehole Test (ASTM D6391)

APPENDIX D

Operations & Maintenance Plan

Stormwater Facility
Operation and Maintenance (O&M) Plan

1) Packaging and Format of Plan

a. Packaging – Plans shall be submitted as a bound hard copy and electronically in pdf format.
b. Format – The Plan shall consist of the following:
   i. Cover page – Project Title, Project Number, Date, Author and Signature
   ii. Table of Contents
   iii. Introduction
   iv. Detailed Facility Description
   v. Detailed Facility Maintenance and Operation Description
   vi. Maintenance Schedule Table
   vii. Attachment 1 – copy of construction plans
   viii. Attachment 2 – copy of signed license agreement, if applicable

2) Introduction

a. Purpose of plan
b. General site description
c. Site map with north arrow, scale; site buildings, facilities, roads, etc. should be labeled

3) Detailed Facility Description

a. Discussion of how facility is supposed to work
b. Include detailed drawings of the facility which clearly denotes points of inflow and outflow, locations where maintenance is performed, etc.
c. If facility is a manufactured structure, include manufacturers product information as an attachment

4) Detailed description of the maintenance activities that need to be done. For each activity the following should be included:

a. Name of maintenance activity
b. Description of how and where activity is to be performed
c. Discussion of who will perform activity e.g. HOA, in-house staff, contracted third party, etc
d. Interval of maintenance e.g. weekly, monthly, etc.
e. Any other pertinent information

5) Maintenance Log

Date	Maintenance Activity	Performed By	Description of Facility Conditions	Amount and Type of Material Removed	Comments

APPENDIX E

Pond Inspection Checklist

Pond Location:				
	Inspection 1	Inspection 2	Inspection 3	Inspection 4
Date & Time:				
Site Status:				
Approx. Date & Amount of Last Rainfall:				
Inspector:				

Copy of this completed inspection checklist along with pictures to file.

Type of Pond: □Retention □Detention □Wet □Roadside Swale
Provide a copy of the O&M Plan with this checklist.
Note: This form may be used for 4 different inspections.

Maintenance Item	Pass / Fail				Comments
	1	2	3	4	
1. Irrigation (Daily)					**◄N/A if Not Applicable**
1. Control of nuisance water from lots and common areas to streets					
2. Control of watering within pond landscape					
2. Retention/Detention Ponds & Swales (Monthly, After Major Storms)					**◄N/A if Not Applicable**
1. Remove cobble or other non-draining material from over sand infiltration areas.					
2. Remove sediment accumulation from sand infiltration areas, rake/till sand for positive drainage					
3. Removal of litter and debris					
4. Low flow channels clear of obstructions					
5. Standing water or wet spots, source of water?					
3. Wet Ponds (Monthly, After Major Storms)					**◄N/A if Not Applicable**
1. Undesirable vegetative growth					
2. Floating or floatable debris removal required					

Maintenance Item	Pass / Fail				Comments
	1	2	3	4	
3. Visible pollution					
4. Shoreline problem					
5. Other (specify)					
4. Pond Sediment Forebays (Monthly, After Major Storms)					**◄N/A if Not Applicable**
1. Sedimentation noted					
2. Sediment cleanout when depth > 50% design depth					
5. Pond Basin (Annual, After Major Storms)					
1. Vegetation and ground cover adequate					
2. Weed control					
3. Unauthorized planting					
4. Slope protection/erosion					
5. Animal burrows					
6. Condition of overflow spillway (if applicable)					
7. Seeps/leaks					
8. Inlet pipe trash rack					
9. Endwalls / Headwalls					
10. Energy dissipation at inlet (riprap or concrete)					
11. Other (specify)					
6. Pond Riser and Principal Spillway Outfall (Annual)					**◄N/A if Not Applicable**
Type: □ Reinforced Concrete, □Corrugated pipe, □Other					
1. Low flow orifice obstructed					

Maintenance Item	Pass / Fail				Comments
	1	2	3	4	
2. Low flow trash rack.					
a. Debris removal necessary					
b. Corrosion control					
3. Weir trash rack maintenance					
a. Debris removal necessary					
b. Corrosion control					
4. Excessive sediment accumulation in or around riser					
5. Condition of riser and barrels					
a. Minor spalling (<1")					
b. Major spalling (rebars exposed)					
c. Joint failures					
d. Water tightness					
6. Outfall channels functioning					
7. Other (specify)					
7. Other (Monthly)					
1. Encroachment on pond or easement area					
2. Complaints from residents					
3. Aesthetics					
a. Grass growing required					
b. Other (specify)					
4. Any public hazards (specify)					

Maintenance Item	Pass / Fail				Comments
	1	2	3	4	
8. Constructed Wetland Area (Annual)					
1. Vegetation healthy and growing					
2. Evidence of invasive species					
3. Excessive sedimentation in Wetland area					
4. Other (specify)					

Comments:

APPENDIX F

Bioretention Soil Media Specifications

Bioretention Soil Media (BSM) Specifications

General Requirements

BSM should achieve a long-term, in-place infiltration rate between five (5) and eight (8) inches per hour.

The following composition includes the measurements for determining the BSM by volume:

BSM Composition	Sand	Sandy Loam			Compost
		Sand	Silt	Clay	
Volume	60%	20%			20%

A. Submittals

The Manufacturer shall submit a letter of verification that the products meet or exceed all requirements.

Tests shall be conducted no more than 120 days prior to the delivery date of the BSM to the project site. Batch-specific test results and certification will be required for projects installing more than 100 cubic yards of BSM.

The applicant should submit the following to ACHD for approval:

1. A one-gallon sample of mixed BSM.
2. Grain size analysis results of the sand component, sandy loam soil component and compost component performed in accordance with American Society for Testing and Materials (ASTM) D422, Standard Test Method for Particle Size Analysis of Soils.
3. Organic matter content test results of compost. Organic matter content tests should be performed in accordance with ASTM F 1647, Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes or Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, Loss-On-Ignition Organic Matter Method.
4. Constant head permeability results of the mixed BSM in accordance with ASTM D2434, Standard Test Method for Permeability of Granular Soils (Constant Head) conducted on a minimum of two samples with a 6-inch mold and vacuum saturation.
5. Provide the following information about the testing laboratory(ies) including:
    a. Name of laboratory(ies)
    b. Contact person(s)
    c. Address(es)
    d. Phone contact(s)
    e. Email address(es)
    f. Qualifications of laboratory(ies), including use of ASTM and U.S. Department of Agriculture(USDA) method of standards

B. Sand Specifications

Sand should be thoroughly washed prior to delivery and free of wood, waste, and coatings such as clay, stone dust, carbonate, or any other deleterious material. Sand for BSM should be analyzed by a qualified lab using #200, #100, #50, #30, #16, #8, #4, and 3/8-inch sieves (ASTM D422 or as approved by ACHD).

C. Sandy Loam Soil Specifications

Sandy loam soil for the BSM shall be tested for phosphorus content: 15-60 mg/kg P by Mehlich3.

Sandy loam soil should comply with the following specifications by weight based on ASTM D422:

- 70-90 percent sand
- 0–30 percent silt
- 2–15 percent clay

Note: these ranges were selected from the USDA soil textural classification for a sandy loam, such that clay content does not exceed 15 percent of sandy loam.

D. Compost Specifications

Compost should 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 from industrial wastewater or sewage sludge.

A qualified lab should analyze compost using No. 200 and 1/2-inch sieves (ASTM D422 or as approved by ACHD), and meet the following gradation:

Sieve Size	Percent Passing (by weight)	
	Min.	Max.
1/2 inch	100	100
No. 200	0	5

Compost should comply with the following requirements:

Parameter	Method	Requirement	Units
Bulk Density	-	1080 - 1400	dry lbs/cubic yd
Moisture Content	Gravimetric	35%–65%	dry solids
Organic Matter	ASTM F 1647 Standard Test Methods for Organic Matter Content of Athletic Field Rootzone Mixes or Testing Methods for the Examination of Compost and Composting (TMECC) 05.07A, "Loss-On-Ignition Organic Matter Method."	35%–65	dry weight

Inert Material/Physical Contaminants		<1%	Dry weight
pH	Saturation Paste	6.0–8.0	
Carbon:Nitrogen Ratio	-	15:1–35:1	
Maturity/Stability	TMECC05.05 or Solvita®*	> 5	Index value
Pathogens			
Salmonella	-	< 3	MPN per 4 g
Fecal Coliform		< 1000	MPN per 1 g

*Solvita is a measurement system for carbon dioxide (CO2) and ammonia (NH3). The results can be used to assess soil health (biology) and compost maturity (CO2+NH3 gas emissions).

E. BSM Specifications

BSM shall be free of roots, clods stones larger than 3-inches in the greatest dimension, pockets of coarse sand, noxious weeds, sticks, lumber, brush, and other litter. It shall not be infested with nematodes or undesirable disease-causing organisms such as insects and plant pathogens. BSM shall be friable and have sufficient structure in order to give good aeration to the soil.

Gradation Limit: The definition of the BSM should be the following USDA classification scheme by weight:

a. Sand: 85–90 percent
b. Silt: 10 percent maximum
c. Clay: 5 percent maximum

The final BSM should meet the following standards. Testing results from the following specifications shall be submitted for approval prior to BSM acceptance.

Parameter	Method	Requirement	Units
Organic Matter	Loss on Ignition	2%-5%	Dry weight
pH	Saturation Paste	6.0-8.0	
Cation Exchange Capacity (CEC)		≥ 5	meq/100 g of dry soil

F. BSM Testing

The Contractor shall not place any soils or soil mixes until the Inspector has reviewed and confirmed the following:

- Soil mix delivery ticket(s). Delivery tickets shall show that the full delivered amount of soil matches the product type, volume and Manufacturer named in the submittals.
- Visual match with submitted samples. Delivered product will be compared to the submitted sample, to verify that it matches the submitted sample.

The Inspector may inspect any loads of soil and stop placement if it is determined that the delivered soil does not appear to match the submittals; and

require sampling and testing of the delivered soil, before authorizing soil placement. All testing costs shall be the responsibility of the Contractor.

G. BSM Mixing and Placement

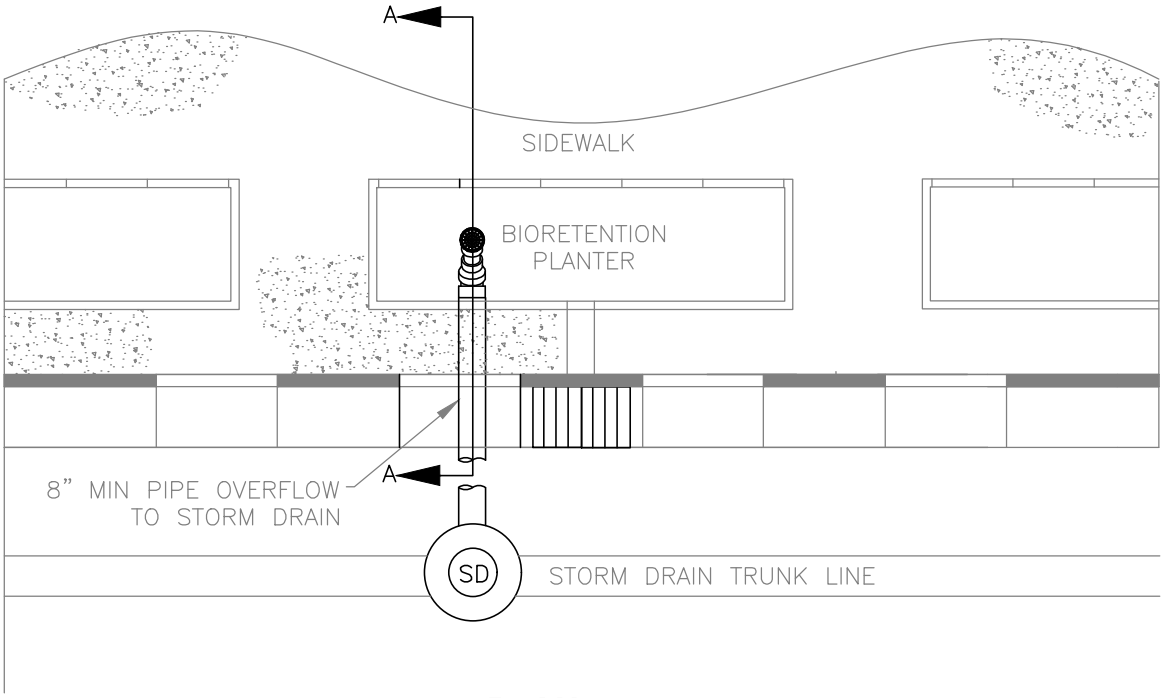
1. The following practices shall be followed to protect the long-term functionality of the facility:

    a. BSM should be mixed prior to being delivered to the site.
    b. Operate equipment adjacent to the facility. Equipment operation within the facility shall be avoided to prevent soil compaction. If machinery must operate in the facility, use lightweight, low ground-contact pressure equipment with turf type tires or wide-track loaders.
    c. Place soil in 6- to 12-inch lifts with machinery adjacent to the facility (to ensure equipment is not driven across soil). If working within the facility, to avoid over-compacting, place first lifts at far end from entrance and place backwards towards the entrance.
    d. Allow BSM lifts to settle naturally, lightly water to provide settlement and natural compaction between lifts. After lightly watering, allow soil to dry between lifts. After all lifts are placed, wait a few days to check for settlement, and add additional media as needed.
    e. Vehicular traffic and construction equipment shall not drive on, move onto, or disturb the BSM once placed and water-compacted.
    f. Rake bioretention soil as needed to level out. Verify BSM elevations before applying mulch or installing plants.

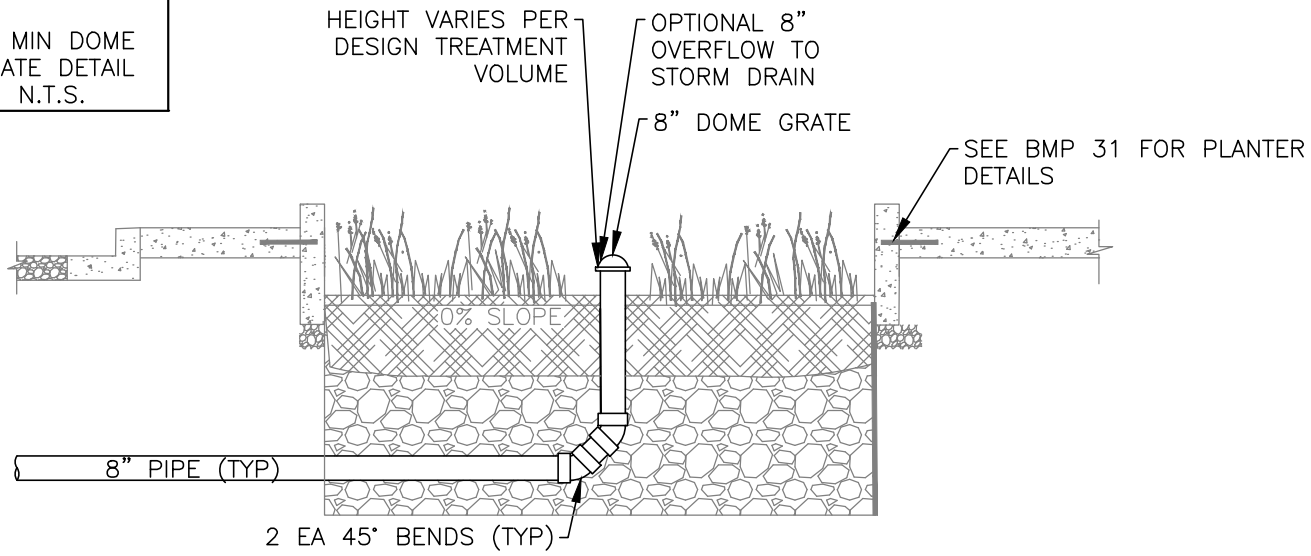
2. Facilities should not be used as temporary sediment control facilities, unless installation of all bioretention-related materials are withheld towards the end of construction, allowing the temporary use of the location as a sediment control facility, and appropriate excavation of sediment occurs prior to installation of bioretention materials.

APPENDIX G

Detail 1 Beehive Overflow
Detail 2 Inlet Protection Apron and Flow Spreader
Detail 3 Anti-Seep Collar
Detail 4 Flow Spreader for Ponds and Swales
Detail 5 Access Roads and Turnaround Detail
Detail 6 Groundwater Observation Well
Detail 7 Stormwater Pond Standards
Detail 8 Borrow Ditch
Detail 9 Shallow Inlet – Detached Walk
Detail 10 Shallow Inlet – Attached Walk
Detail 11 Drop Inlet Layout Tolerances
Detail 12 Seepage Bed/Sewer & Water Service Conflict Options

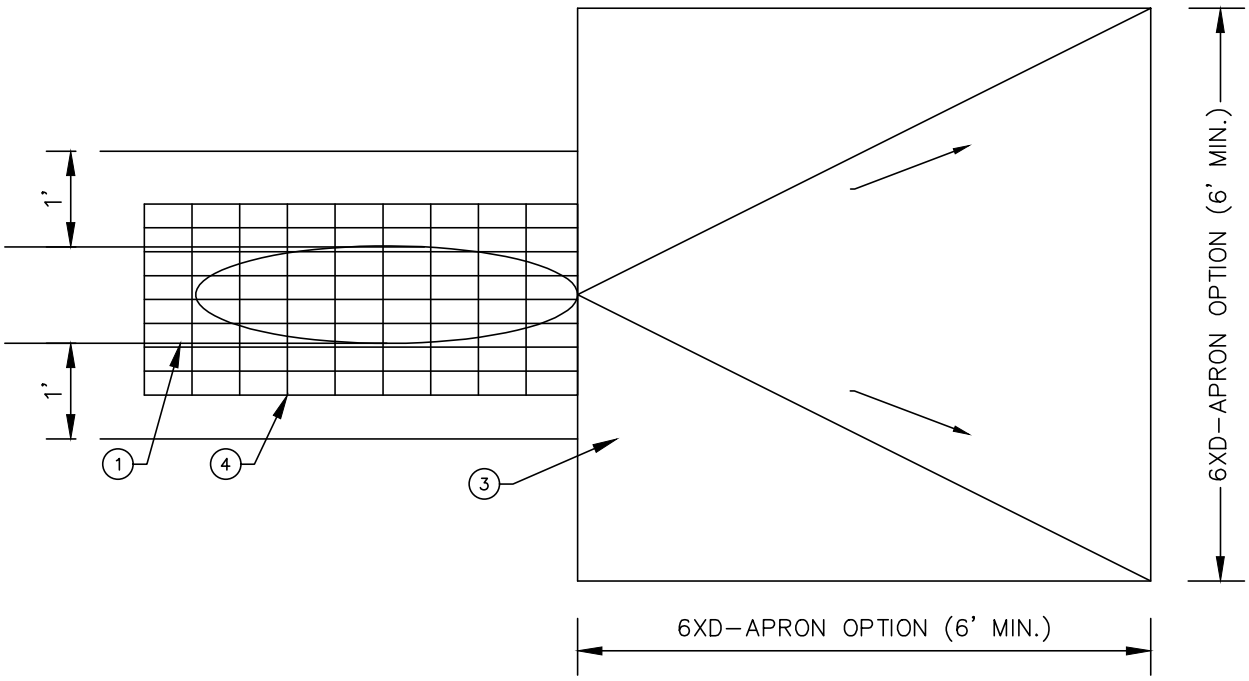


PLAN
N.T.S.

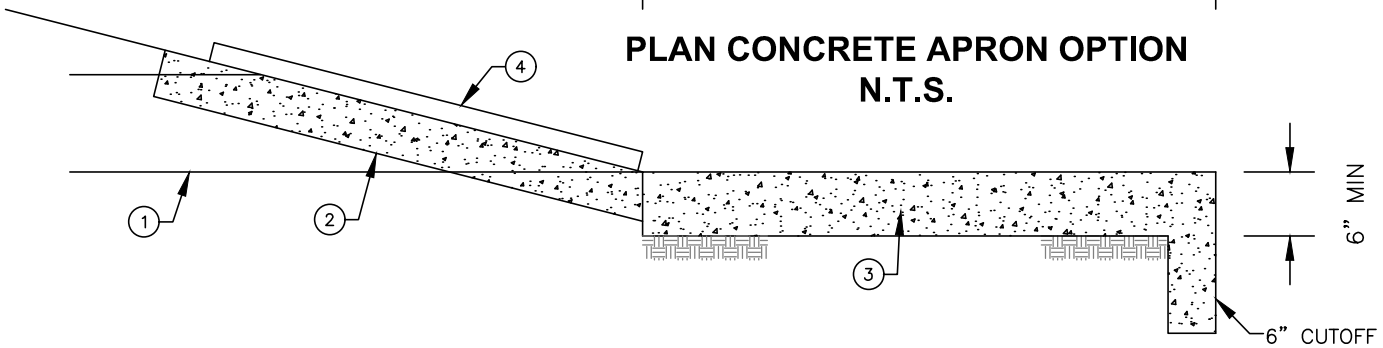


SECTION A-A
N.T.S.

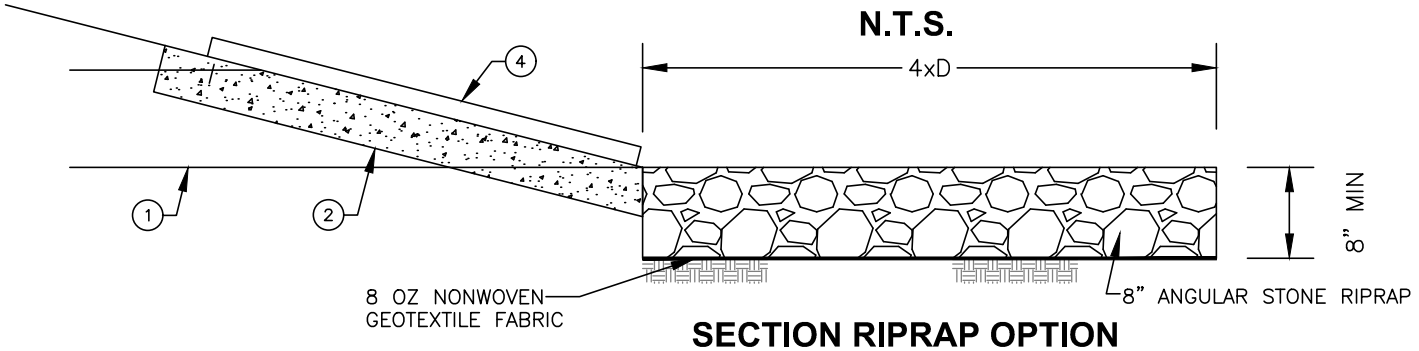
2015 ACHD STORMWATER DESIGN GUIDELINES	BEEHIVE OVERFLOW	STANDARD DRAWING DETAIL 01



PLAN CONCRETE APRON OPTION
N.T.S.



SECTION CONCRETE APRON OPTION
N.T.S.

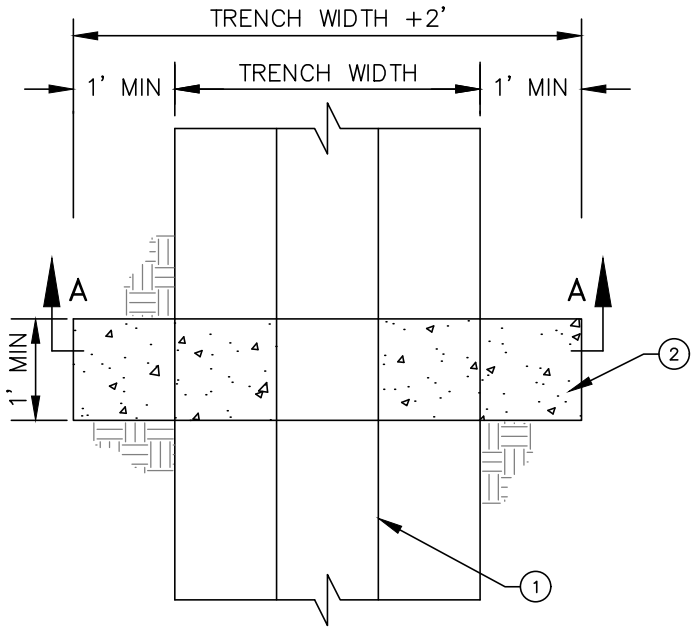


SECTION RIPRAP OPTION
N.T.S.

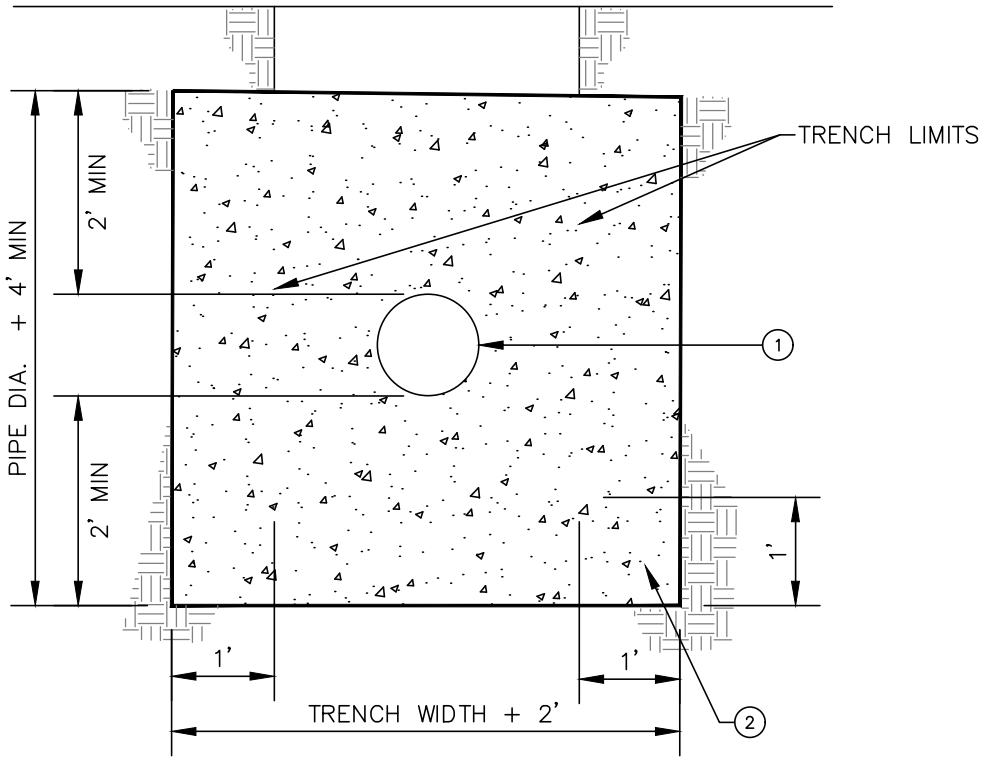
LEGEND:
1. INLET PIPE (12" MIN)
2. HEADWALL. CONCRETE CL. 4000 PER ISPWC SECTION 703
3. INLET PROTECTION APRON. CONCRETE CL. 4000 PER ISPWC SECTION 703
4. PROTECTION GRATE (MIN. 4"X6" OPENINGS)

NOTES:
A. "D" EQUALS THE DIAMETER OF THE INLET PIPE IN FEET
B. BEVEL INLET PIPE TO MATCH SIDE SLOPE

2015 ACHD STORMWATER DESIGN GUIDELINES	INLET PROTECTION APRON AND FLOW SPREADER	STANDARD DRAWING DETAIL 02



PLAN
N.T.S.

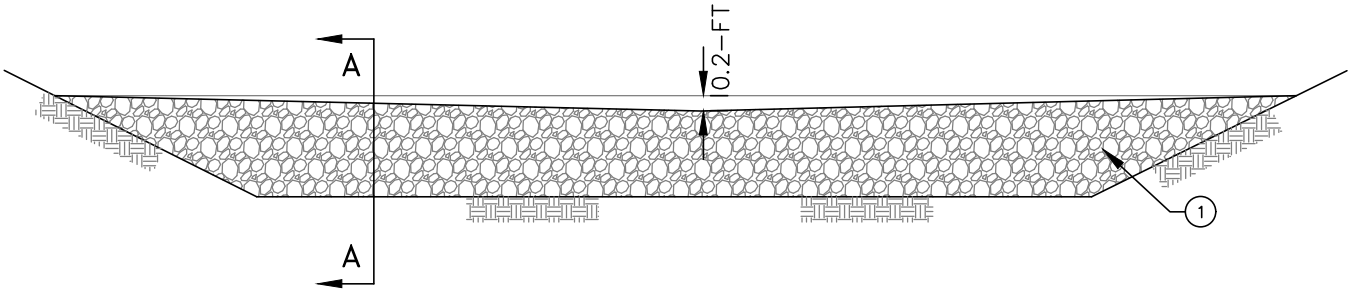


SECTION A-A
N.T.S.

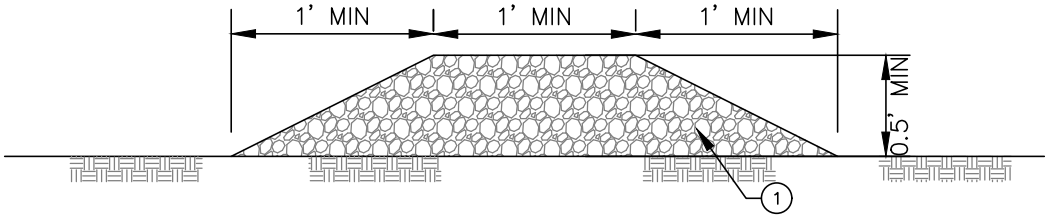
LEGEND:
(1) STORM DRAIN PIPE
(2) CONCRETE SEAL (ISPWC 703)

NOTES:
A. ANTI-SEEP COLLAR TO BE USED IN MAN MADE EMBANKMENTS
B. CLEAN PIPE OF DIRT AND FOREIGN MATERIAL BEFORE POURING CONCRETE COLLAR

2015 ACHD STORMWATER DESIGN GUIDELINES	ANTI-SEEP COLLAR	STANDARD DRAWING DETAIL 03



SECTION
N.T.S.



SECTION A-A
N.T.S.

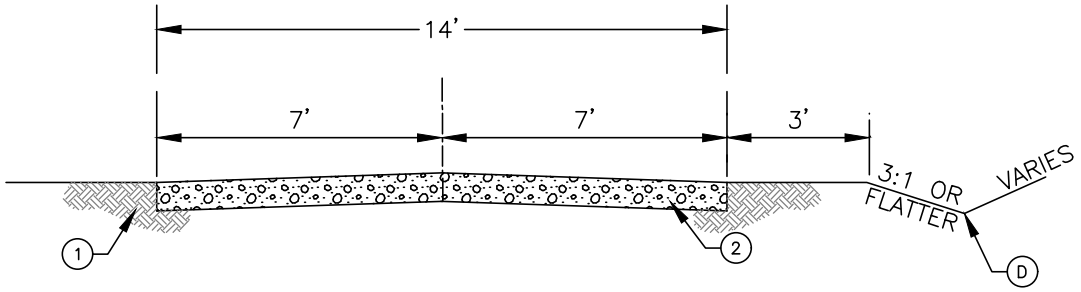
LEGEND:

(1) 3"–6" CLEAN RIVER ROCK (ISPWC SECTION 801)

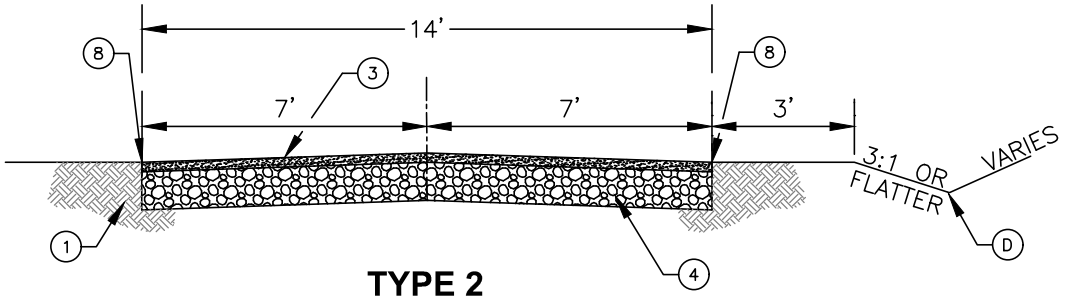
NOTES:

1. FLOW SPREADER SHALL BE USED WHEN LONGITUDINAL GRADE >1% FOR 100–FEET OR MORE.

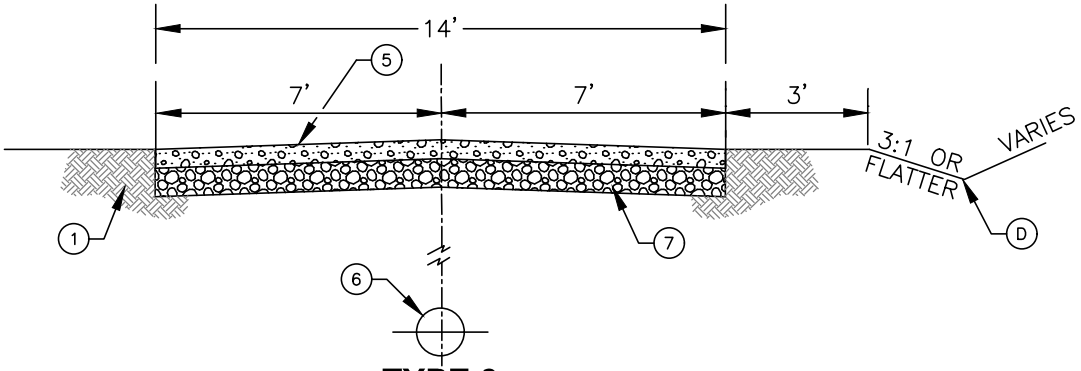
2015 ACHD STORMWATER DESIGN GUIDELINES	FLOW SPREADER FOR PONDS AND SWALES	STANDARD DRAWING DETAIL 04



TYPE 1
N.T.S.



TYPE 2
N.T.S.



TYPE 3
N.T.S.

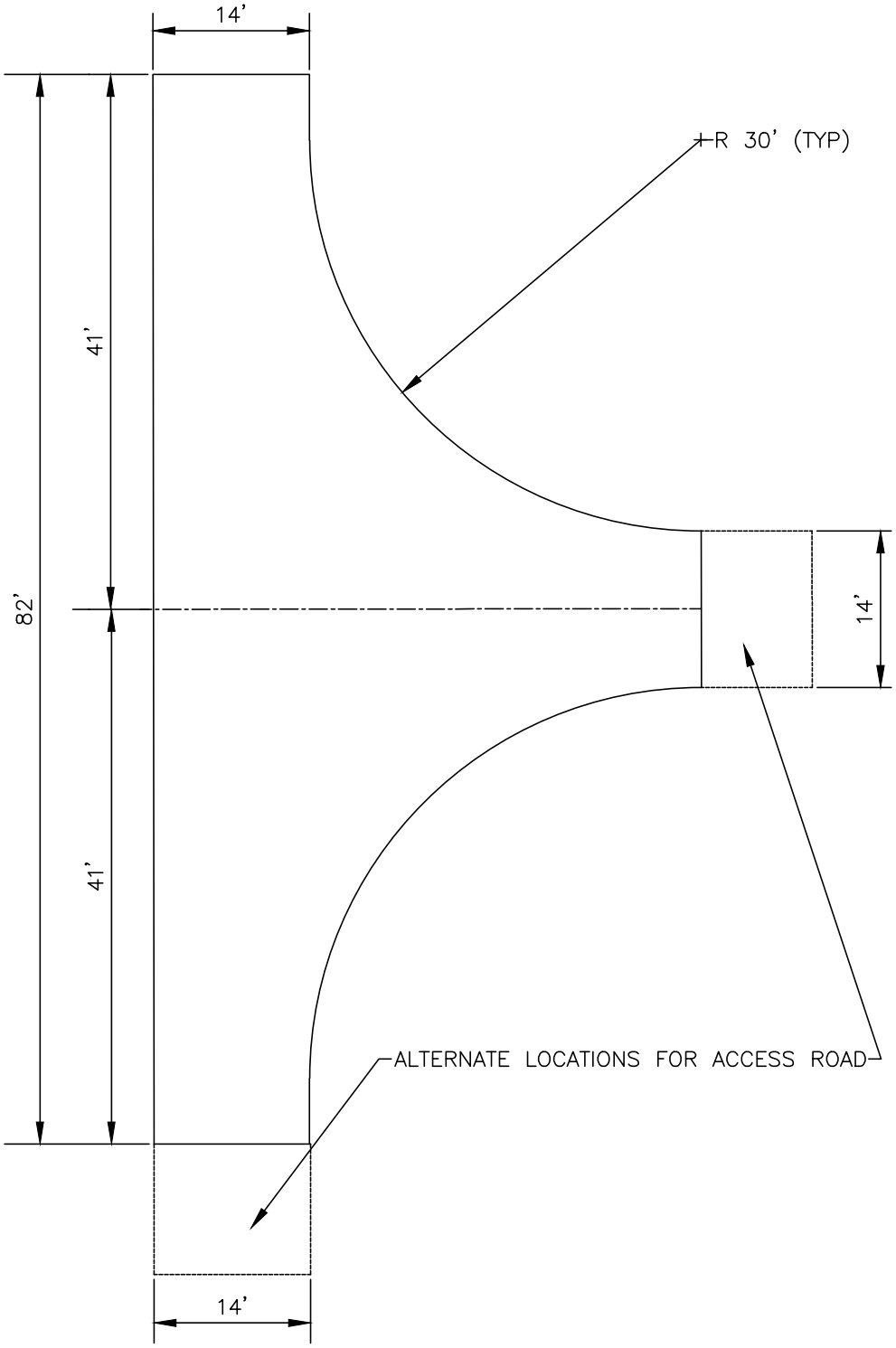
LEGEND:

1. NATURAL GROUND
2. 8" OF 3/4" MINUS CRUSHED AGGREGATE COMPACTED TO 95% DRY DENSITY
3. GRASSCRETE/GRASSPAVE OR APPROVED EQUAL
4. 10" OF 6" MINUS PITRUN GRAVEL COMPACTED TO 95% DRY DENSITY
5. 3" OF 3/4" MINUS CRUSHED AGGREGATE COMPACTED TO 95% DRY DENSITY
6. PROPOSED PIPE LINE
7. 8" OF 6" MINUS PITRUN GRAVEL COMPACTED TO 95% DRY DENSITY
8. DELINEATE EDGE WITH LANDSCAPE CURB OR PLANTS

NOTES:

1. PROVIDE 2% CROWN ON ALL ROAD TYPES
2. IF ROADWAY PROVIDES FIRE ACCESS, WIDTH MUST BE AT LEAST 20' WITH 10" OF BASE MATERIAL OR PER FIRE DEPARTMENT REQUIREMENTS, WHICHEVER IS MORE RESTRICTIVE
3. BORROW DITCHES SHALL HAVE A 3:1 MAX FORESLOPE WITH 4:1 SLOPE RECOMMENDED. THE BACK SLOPE SHALL BE 1:1 MAX WITH 4:1 RECOMMENDED

2015 ACHD STORMWATER DESIGN GUIDELINES	ACCESS ROAD AND TURNAROUND DETAILS	STANDARD DRAWING DETAIL 05 1 OF 2

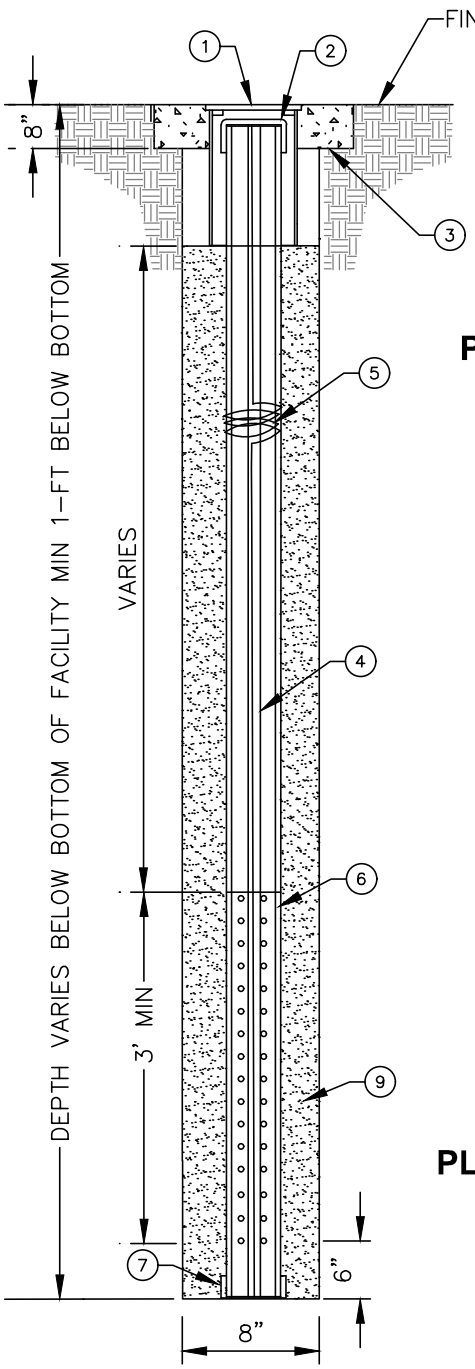


PLAN
N.T.S.

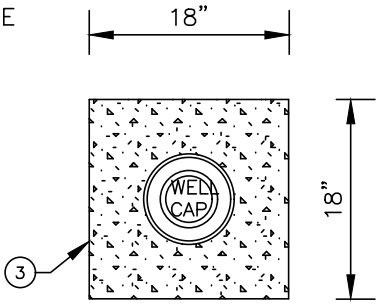
NOTES:

1. IF ROADWAY PROVIDES FIRE ACCESS, MINIMUM WIDTH IS 20' AND MINIMUM CURVE RADIUS IS 60', UNLESS OTHERWISE SPECIFIED.

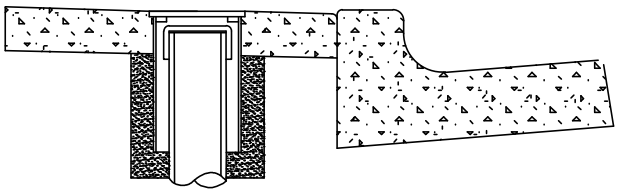
2015 ACHD STORMWATER DESIGN GUIDELINES	ACCESS ROAD AND TURNAROUND DETAILS	STANDARD DRAWING DETAIL 05 2 OF 2



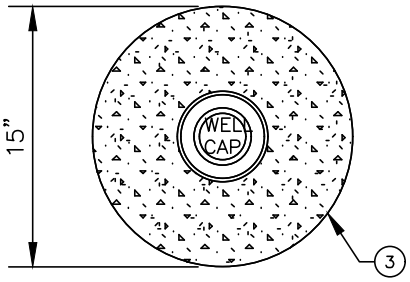
SECTION
N.T.S.



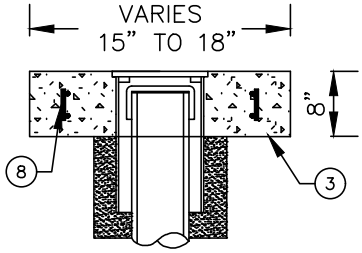
PLAN CONCRETE COLLAR NON-TRAFFIC AREAS
N.T.S.



SECTION WELL COVER IN SIDEWALK
N.T.S.



PLAN CONCRETE COLLAR - TRAFFIC AREAS
N.T.S.



SECTION CONCRETE COLLAR
N.T.S.

2015 ACHD STORMWATER DESIGN GUIDELINES	GROUNDWATER OBSERVATION WELL	STANDARD DRAWING DETAIL 06 1 OF 2

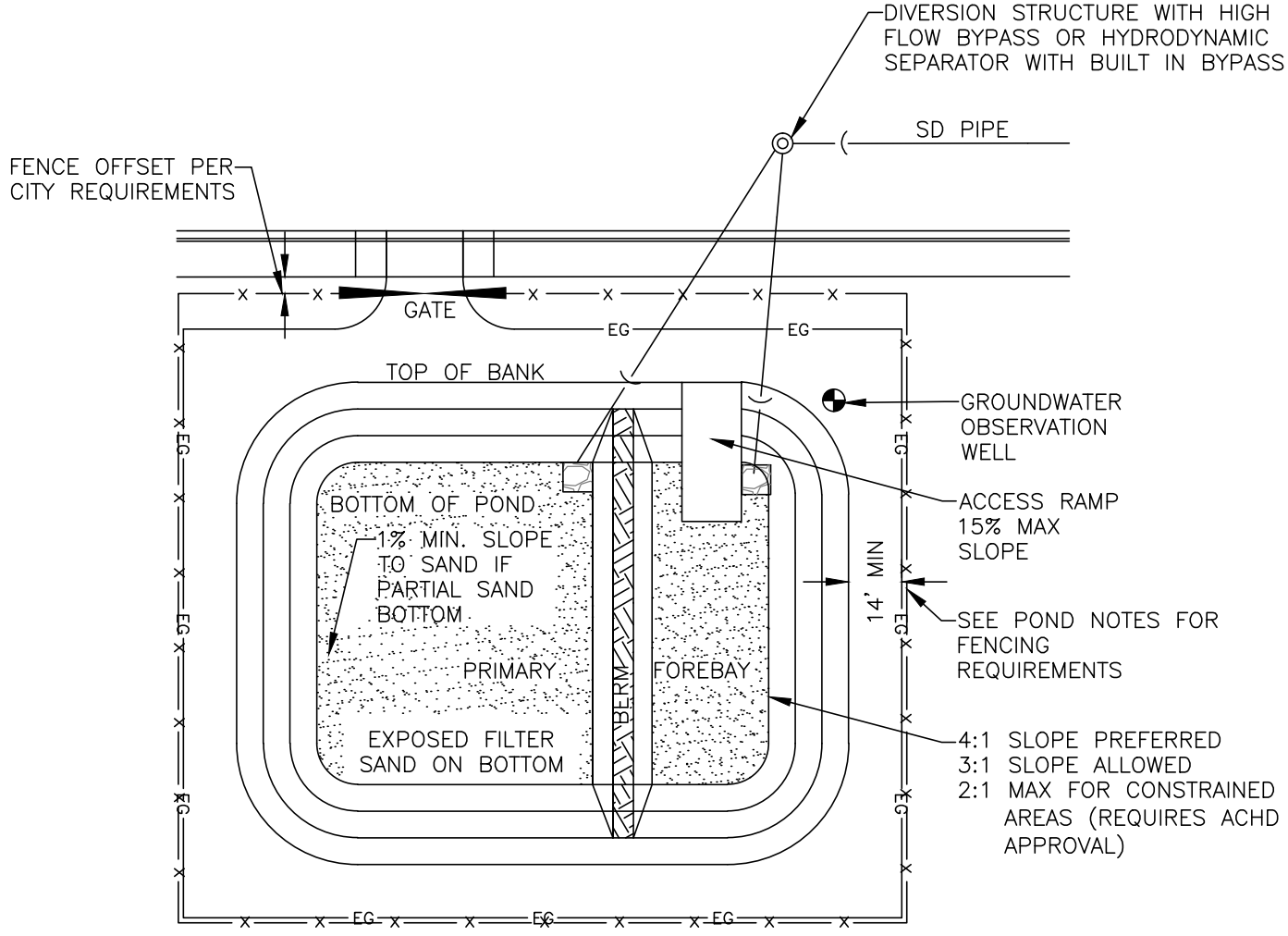
LEGEND

1. WELL COVER, 8" DIA. WATERTIGHT GALVANIZED STEEL BOLT DOWN COVER AND CANISTER
2. PVC CAP, GASKETED (WATERTIGHT)
3. CONCRETE (COLLAR), CLASS 3000 (ISPWC SECTION 703)
4. 2" DIAMETER PVC PIPE, SCHEDULE 40 WITH SLOTS
5. TRACER WIRE SHALL BE A MINIMUM OF 18 GAUGE, INSULATED, SINGLE–CONDUCTOR COPPER WIRE, INSULATION COLOR SHALL BE GREEN WITH THREE 6" DIAMETER COILS
6. WELLS BACKFILLED IN A PIT REQUIRE 6" PERFORATED PVC PIPE CASING, ASTM D–3035, SDR 35 WITH 6 EA– 3/8" DIA HOLES AT 3" ON CENTER. DRILLED WELLS MAY HAVE A 4" PIPE CASING
7. PVC CAP, SOLVENT WELDED OR GASKETED (WATERTIGHT)
8. (2) #4 REBAR HOOPS WITH #4 VERTICALS
9. FILTER SAND (ISPWC SECTION 801) OR ASTM C33 FILTER SAND

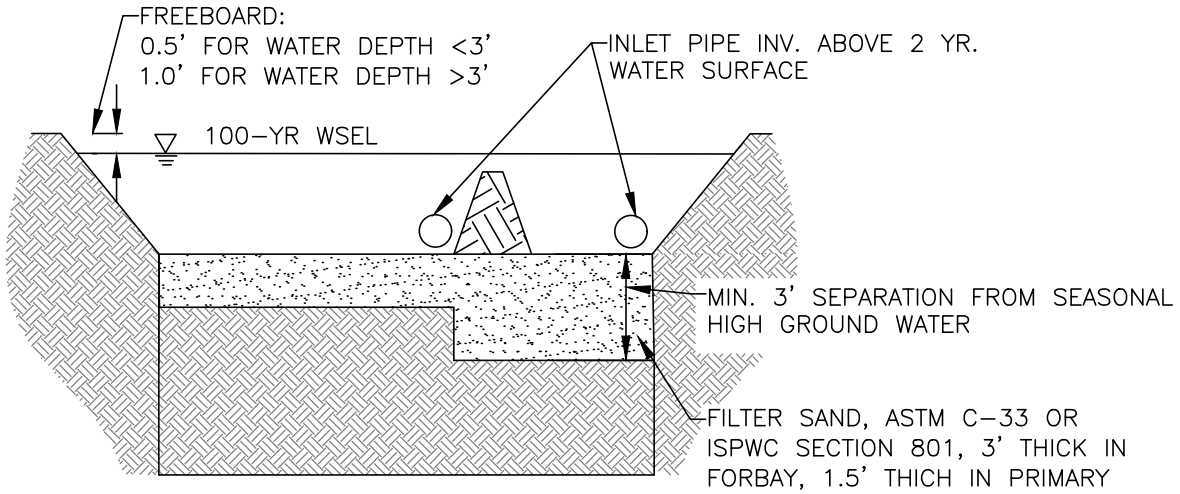
NOTES:

1. WELLS ARE FOR OBSERVATION OF GROUNDWATER LEVEL NEAR STORM DRAINAGE FACILITIES
2. THIS DETAIL IS FOR WELLS DRILLED IN UNDISTURBED SOIL AND FOR EXCAVATED PITS
3. LOCATION OF GROUNDWATER OBSERVATION WELLS SHALL BE APPROVED BY ACHD

2015 ACHD STORMWATER DESIGN GUIDELINES	GROUNDWATER OBSERVATION WELL	STANDARD DRAWING DETAIL 06 2 OF 2



PLAN
N.T.S.



SECTION
N.T.S.

NOTES:
1. SEE SHEET 2 OF 2 FOR POND NOTES

2015 ACHD STORMWATER DESIGN GUIDELINES	STORMWATER POND STANDARDS	STANDARD DRAWING DETAIL 07 1 OF 2

POND NOTES:

1. FOR EMBANKMENT HEIGHTS GREATER THAN 10', REFER TO IDAHO DEPARTMENT OF WATER RESOURCES REQUIREMENTS.

2. AN EMERGENCY SPILLWAY IS ENCOURAGED WHERE POSSIBLE.

3. ALL EXPOSED PIPES TO POND BASINS SHALL BE RCP OR COVERED/COATED TO RESIST DEGRADATION FROM SUNLIGHT.

4. 14' WIDE MIN GRAVEL ACCESS ROAD AS NEEDED TO STRUCTURES WITH TURNAROUND OR LOOP WHEN LENGTH >= 50-FT. ROAD MAXIMUM GRADE OF 10%, MAXIMUM 15% GRADE FOR RAMPS TO POND BOTTOM (RAMP REQ'D WHEN POND BOTTOM AREA EXCEEDS 1500 S.F.) 30' MINIMUM INSIDE CURVE RADIUS.

5. EMBANKMENT SLOPES – IRRIGATED TURF GRASS OR DRY LAND GRASS WITH EROSION CONTROL BLANKET. NO IRRIGATION ON BASIN FLOOR. NO WOODY VEGETATION BELOW 100-YEAR WATER SURFACE OR WITHIN 10' OF EMBANKMENT SPILLWAY, PIPES, OR STRUCTURES.

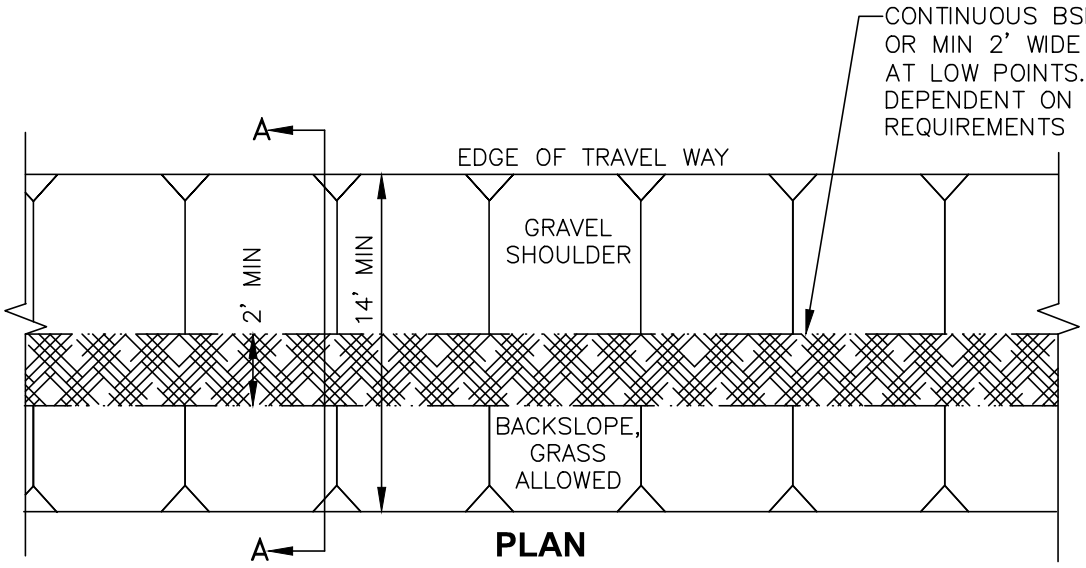
6. EXCAVATE AND PLACE FILTER SAND AFTER CONTRIBUTING DRAINAGE AREA HAS SITE SEDIMENT & EROSION CONTROL MEASURES IN PLACE.

7. LICENSE AGREEMENT WITH ACHD FOR STORMWATER FACILITY MAINTENANCE IS REQUIRED.

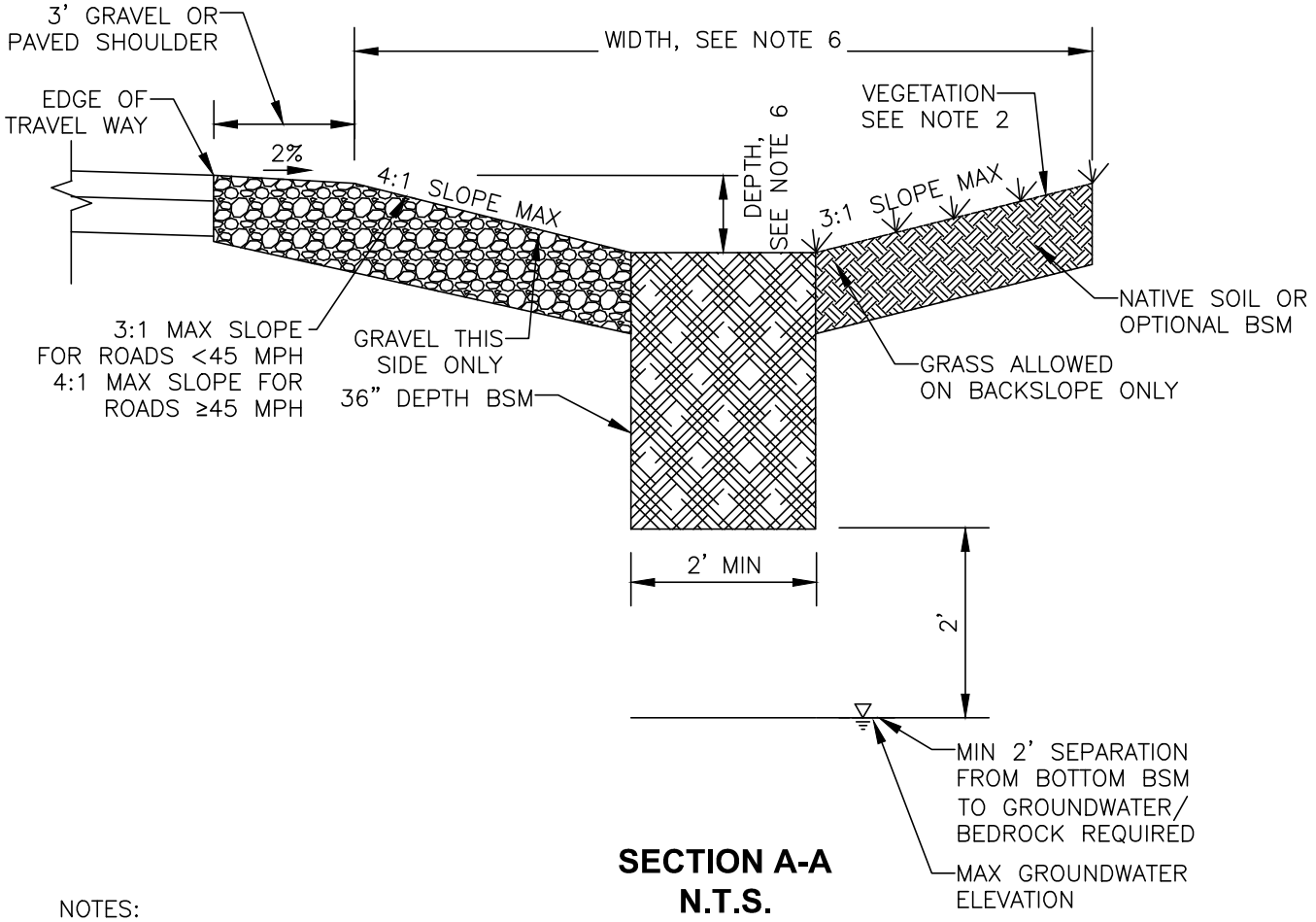
NOTES FOR ACHD OWNED PONDS:

1. 6-FT TALL CHAIN LINK FENCE W/BLACK POLY COATING AND TOP BAR IS REQUIRED FOR ALL ACHD OWNED PONDS, OPTIONAL FOR HOA PONDS. GATES SHALL BE 20' WIDE.

2. DROUGHT TOLERANT NATIVE PLANTS ARE REQUIRED. HYDROSEED, MULCH AND TACKIFY BANKS. ANY LANDSCAPING AND SPRINKLERS SHALL BE NEGOTIATED WITH THE CITY THROUGH A COST SHARE AGREEMENT.



PLAN
N.T.S.

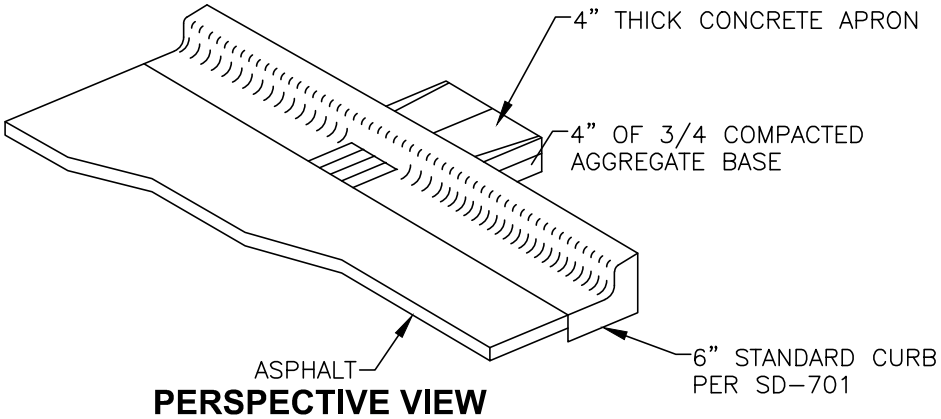


SECTION A-A
N.T.S.

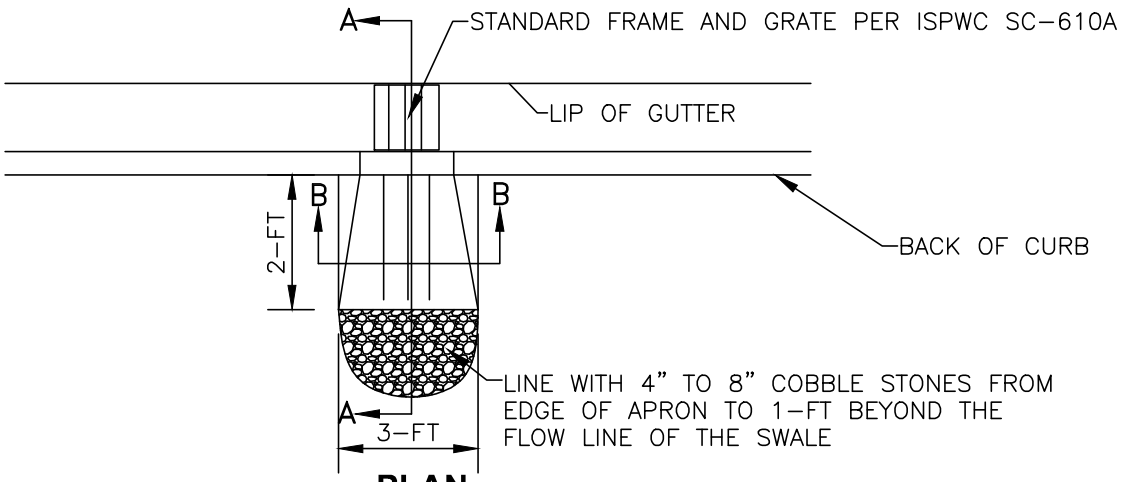
NOTES:

1. BORROW DITCHES SHALL BE DESIGNED FOR INFILTRATION OF STORMWATER AT THE TREATMENT AREA
2. DROUGHT TOLERANT PLANT SPECIES IN INVERT AND BACKSLOPE OF BORROW DITCH ONLY
3. IF BSM WINDOWS ARE USED IN LIEU OF CONTINUOUS BSM TRENCH, PROVIDE DRAINAGE CALCULATIONS TO SHOW INFILTRATION OF 90% VOLUME IN 48–HOURS
4. BIORETENTION SOIL MEDIA SPECIFICATIONS PER SECTION 8200
5. 3:1 MAX SLOPE FOR ROADS <45 MPH, 4:1 MAX SLOPE FOR ROADS ≥45 MPH
6. BORROW DITCH WIDTH AND DEPTH VARIES BASED ON SIZING REQUIREMENTS
7. CURBING MAY BE REQUIRED
8. USE INTENDED FOR UNDEVELOPED, RURAL ARTERIALS

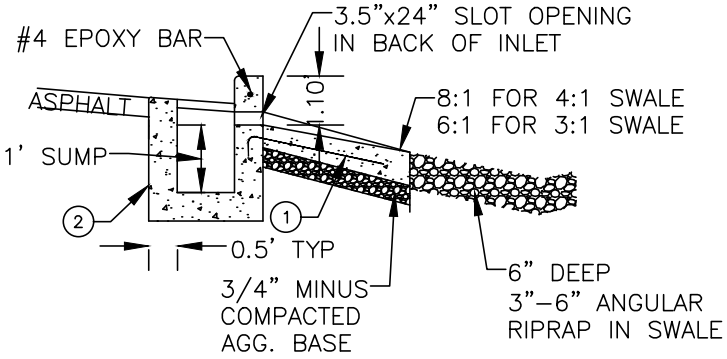
2015 ACHD STORMWATER DESIGN GUIDELINES	BORROW DITCH WITH BSM WINDOW	STANDARD DRAWING DETAIL 08



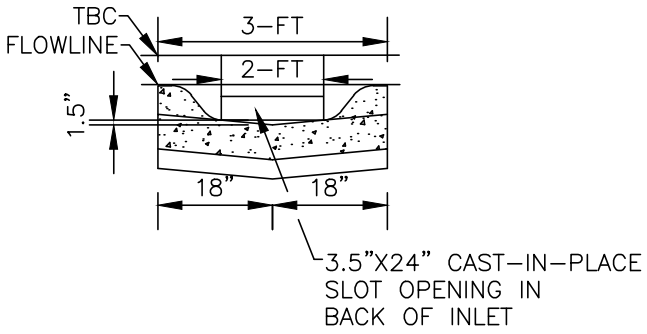
PERSPECTIVE VIEW
N.T.S.



PLAN
N.T.S.



SECTION A-A
N.T.S.

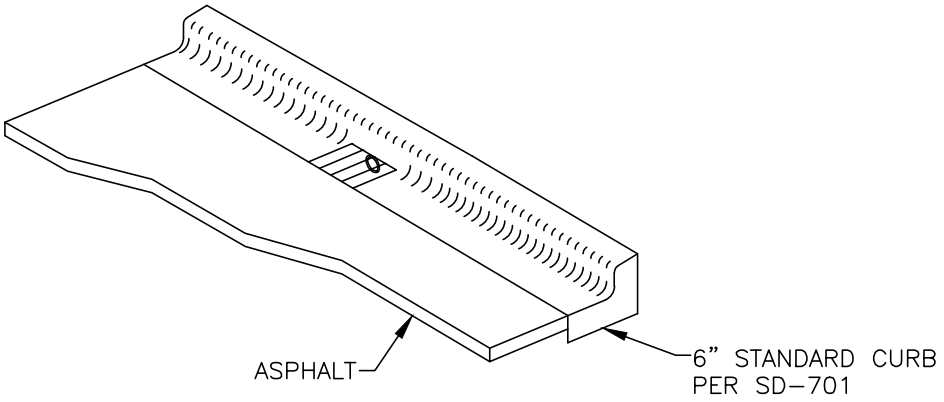


SECTION B-B
N.T.S.

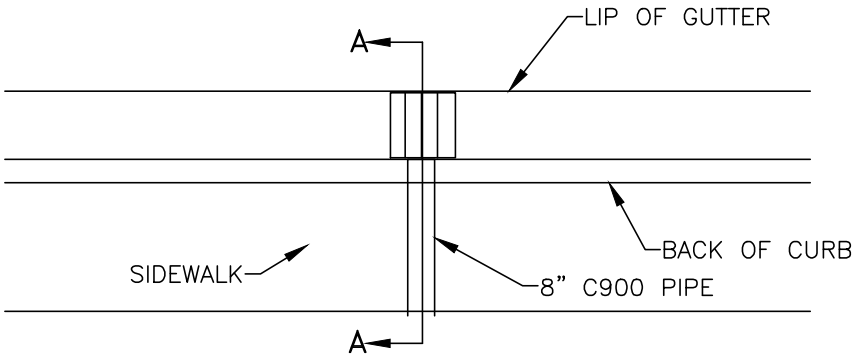
LEGEND:
(1) 3 EA #4 BARS 2-FT LONG AT MID DEPTH OF CONCRETE SPACE EQUALLY ACROSS CURB OPENING
(2) STANDARD TYPE 1 INLET PER SD-601 OF ISPWC/ACHD SUPPLEMENTAL WITH THESE MODIFICATIONS. FRAME & GRATE PER ISPWC/ACHD SUPPLEMENTAL SD-609/610A

NOTES:
1. REQUIRED WITH INFILTRATION SWALE DESIGN FOR DETACHED SIDEWALK
2. CONCRETE APRON SHALL TO REMAIN FREE OF ALL OBSTRUCTIONS INCLUDING GRASS AND OTHER VEGETATION
3. SEE SWALE BMPS FOR SWALE DETAILS

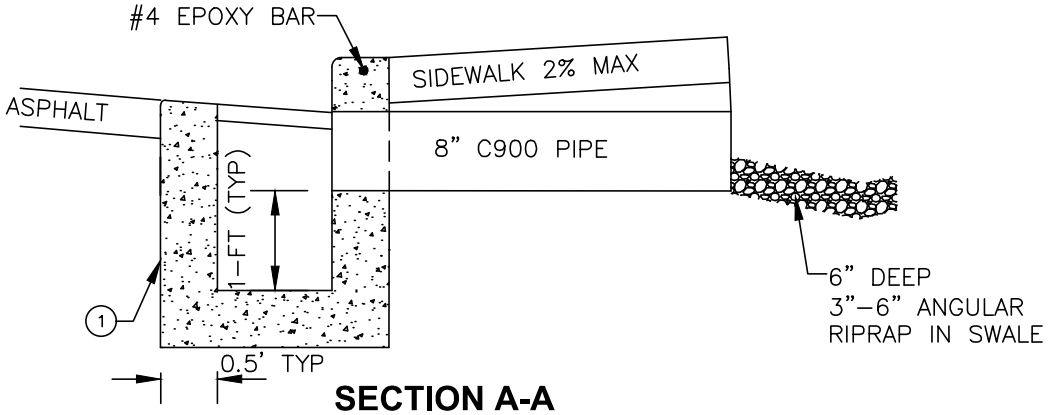
2015 ACHD STORMWATER DESIGN GUIDELINES	SHALLOW INLET DETACHED WALK	STANDARD DRAWING DETAIL 09



PERSPECTIVE VIEW
N.T.S.



PLAN
N.T.S.

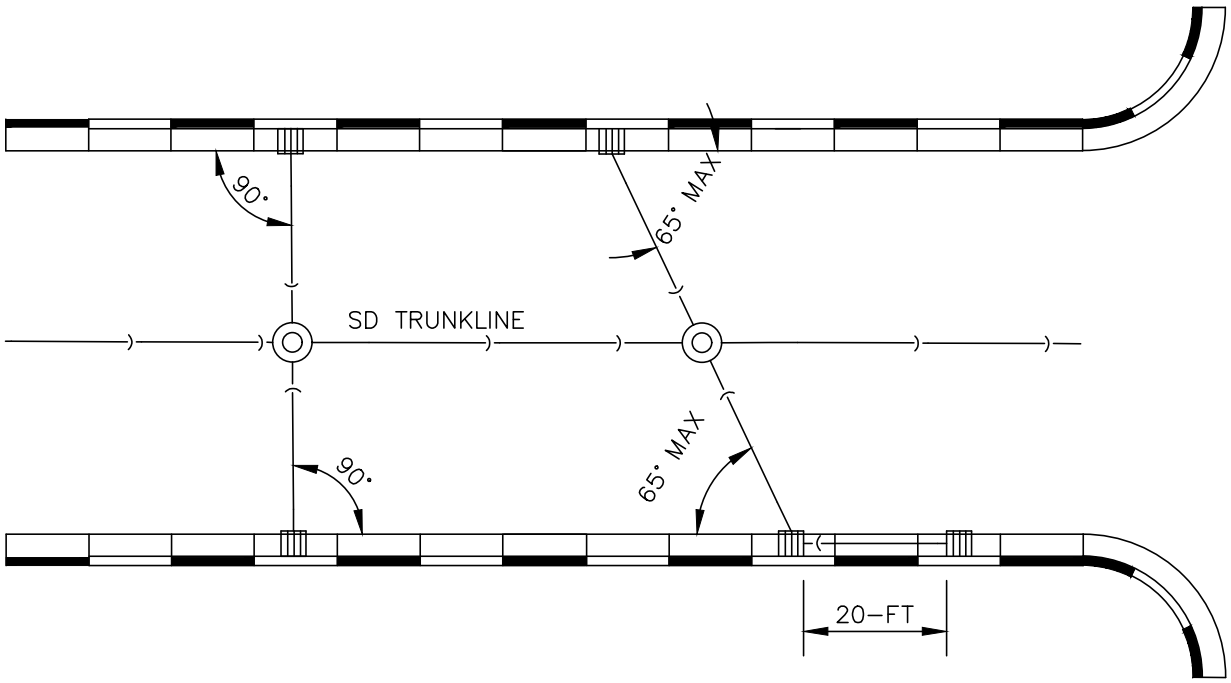


SECTION A-A
N.T.S.

LEGEND:
(1) STANDARD TYPE 1 INLET PER SD-601 OF ISPWC/ACHD SUPPLEMENTAL WITH THESE MODIFICATIONS. FRAME & GRATE PER ISPWC/ACHD SUPPLEMENTAL SD-609/610A

NOTES:
1. REQUIRED WITH INFILTRATION SWALE DESIGN FOR ATTACHED SIDEWALK
2. SEE SWALE BMPS FOR SWALE DETAILS

2015 ACHD STORMWATER DESIGN GUIDELINES	SHALLOW INLET ATTACHED WALK	STANDARD DRAWING DETAIL 10

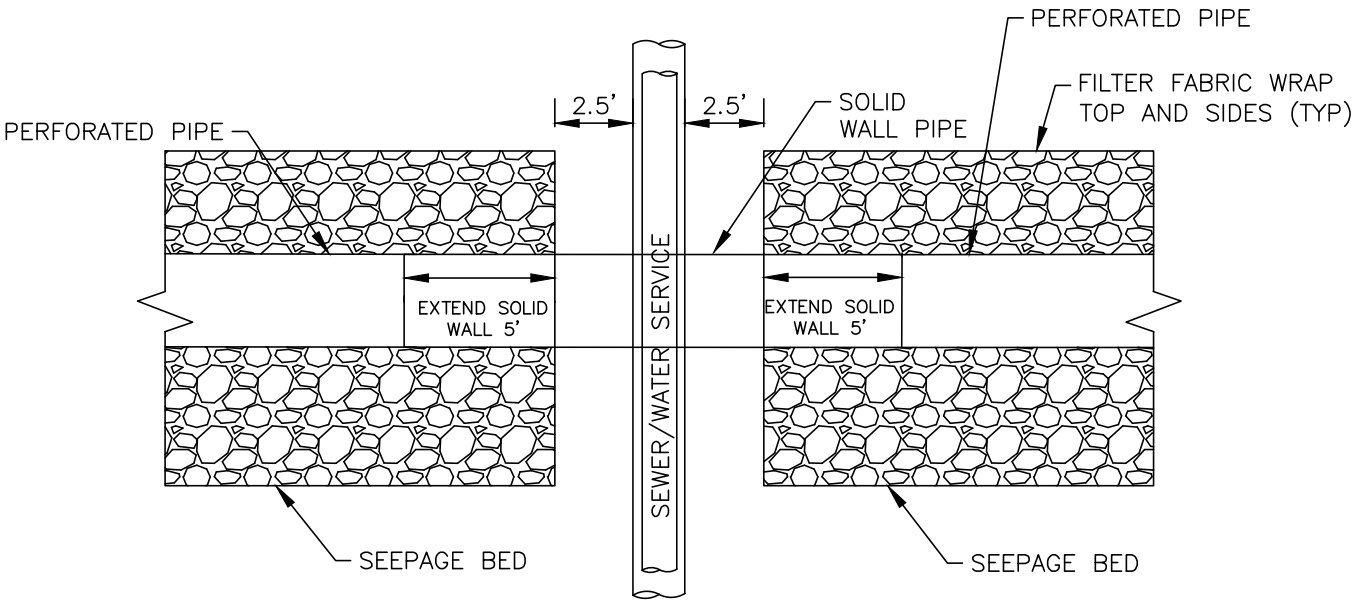


PLAN
N.T.S.

NOTES:

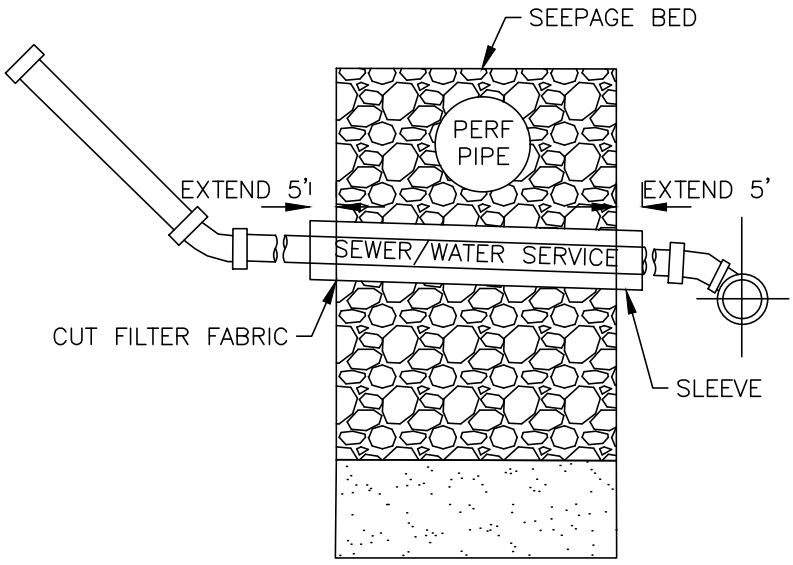
1. STORM DRAIN PIPE LATERALS SHALL BE PERPENDICULAR TO THE CURB (DI FACE) OR NO GREATER THAN A 65° ACUTE ANGLE
2. MAXIMUM PIPE LATERAL LENGTH FROM SHORT END OF DI IS 20–FEET WITH 12–IN MAX PIPE SIZE
3. PIPES >12–IN SHALL CONNECT TO DI FACE
4. STORM DRAIN PIPES SHALL BE LOCATED WITHIN THE APPROVED UTILITY CORRIDOR OR APPROVED BY A WRITTEN VARIANCE

2015 ACHD STORMWATER DESIGN GUIDELINES	DROP INLET LAYOUT TOLERANCES	STANDARD DRAWING DETAIL 11



OPTION 1: BREAK BED

PLAN
N.T.S.



OPTION 2: SLEEVE LINE

SECTION
N.T.S.

NOTES
1. OPTION 1 REQUIRES SEEPAGE BED LENGTH TO BE INCREASED BY GAP LENGTH

2015 ACHD STORMWATER DESIGN GUIDELINES	SEEPAGE BED/SEWER & WATER SERVICE CONFLICT	STANDARD DRAWING DETAIL 12