Summit County Structural Post Construction BMP Manual

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GENERAL

A. Introduction

This appendix provides a list and description of appropriate structural BMPs that a permit applicant could select from to meet the stormwater treatment requirements described in Appendix A. This list is not intended to be comprehensive, and alternative structural controls may be selected subject to approval by Summit County. Additional information and detailed examples of long-term post-construction stormwater BMPs can be found online at:

http://cfpub.epa.gov/npdes/stormwater/menuofbmps/post.cfm
http://www.deq.state.id.us/water/stormwater_catalog/index.asp

All structural post-construction BMPs shall be inspected regularly (at least every six months or as otherwise noted) to determine maintenance needs.

For the purposes of meeting the water quality treatment requirements outlined in Appendix A, the sliding scale and TSS design removal rates shown in Tables 1 and 2 should be used. TSS removal rates for alternative structural controls will be determined by the applicant and approved by the County Engineer. Credible references justifying/documenting the removal rates used shall be submitted by the permit applicant.

For sites where newly-developed impervious areas lie within 50 feet of a live water body (perennial or intermittent stream, lake, pond, spring, or reservoir), the Table 1 sliding scale does not apply and the default 80% TSS removal standard must be met. The less-stringent removal efficiencies listed in Table 1 apply only to sites that refrain from creating new impervious cover near live water bodies.

B. Location of Structural BMPs

Structural BMPs should never be constructed in natural streams (perennial or intermittent) or wetlands. BMPs should be designed to only intercept and capture storm water runoff, not natural stream channel runoff.

Table 1.1 Sliding Scale for Required TSS Removal Efficiency (adapted from City of Boise.

% of parcel area that is impervious	% TSS removal efficiency required[a]
≤ 30	40
35	47
40	53
45	59
50	62
55	66
60	68
65	70
70	72
75	74
80	75
85	77
90	78
95	79
100	80

[a]for sites where newly-developed impervious cover lies within 50 feet of a live water body, the values in Table 1 do not apply and instead a removal efficiency of 80% must be met, even if the total site imperviousness % is less than 100%.

Table 2.1 TSS Removal Rates for Selected BMPs (adapted from Schueler 1997, Winer 2000, & EPA 1993).

BMP	Design Removal Rate (%)	Comments
Dry Detention Ponds	15	Quantity control pond
Wet Detention Ponds	60	Quantity control pond
Dry Extended Detention Pond	45	Sediment forebay included
Wet Extended Detention Pond	80	Sediment forebay included
Evaporation Pond	100	Designed to evaporate or retain
Bioinfiltration Swale	70	
Sand Filter	80	Pretreatment, includes Austin, underground, pocket, and Delaware designs
Organic Filter	80	Pretreatment, includes compost and peat/sand
Catch Basin Insert	25	Off-line only
Infiltration Facilities	95*	*removal rate only valid with adequate maintenance and pre-treatment
Sediment Trap	25	
Grass Buffer Strip	85	Minimum width of 10'
Oil/Water Separator	15	

BMP1: OIL/WATER SEPARATORS

A. Introduction

This section includes standards for oil/water separators to be installed to treat runoff from gas stations and parking lots. These systems can be used to intercept and remove contaminants from storm water runoff. They can also be used during redevelopment to retrofit an existing system in order to provide water quality treatment. Oil/water separators and catch basin inserts should not be used alone to treat storm water runoff but rather in combination with other BMPs to improve water quality.

B. Description

These structures are used to capture floatibles, oil and grease, and sediment found in runoff. Two types of oil/water separators are discussed in this section: coalescing plate interceptor (CP) (Figure 1.1) and the conventional gravity separator, or API (Figure 1.2). The CP and API separators can function as pre-treatment systems if regularly maintained. A third system, the spill control (SC) separator should be considered for sites where there is a risk of leaks and small spills, such as gas station sand chemical storage areas. It is not considered a pre-treatment system.

C. Sizing

The contributing area to any individual oil/water separator should be limited to one acre of impervious cover. The maximum allowable velocity through the throat of the separator (0.5 fps) will also limit the size of the area served. Separators, boxes, or vaults are sized based on the contributing runoff area, sedimentation rates of particles, and maximum velocities through the throat of the separator.

Certain developments such as fuel farms or gas stations should consider properly sized facilities to capture floatibles such as oil and grease. The American Petroleum Institute (API) standards related to oil rise rates and turbulence should be used to design these facilities.

D. Access

Provide access for inspection, proper maintenance, and monitoring activities, including clearance from structures to allow for equipment to clean out devices. Provide access to each compartment. If the length or width of any compartment exceeds 15', an additional access point for each 15' is required.

E. Design Life

The system shall be designed either to the manufacturer's specifications or 50 years, whichever is greater.

All metal parts should be corrosion-resistant. Acceptable materials include parts made of aluminum and stainless steel, fiberglass, or plastic. Metal parts that come in contact with storm water runoff should not be painted because the paint tends to wear off.

Vault baffles should be made of concrete, stainless steel, fiberglass reinforced plastic, or other acceptable material and should be securely fastened to the vault. Apply the HS-20 traffic loading standard when locating the API and CP systems in parking lots.

F. Maintenance

Clean accumulated oil, grease, sediments and floating debris every two years, unless inspections show that more frequent maintenance is necessary. Oil/water separators should be inspected monthly to insure proper maintenance.

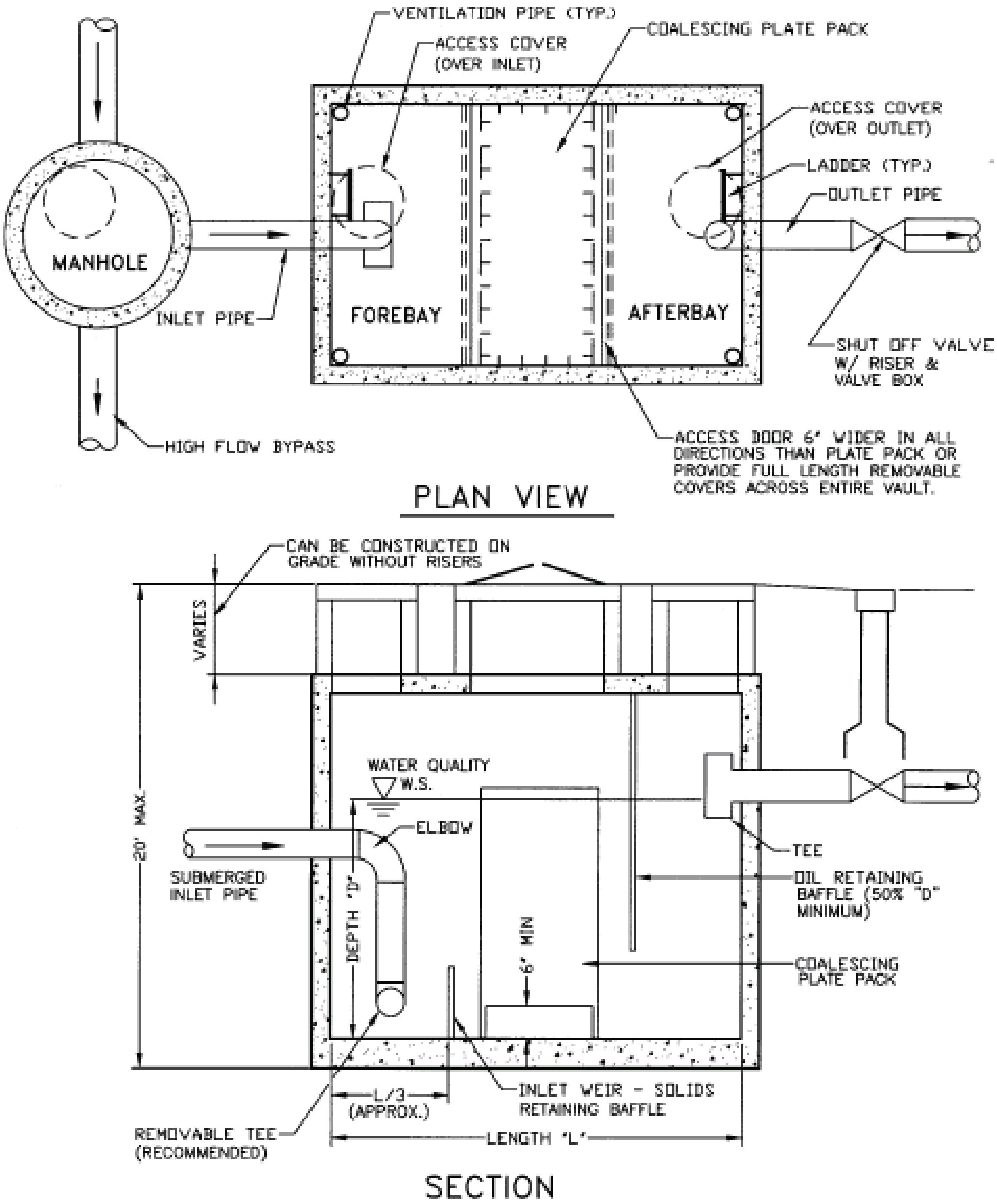

Figure 1.1. Coalescing Plate Oil/Water Separator.

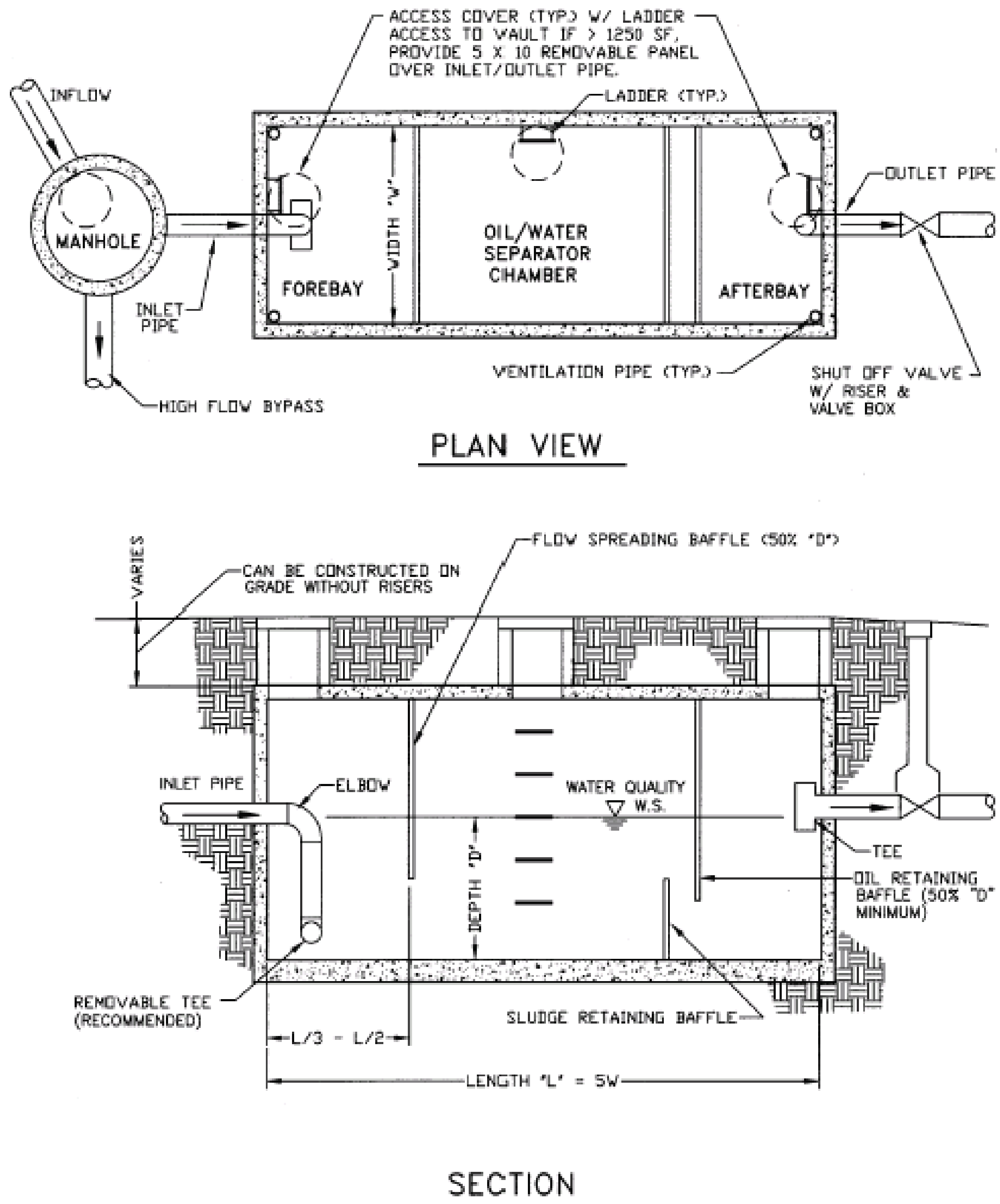

Figure 1.2. Conventional Gravity Oil/Water Separator.

BMP2: CATCH BASIN INSERTS

A. Introduction

A catch basin insert is a device installed underneath a catch basin inlet that treats storm water through filtration, settling, absorption, adsorption, or a combination of these mechanisms.

A variety of catch basin inserts are commercially available from various different manufacturers. Summit County does not endorse any single product or manufacturer over any other; however, each selected product will be subject to review by the County and must be approved prior to installation.

Because they have limited capacity and limited sediment removal capabilities, catch basin inserts should NOT be used alone to treat storm water runoff but rather as pretreatment to another storm water management BMP or series of BMPs.

B. Installation

The insert must be fitted with oil-absorbent/adsorbent filter media. The filter must be changed monthly or when the filter media surface is covered with sediment. If the insert is installed in an existing catch basin, the insert shall be demonstrated to fit properly so that there is a positive seal around the grate to prevent low-flow bypass. If the insert is installed in a new or redevelopment project, it shall be installed according to the manufacturer's recommendations. The insert should be installed in the catch basin after the site has been paved or stabilized (for new development) or after completion of construction (for a redevelopment site that is already paved).

C. Access

The catch basin insert shall be located in an easily-accessible area for maintenance activities. It should not placed in an area with continuous vehicle parking. Consequently, redevelopment projects may have to modify a parking stall in order to provide access to a catch basin insert.

D. Maintenance

Catch basin inserts shall be maintained at a frequency recommended by the manufacturer. Inspections should occur at least monthly during wet months and during periods of high runoff and once every 2 months during the remainder of the year. Full replacement or renewal of oil absorbent/adsorbent material shall be part of maintenance activities. In addition, the catch basin sump should be inspected for sediment accumulation. Filter media shall be disposed of in accordance with applicable regulations. In most cases, dewatered filter media may be disposed of as solid waste. To insure proper maintenance of the catch basin inserts inspections should occur monthly.

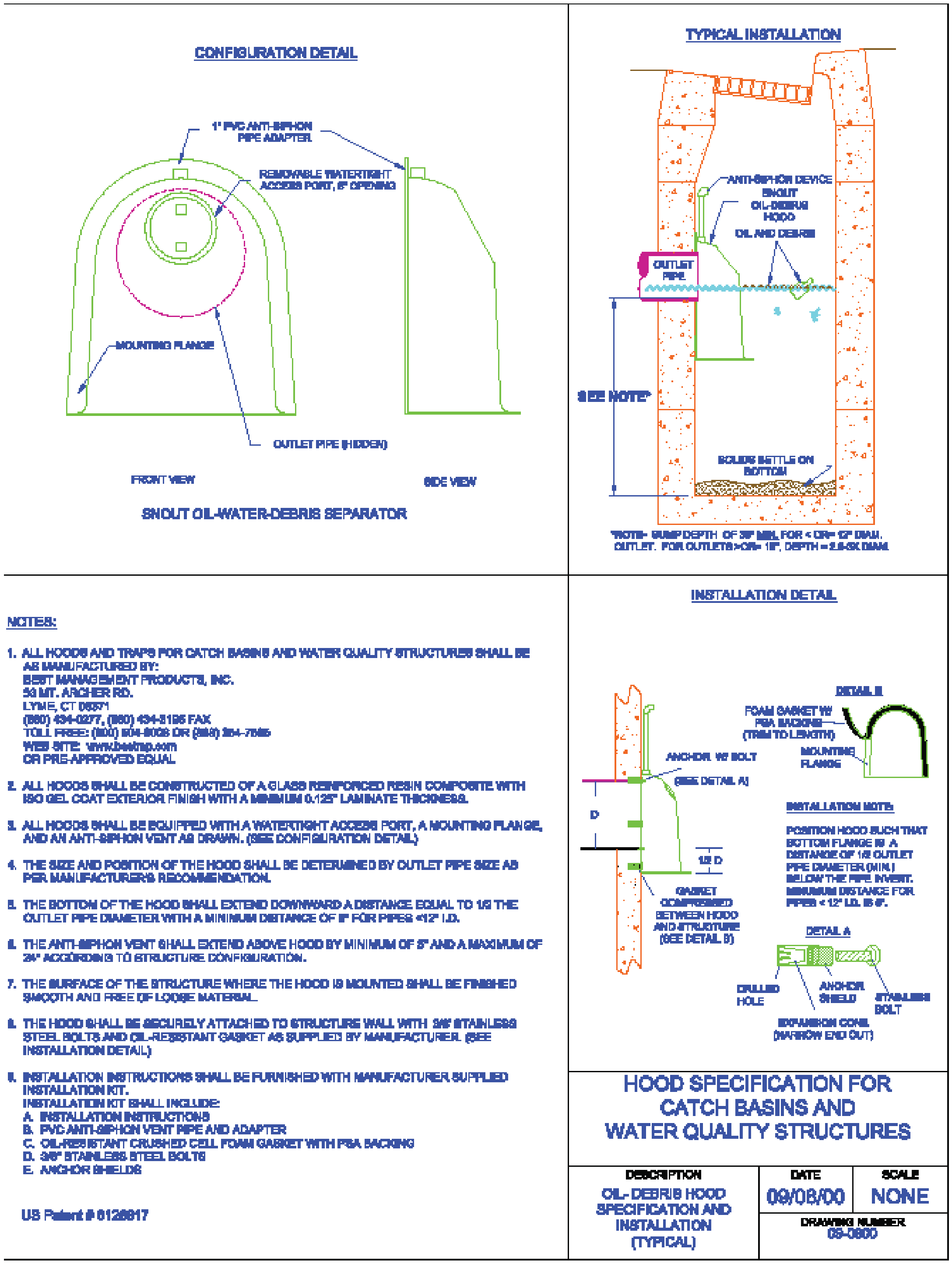

Figure 2.1. **Sample Detail of One Type of Catch Basin Insert (SNOUT brand). Summit County does not endorse this brand over any other.**

BMP3: INFILTRATION FACILITIES (GENERAL)

A. Introduction

This section contains requirements for facilities that manage storm water by subsurface disposal through infiltration. Requirements are included for seepage beds (infiltration trenches), infiltration basins, and infiltration swales. A seepage bed (Figure 3.1) receives runoff in a shallow excavated trench that has been backfilled with stone to form a below-grade reservoir. Seepage beds are typically located beneath landscaped or parking areas. A seepage bed can also be open to the surface and covered with landscaping rock. This type of system is referred to as an open trench. An infiltration basin (Figure 3.2) impounds water in a surface pond until it infiltrates the soil. Infiltration basins do not maintain a permanent pool between storm events and should drain within 48-72 hours after a design storm event. Infiltration swales (Figure 3.3) are vegetated channels designed to retain/detain, treat and infiltrate stormwater runoff.

B. Plan Submittal

For each infiltration facility, the applicant will be required to submit the general information listed in Section 3.A.1 of Appendix A as well as the following additional information:

- site characteristics that pertain to the proposed infiltration system (site evaluation information) soils report and geologic report with boring logs
- written opinion of site suitability by a hydrologist, geologist, soil scientist or engineer
- recommended design infiltration rate
- infiltration test data and results

C. Construction

Before the site is disturbed, the area selected for the infiltration system shall be secured to prevent heavy equipment from compacting the underlying soils. Runoff should be diverted away from the completed infiltration system during all phases of construction, until the site is completely stabilized. Excessive sediment loading during construction can severely impact the long-term performance of infiltration systems.

D. Setbacks and Separation Distances

- Infiltration facilities shall be located 100' from surface water supplies and tributaries used as drinking water and 50' from surface waters not used as drinking water, excluding drainage and irrigation water delivery systems.

- Infiltration facilities shall be located 100' from public and private drinking water wells.

- Infiltration facilities shall be located 5' from bedrock or basalt (vertical distance from bottom of facility to bedrock). Infiltration facilities must not be used on slopes >20%.

E. Infiltration Rate

The infiltration rate shall be measured at a depth equal to the proposed bottom grade of the facility. Appropriate soil types are those that have an infiltration rate of 0.5"/hour or greater, as initially determined from NRCS Soil Textural Classification and subsequently confirmed by field geotechnical tests. Maximum soil percolation rates shall generally not exceed 8" per hour.

F. Maintenance

Systems should be inspected and cleaned during regular semi-annual inspections. This inspection schedule applies to all of the infiltration facilities unless otherwise noted. The maximum depth of sediment allowed should be stated in the O&M Plan with an estimate of impact on infiltration rate. Sediments shall be removed and disposed of properly.

BMP3.1: SEEPAGE BEDS

A. Limitations

Seepage beds are prohibited in the following situations:

- where hazardous or toxic materials greater than SARA Title III “reportable quantities” are stored or handled, including loading and unloading areas

- where there is existing soil and/or ground water contamination

- n fill material, where there is the possibility of creating an unstable grade and potential for movement at the interface between the fill and in-situ soils

Vadose zone characteristics and depth to water will determine where seepage beds will be prohibited. A final determination regarding the use of seepage beds is based on evaluating the natural, unaltered characteristics of the proposed location for the system. Table 3.1 illustrates how restrictions may be applied.

Table 3.1. Restrictions for Seepage Beds.

	Vadose Zone			
Depth to groundwater (below ground surface)	**Gravels, pebbly gravels, pebbles**	**Sands, sands interbedded with silt and or clays, silty clays**	**Rhyollite or Granitics**	**Basalts**
< 15 feet[a]	seepage beds prohibited	seepage beds prohibited	seepage beds prohibited	seepage beds prohibited
15-30 feet	additional treatment required	no additional restrictions[1]	subject to further evaluation	subject to further evaluation
31-100 feet	additional treatment required	no additional restrictions[1]	subject to further evaluation	subject to further evaluation
>100 feet	additional treatment required	no additional restrictions[b]	subject to further evaluation	subject to further evaluation

[a] Assumes bottom of seepage bed is 5' below ground surface.
[b] Assumes the separation distance between the bottom of the seepage bed and ground water is 10'.

B. Setbacks and Separation Distances

- Seepage beds must be separated a minimum of 10'from ground water (vertical distance from bottom of facility to seasonal high ground water level). A test boring shall be drilled to a sufficient depth to verify that a 10' separation distance between the proposed bottom of the facility and seasonal high ground watertable is met. Each facility shall have one test boring, unless prior approval is obtained from Public Works.

- Seepage beds must be separated 10' from structures (foundations, septic systems, other seepage beds).

- Seepage beds must be separated 20' from basements.

- Seepage beds must be separated 10' from property boundaries.

C. Design

- Seepage beds should be designed to provide a direct method for removal of contaminants and sediments before direct discharge into the vadose zone. If the bed has a surface inlet, the system must be designed to capture sediment either through a grass buffer strip, biofiltration swale, or sediment trap. Depending on the expected site activities, a pretreatment system, such as an oil/water separator should also be considered.

- A vegetated buffer (20' minimum) is recommended for open trenches.

- A stone aggregate of clean, washed drain rock, 1.5- 2" in diameter should be used. This size of aggregate will give a void ratio of 30-40%. Aggregate between .5-2.0" may be used but the void ratio must be certified.

- The bottom of the seepage bed shall be covered with a 6-12" layer of clean, washed sand that meets either specification: ASTM C-33 or ITD Standard 703.02, “Fine Aggregate for Concrete”.

- The seepage bed aggregate must be lined on the sides by an appropriate geotextile fabric. If the trench is a open trench, it should also be lined at the top and the top fabric layer should be located 1' below the surface to prevent surface sediment from passing through into the stone aggregate. Filter fabric can be placed on the bottom of the trench. Filter fabric should have a minimum weight of at least 4 oz./yd 2, a filtration rate of 0.08"/second, and an equivalent opening size of30 for non-woven fabric.

- Seepage beds must have observation wells to determine how quickly the seepage bed drains after a storm. Wells shall be placed and every 2000 SF, with a minimum of 1 well/seepage bed. The observation well should be a perforated PVC pipe, 4-6" in diameter, extending to the bottom of the bed where it is connected to a foot plate. It should be capped and locked to prevent vandalism or tampering.

- If the seepage bed is located in a landscaped area, the bed should be constructed in one of the following ways: the bed should be covered with native soils and planted in grass, or if the seepage bed is an open trench, covered with stone aggregate and protected from sediment build-up with a vegetated buffer strip 20-25' wide on either side of the bed.

D. Operation and Maintenance

The system should be located so that it can be easily accessed by equipment necessary to maintain the pretreatment system and trench. The buffer and surface vegetation must be maintained by reseeding bare spots and mowing as frequently as needed to preserve aesthetics.

When ponding occurs at the surface or in the bed, corrective maintenance is required immediately. Ponding indicates the bed is clogged. Stripping off the top layer of soil, replacing the clogged filter fabric, and then replacing the top foot of aggregate or soil will correct the problem. Ponded water inside the trench (as visible from the observation well) after 24 hours or several days can indicate that the bottom of the trench is clogged. If this problem has occurred, then it is necessary to remove all of the layers and replace them.

E. Closure or Replacement

The owner is required to repair, replace, or reconstruct the infiltration system if it fails to operate as designed. A system fails to operate as designed when water is standing 24 hours or longer following the design storm. The maintenance and operation schedule for an infiltration system shall include such a provision. The owner is required to notify Summit County if the owner plans to close or replace the infiltration system. Additional studies may be required for all facilities depending on the land use of the site.

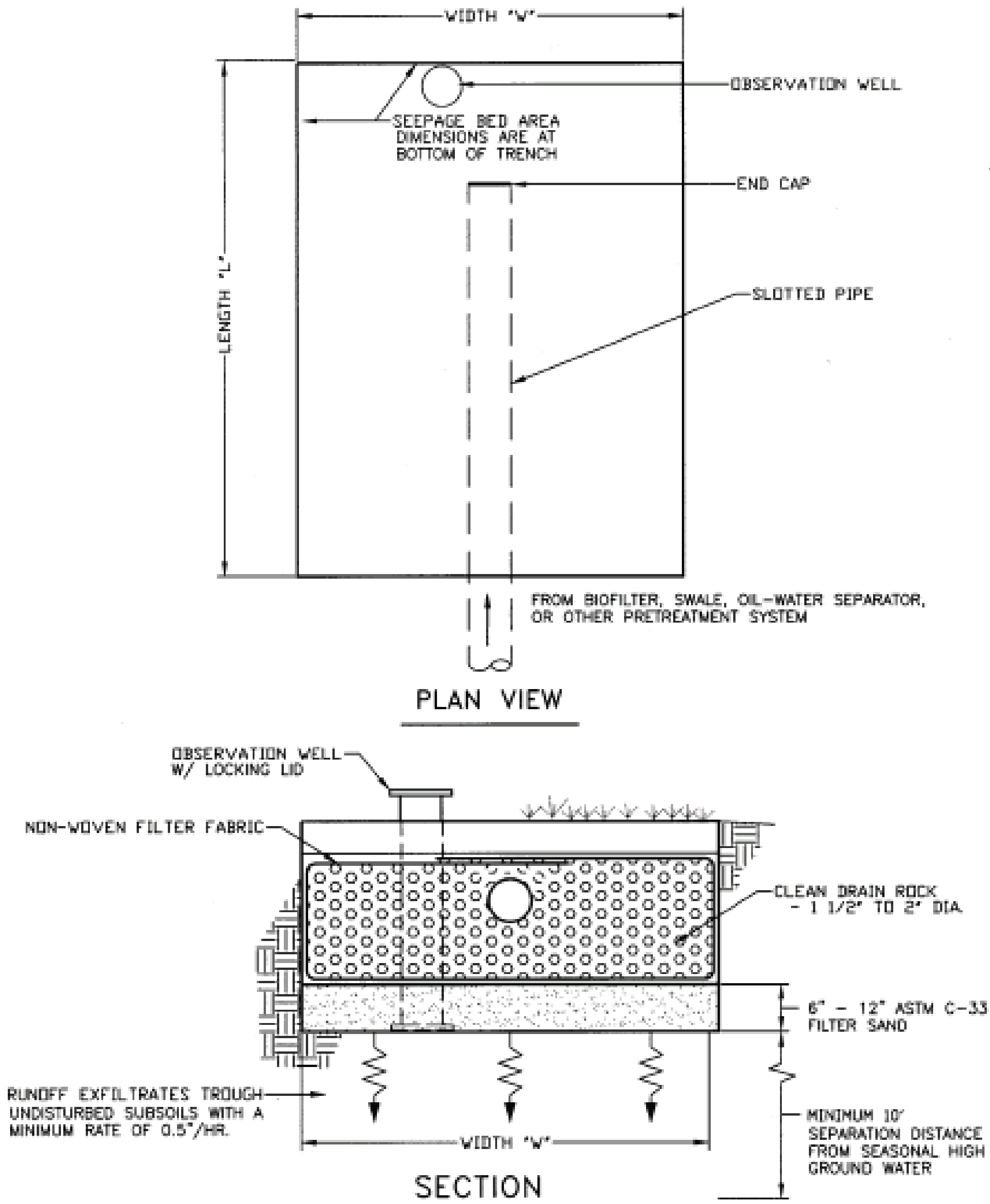

Figure 3.1. Seepage Bed.

BMP3.2 INFILTRATION BASIN

A. Applicability

An infiltration basin is suitable in residential and commercial developments. Infiltration basins should not be placed in locations where the basin could cause flooding to downstream properties or in natural drainages such that the basin would restrict inflows to the point of causing upstream flooding.

B. Sizing

In determining the size of the basin, the critical parameters are the storage capacity and the maximum rate of runoff released from the basin. In addition the basin size should be based on expected sediment accumulation and frequency of maintenance.

C. Forebay/Sediment Trap

A rock or an earthen berm shall be constructed with a minimum top width of 4' and side slopes no steeper than 3:1. The forebay/sediment trap shall have a treatment volume equal to 0.75 times the runoff from the mean annual storm (0.23").

D. Construction Requirements

Infiltration basins shall be constructed in appropriate soil types. Infiltration basins should be excavated in a manner that will minimize disturbance and compaction of the basin. The basin bottom should be sloped to maximize infiltration. In addition, infiltration basins should not be constructed in highly erodible contributing areas, on slopes > 15%, or within fill soils. Inlet and outlet channels must be stabilized.

E. Separation Distance

The bottom of the infiltration basin should be separated by at least 3' vertically from the bedrock layer or seasonal high water table, as indicated by on-site geotechnical test results. Within the 3' separation distance, there must be at least a 2' layer of soil that conforms to infiltration rate requirements.

F. Pretreatment

Each infiltration basin shall have additional pretreatment. One of the following techniques can be used:

- construct grass channel
- construct grass filter strip
- install bottom sand layer
- install upper filter fabric with 6" sand layer
- use washed cobble rock as aggregate
- vegetate basin with deep-rooted turf

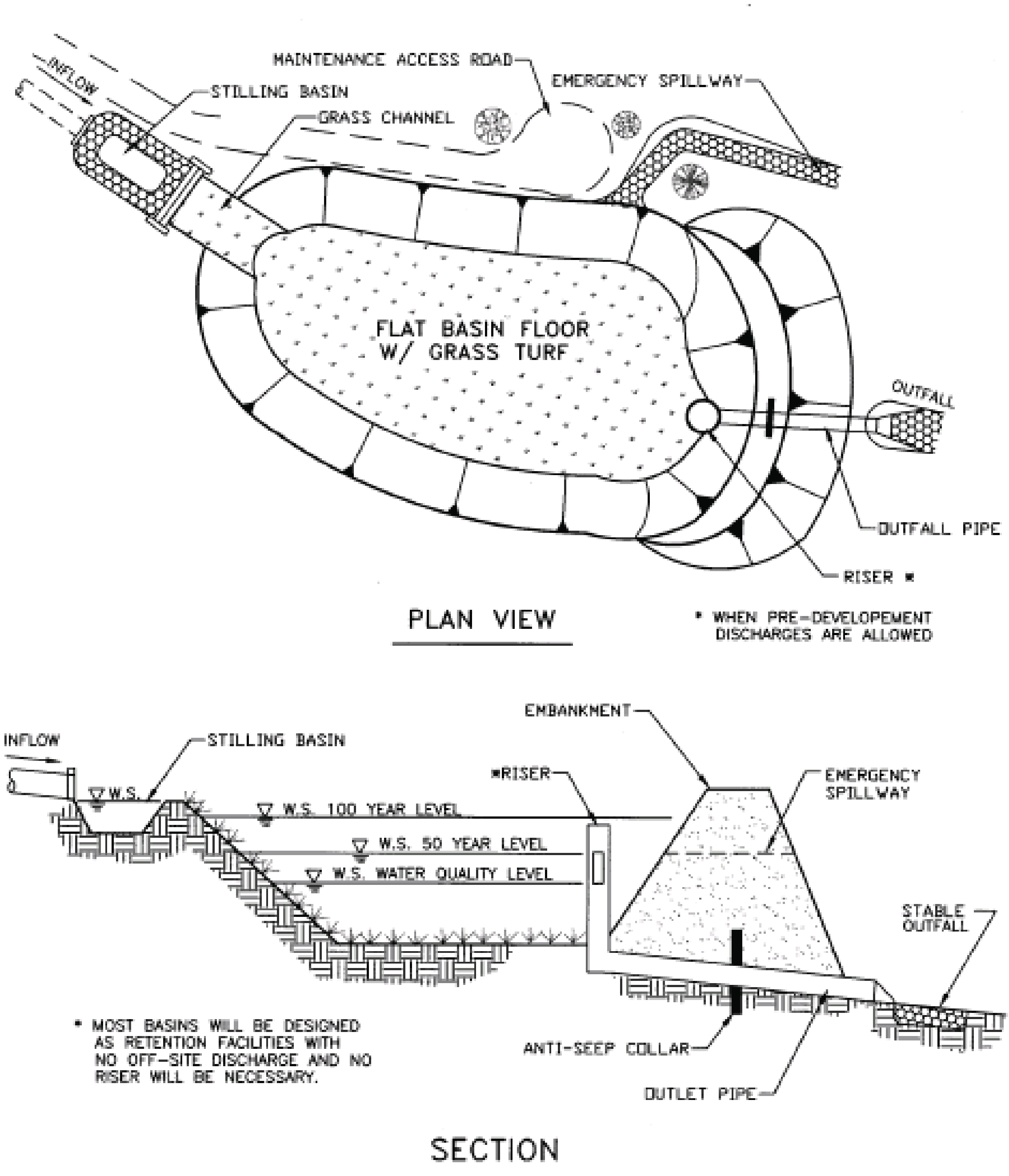

Figure 3.2. Infiltration Basin.

BMP3.3 INFILTRATION SWALE

A. Design

- Swale bottom slopes shall be between 1-4%.

- Curb cut pavement shall be installed at a maximum height of 6" above the swale if curb cuts will be used to introduce flow to the swale. Curb cuts shall be between 12-36" wide.

- A flow spreading device at the swale inlet shall be installed. Appropriate devices include shallow weirs, stilling basins, and perforated pipes. Provide a sediment clean-out area.

- Energy dissipation shall be provided at the inlet. Appropriate means are stilling basins and rip rap pads. If rip rap is used, it should be sized for the expected runoff velocity. A drainage window may be provided to direct the storm water runoff from events larger than the quantity design storm to the free draining material in the under drain. The top of the drainage window should be placed at an elevation above the water surface of the quantity design storm and should be located at the lower end of the swale.

- The swale side slopes shall be no more than 3:1.

- The swale bottom width shall be no greater than 8'.

- Swale shall be a maximum of 1.5' deep.

- The swale shall be grass-covered. Uniformly fine, close-growing, water-tolerant grasses should be used. Landscaping rock may also be used with an open trench.

- The swale under drain shall be constructed using clean 2" drain rock. The rock shall be wrapped in geotextile filter fabric, with a weight of greater than 4 ounces per square yard. The under drain will be a minimum depth of 12".

- A 6-12" layer of clean, washed sand that meets either specification: ASTM C-33 or ITD Standard 703.02, “Fine Aggregate for Concrete” shall be placed below the under drain.

B. Setbacks and Separation Distances

- Swale perimeter slope must be a minimum of 2' from the property line.

- There shall be at least 3' of separation between the bottom of the swale or under drain and the seasonal high ground water table.

C. Landscaping

Vegetate swales uniformly with fine, close-growing, water-tolerant grasses that can withstand seasonally saturated soils. Swales shall not be used until the vegetation is established. The side slopes above the swale treatment area should be vegetated to prevent erosion. Additional grass or nonaggressive ground covers are appropriate.

Barrier shrubs, such as barberry, planted around the swale should be considered when there is a possibility that the public could damage the swale or hinder its function. Other plant materials are appropriate if recommended by a landscape professional.

Trees and shrubs should be planted high on the side slopes or above the water line elevation for the design storm. Avoid using bark, mulch, fertilizers, and pesticides in swale bottoms or sides. These materials tend to run off the planted area and into the swales reducing its treatment effectiveness. When storm water control and landscaping are integrated, the following standards apply:

- Up to 15% of the total area of the swale designated for storm water infiltration may be covered with ground cover plants other than grass.
- Up to 10% of the total area of the swale designated for storm water infiltration may be elevated above the bottom of the swale to allow the planting of trees and shrubs.

The decrease in swale area resulting from this action will be compensated for by infiltration of runoff that occurs during the storm. If trees and shrubs will be used, plant them on the top perimeter of swale side slopes. Minimize shading the vegetation in the swale treatment area. A spacing of at least 20' (6 meters) is appropriate for trees planted close to a swale. Avoid planting trees that would continuously shade the entire length of the swale. In addition, avoid using bark, mulch, fertilizers, and pesticides in these areas. These materials tend to run off the planted area and into the swale reducing its treatment effectiveness.

D. Pretreatment

To protect ground water from possible contamination, runoff cannot be infiltrated without proper pretreatment. Pretreatment shall be provided by a grass buffer strip, sediment forebay, biofiltration swale, oil/water separator, or sediment trap.

E. Operation and Maintenance

Grass should be mowed to maintain an average grass height between 3"-9", depending on site characteristics. Monthly mowing is needed from May through September to maintain grass vigor. Grass clippings should be removed from the swale and composted on site or disposed of properly off site.

Sediment deposition at the head of the swale should be removed if grass growth is being inhibited for more than 10% of the swale length or if the sediment is blocking the even spreading or entry of water to the rest of the swale. Annual sediment removal and spot reseeding should be anticipated.

The swale should be regraded to produce a flat bottom width then reseeded if flow channelization or erosion has occurred. Regrading should not be required every year.

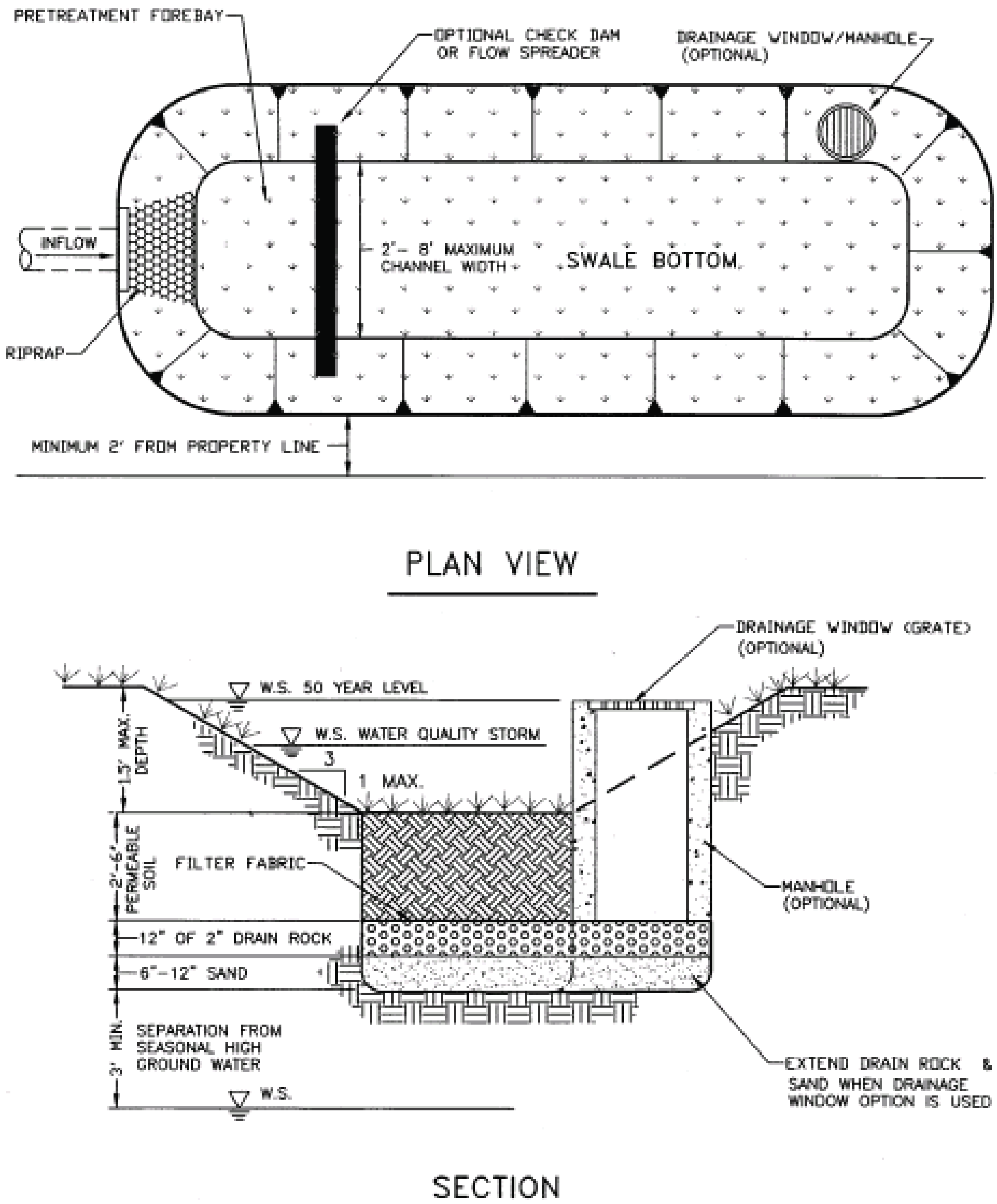

Figure 3.3. Infiltration Swale.

BMP4: PONDS (GENERAL)

A. Definitions

A detention pond (water quantity) (Figure 4.1) is a pond designed to collect and temporarily hold surface and storm water runoff from a site and release it at a slower rate than it is collected. The water should drain within 24 hours. Detention ponds are traditionally used to mitigate downstream impacts and alleviate flooding problems.

An extended detention pond (water quality) (Figure 4.2) is a pond designed to treat and release surface and storm water runoff from a site. Extended detention ponds are designed to provide water quality treatment and may be used to provide peak flow attenuation. The water is held for at least 48-72 hours to allow for treatment of pollutants by settlement, nutrient absorption, and filtering by plant materials.

B. Requirements for All Ponds

- Design Life

  The system should be designed for at least a 50-year life.

- Location

  Ponds should not be constructed in natural streams or wetlands. Ponds should be located off-channel and should only hold storm water runoff, not natural runoff.

- Site Evaluation/Site Suitability

  Sites should be evaluated for soils, depth to bedrock, and depth to water table. Requirements will depend on pond type. Ponds may be used at sites where a receiving body or structure can accept pond discharges. Ponds designed to meet on-site detention requirements shall not be located in regulatory flood plains. Also, ponds should not be used in areas where storm water has the potential to contain soluble metals, toxic organics, or where high sediment loads may occur.

- Design

  The design of any detention pond requires consideration of several factors. Balancing the requirements is done by developing an inflow hydrograph, a depth-storage relationship, and a depth-outflow relationship. The inflow/storage/outflow relationships should be based on a storm duration that identifies a peak detention pond volume for the storm interval required. Refer to Appendix A, Section 3.B(6) for water quantity and quality design criteria.

The factors to be considered include:

- basin size
- minimum free board
- maximum allowable depth of temporary ponding
- recurrence interval of the storm being considered
- storm duration
- timing of the inflow
- allowable outflow rate
- the length of time water remains in the facility.

- Maximum Outflow Rate

  The maximum outflow rate shall not be more than the pre-development rate of runoff for each storm return interval. The receiving system must be shown to be capable of accommodating the pre-development flow.

- Outlets

  Outlet pipes shall be at least 12" in diameter. If riser pipes are used, they shall be 1 1 /2 times the cross sectional area of the outfall pipe. Trash racks or anti-vortex devices shall be installed. All pipe joints are to be watertight. Anti-seep cutoff walls, 8" thick, or other seepage control methods are to be installed around outlet pipes. The channel immediately below the pond outfall shall be protected against erosion and shall transition to natural drainage conditions in the shortest distance possible.

- Dam Safety Requirements

  If a pond is categorized as a dam by the State of Utah, the relevant sections of the Utah Code will apply. Contact the Utah Division of Water Rights for more information on dam safety requirements.

- Vegetative Buffers

  Vegetative buffer strips shall be established around the perimeter of the pond for erosion control and additional sediment and nutrient removal. Buffer strips should include all areas between the normal pond water surface elevation to the top of the pond embankment.

- Side Slopes/Safety

  Take all practical safety precautions. Side slopes should not exceed 4:1 (3:1, if the pond will normally remain dry).

- Soils

  A soils investigation is required on all ponds. At a minimum, it shall include information along the centerline of the proposed dam in the emergency spillway location and the planned borrow area. It should include recommendations on cutoff trenches, compaction, and any other special design requirements.

- Freeboard and Emergency Spillway

  All open surface facilities shall be designed with adequate freeboard above the maximum design water elevation. Emergency spillways are required on all ponds. The spillway shall be sized to safely pass the 100-year developed peak flow.

- Maintenance Access

  Direct access to the pond bottom, inlet sedimentation area, and control structure is required. A right-of-way maintenance easement from a road to the pond (if not accessible from the public right-of-way), shall be provided.

- Inspection

  Detention ponds should be inspected during regular semi-annual inspections to determine maintenance needs.

BMP4.1: DETENTION PONDS

A. Definition

Detention ponds are designed to detain a volume of water to attenuate peak flows. A wet pond has a permanent pool and provides temporary storage of storm water runoff. A dry detention pond does not maintain a permanent pool between storm events.

B. Applicability

Detention ponds are suitable in residential, commercial, and industrial sites.

C. Pond Geometry

The pond can be any shape provided that it has sufficient capacity to meet general design requirements.

D. Outlet Design

At the peak flow rate, pond volume shall be equal to the difference between pre and post-development storm volumes. The outlet structure shall be designed in accordance with the water quantity and quality requirements of Appendix A, Section 3.B(6). The outlet design shall incorporate a multi-stage riser that will allow water (above the permanent pool, in a wet pond) to be drained over 24 hours. The outlet shall be designed to mimic pre-development flow rates. The outlet structure shall be designed to prevent clogging and plugging.

E. Construction Requirements

Detention ponds shall be excavated in a manner that will minimize disturbance and compaction of the pond. Sediment measuring devices shall be installed at opposite ends of the bottom of the basin or sediment trap to measure sediment accumulation.

F. Sediment Storage

Ponds shall be designed to contain computed storage volume plus 15% of the computed storage volume to adequately accommodate sediment deposition.

G. Forebay/Sediment Trap

Each pond shall have a sediment forebay or equivalent upstream pretreatment. The forebay shall have a separate cell formed by an acceptable barrier. A fixed vertical sediment depth marker shall be installed in the forebay to measure sediment accumulation.

Minimum forebay size shall be equal to 15% of the water quality treatment volume. Optimal volume should be equal to 25% of the water quality treatment volume. Forebay volume shall be in addition to permanent pool volume, where applicable, and shall be separated from permanent pool, if possible. A weir flow structure or physical separation with pipes may be utilized. A rock or an earthen berm shall be constructed with a minimum top width of 4' and side slopes no steeper than 3:1 to provide separation from the permanent pool. A drainpipe should be included in the forebay to dewater the pool area for maintenance purposes.

H. Inlet Protection

The inlet shall be protected against erosion or scour. Riprap or other material may be required at the inlet to provide for energy dissipation.

I. Stabilization

Wet detention 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 vegetatively stabilized, established, and maintained. Whenever possible, wetland plants should be used in a pond design, either along the aquatic bench or within shallow areas of the pool.

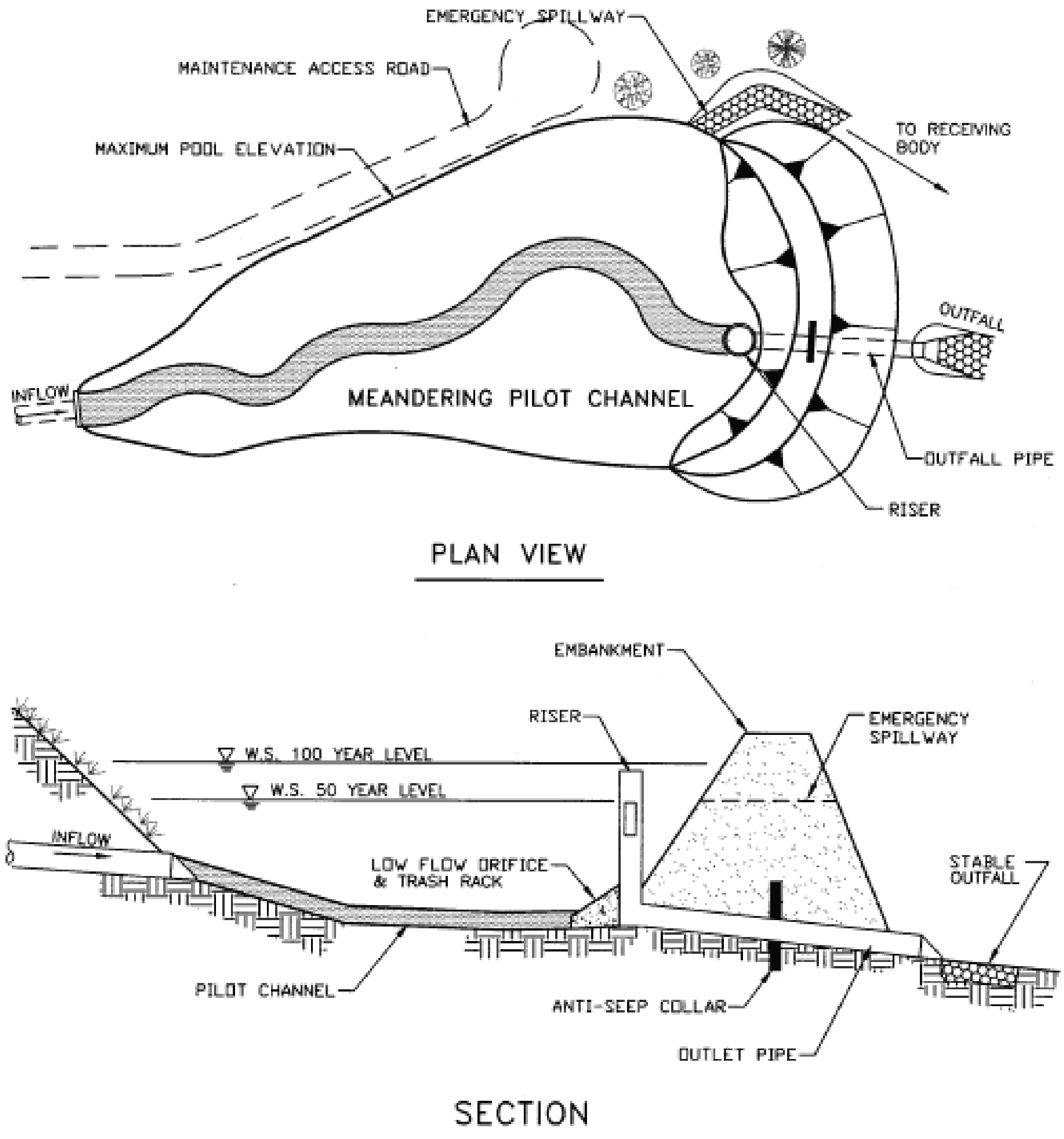

Figure 4.1.   Detention Pond.

BMP4.2: EXTENDED DETENTION PONDS

A. Definition

An extended detention pond is a constructed pond designed to detain a volume of water for a minimum time to allow for the settling of particles and associated pollutants. This type of pond can also be utilized for flood control by including additional temporary storage for peak flows. A wet extended detention pond incorporates both a permanent pool and extended detention. Dry extended detention ponds do not maintain a permanent pool between storm events.

B. Applicability

Ponds should not be used where storm water has the potential to contain soluble metals or toxic organics. In addition, ponds placed in areas where high sediment loads may occur, require frequent maintenance but still may be the most cost-effective treatment method. A wet extended detention pond is suitable in residential, commercial, and industrial sites. It is appropriate in areas where nutrient loadings are expected to be high. Dry extended detention ponds do not maintain a permanent pool between storm events.

C. Pond Geometry

The pond shall be designed to lengthen the flow path, thereby increasing detention time and limiting peak flow rates to pre-development rates. Shallow basins with large surface areas also provide better removal efficiencies than small deep basins. The pond geometry shall meet the following criteria:

- Permanent pool depth shall not exceed 12' with an average depth between 4-6'.
- Length from inlet to outlet should be as far apart as possible.
- Length to width ratio should be approximately 3:1 and side slopes should be 4:1.

D. Sizing

Size the pool according to the design storm criteria in Appendix A, Section 3.B(6). The critical parameters in determining the size of the basin are the storage capacity and the maximum rate of runoff released from the basin. The design shall provide an average of 48-72 hours detention time. This design objective can be achieved by setting the maximum detention time for the greatest runoff volume at approximately 40 hours. The average detention time for very small storms should be at least 6 hours.

E. Forebay

Each pond shall have a sediment forebay or equivalent upstream pretreatment. The forebay shall have a separate cell formed by an acceptable barrier. A fixed vertical sediment depth marker shall be installed in the forebay to measure sediment accumulation.

Minimum forebay size shall be equal to 15% of the water quality treatment volume. Optimal volume should be equal to 25% of the water quality treatment volume. Forebay volume shall be in addition to permanent pool volume, where applicable, and shall be separated from permanent pool, if possible. A weir flow structure or physical separation with pipes may be utilized. A rock or an earthen berm shall be constructed with a minimum top width of 4' and side slopes no steeper than 3:1 to provide separation from the permanent pool. A drainpipe should be included in the forebay to dewater the pool area for maintenance purposes.

F. Outlet Design for a Wet Extended Detention Pond

The outlet shall be designed to pass a flow rate necessary for extended quantity attenuation. The outlet design shall incorporate a multi-stage riser that will allow water to be drained over a minimum of 48-72 hour period depending upon the design storm.

Ponds may be constructed with safety benches. The perimeter of all deep permanent pool areas (at least 4' deep) shall be surrounded by two safety benches with a combined minimum width of 15'. The benches should be designed as follows:

- A safety bench that extends landward from the normal water level edge to the toe of the pond side slope. The maximum slope of the safety bench shall be 12%.
- An aquatic bench that extends from the normal shoreline and has a maximum depth of 18" below the normal pool water surface elevation. Pond slope between the top of the bank and bench shall not exceed 2:1.

G. Outlet Design for a Dry Extended Detention Pond

A perforated riser can be used to slowly release the water over a prolonged period. A cutoff collar should be considered for the outlet pipe to control seepage.

H. Construction Guidelines

Wet extended detention ponds should be excavated in a manner that will minimize disturbance and compaction of the pond. Sediment measuring gauges should be installed at opposite ends of the bottom of the basin to measure sediment accumulation.

I. Stabilization

A landscaping plan for a wet extended detention pond and its buffer shall be submitted to indicate how aquatic and terrestrial areas will be vegetatively stabilized and established. Whenever possible, wetland plants should be used in a pond design, either along the aquatic bench or within shallow areas of the pool. Bottom and banks of all dry extended detention ponds shall be stabilized with gravel, rock, vegetation, or other acceptable material to control dust and prevent erosion.

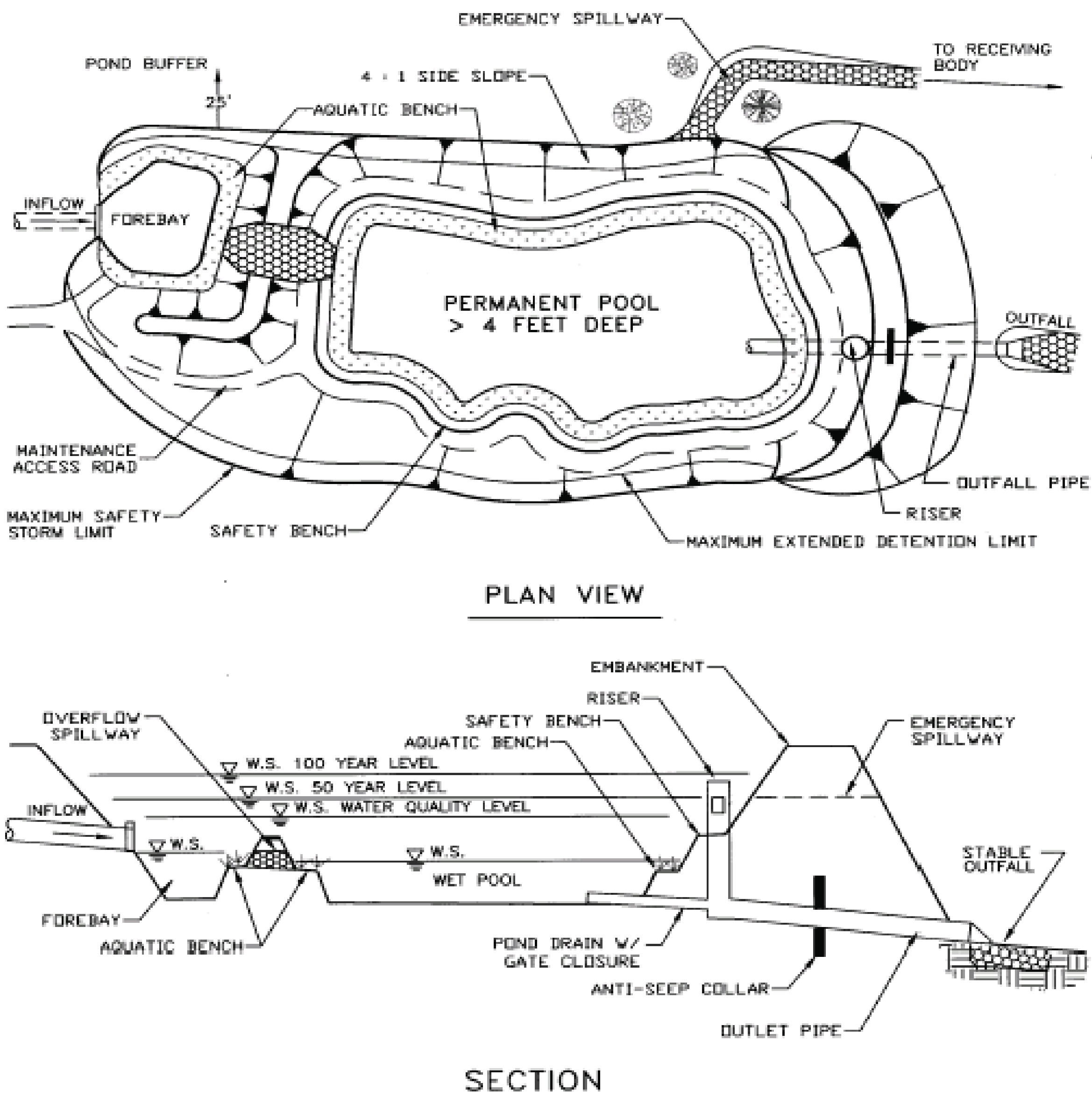

Figure 4.2. Extended Detention Pond.

BMP5: BIOFILTRATION SYSTEMS

A. Introduction and Purpose

This section includes requirements that apply to biofiltration swales (Figure 5.1) and grass buffer strips (Figure 5.2). These BMPs are pre-treatment systems that utilize plant materials for various physical and biological processes in the water quality treatment of runoff. These systems should not be used alone to treat storm water runoff. Rather, they should be used in combination with other structural and nonstructural BMPs to improve water quality.

B. Plan Submittal Requirements

The applicant will be required to provide a written report that includes the Plan Submittal Requirements and a Landscape Plan.

C. Sizing

Unless a bypass is included, the biofilter must be sized as both a treatment device and to pass the peak hydraulic flows. The depth of the storm water should not exceed the height of the grass.

D. Landscaping

Vegetate biofilters with fine, close-growing, water-tolerant grasses that can withstand seasonally saturated soils. Biofilters shall not be used to manage storm water until the vegetation is established. The side slopes of a biofilter should be vegetated to prevent erosion. Barrier shrubs, such as barberry, planted around the biofilter should be considered when there is a high potential for people to damage the biofilter or hinder the biofilter's function. Other grasses or nonaggressive ground covers are appropriate if recommended by a landscape professional.

If trees will be planted near the biofilter, then minimize shading the vegetation in the biofilter treatment area. A spacing of at least 20' (6 meters) is appropriate for trees planted close to a biofilter. Avoid planting trees that would continuously shade the entire length of the biofilter. In addition, avoid using bark, mulch, fertilizers, and pesticides in these areas. These materials tend to run off the planted area and into the biofilter reducing its treatment effectiveness.

E. Operation and Maintenance

Systems should be inspected during regular semi-annual inspections. This inspection schedule applies to all biofiltration systems unless otherwise noted.

Grass shall be mowed to maintain an average grass height between 3 -9", depending on the site situation. Monthly mowing is needed from May through September to maintain grass vigor. Grass clippings should be removed from the swale and composted on site or disposed of properly off site.

Sediment deposited at the head of the swale shall be removed if grass growth is being inhibited for more than 10% of the biofilter length or if the sediment is blocking the even spreading or entry of water to the rest of the facility. Annual sediment removal and spot reseeding should be anticipated.

If flow channelization or erosion has occurred, the facility shall be regraded, then reseeded as necessary.

Access for mowing equipment and maintenance shall be provided. Consideration should be given to providing wheel strips in the bottom of the swale if vehicular access (other than grass mowing equipment) is needed.

BMP5.1: BIOFILTRATION SWALES

A. Description

Biofiltration swales are storm water runoff systems which treat and then discharge storm water runoff to another system.

B. Design

- A hydraulic residence time for the storm water runoff of 9 minutes is required.
- Water velocity, as determined by Manning's "n", should not exceed 0.9 feet/second.
- The Manning's "n" for grass shall be in the range between 0.02 and 0.024.
- Swales shall be sloped as necessary to obtain the desired design velocity and residence time.
- If flow is to be introduced to the swale via curb cuts, then curb cut pavement elevation shall be no higher than 6" above swale. Curb cuts should be between 12-36" wide.
- Install a flow spreading device at the swale inlet. Appropriate devices include shallow weirs, stilling basins, and perforated pipes. Provide a sediment clean-out area. A sediment catch basin or a larger pre-settling device would control sediments at the swale inlet and allow for easy maintenance.
- Provide for energy dissipation at the inlet. Appropriate means are stilling basins and rip rap pads.
- Swale using rip rap should be sized for the expected runoff velocity.
- Swale side slopes shall be no steeper than 3:1.Swale bottom width shall be no greater than 8'.The maximum depth of flow through the biofiltration swale shall be 3.0".

C. Setbacks and Separation Distances

Perimeter slope of the swale must be a minimum of 2' from property line.

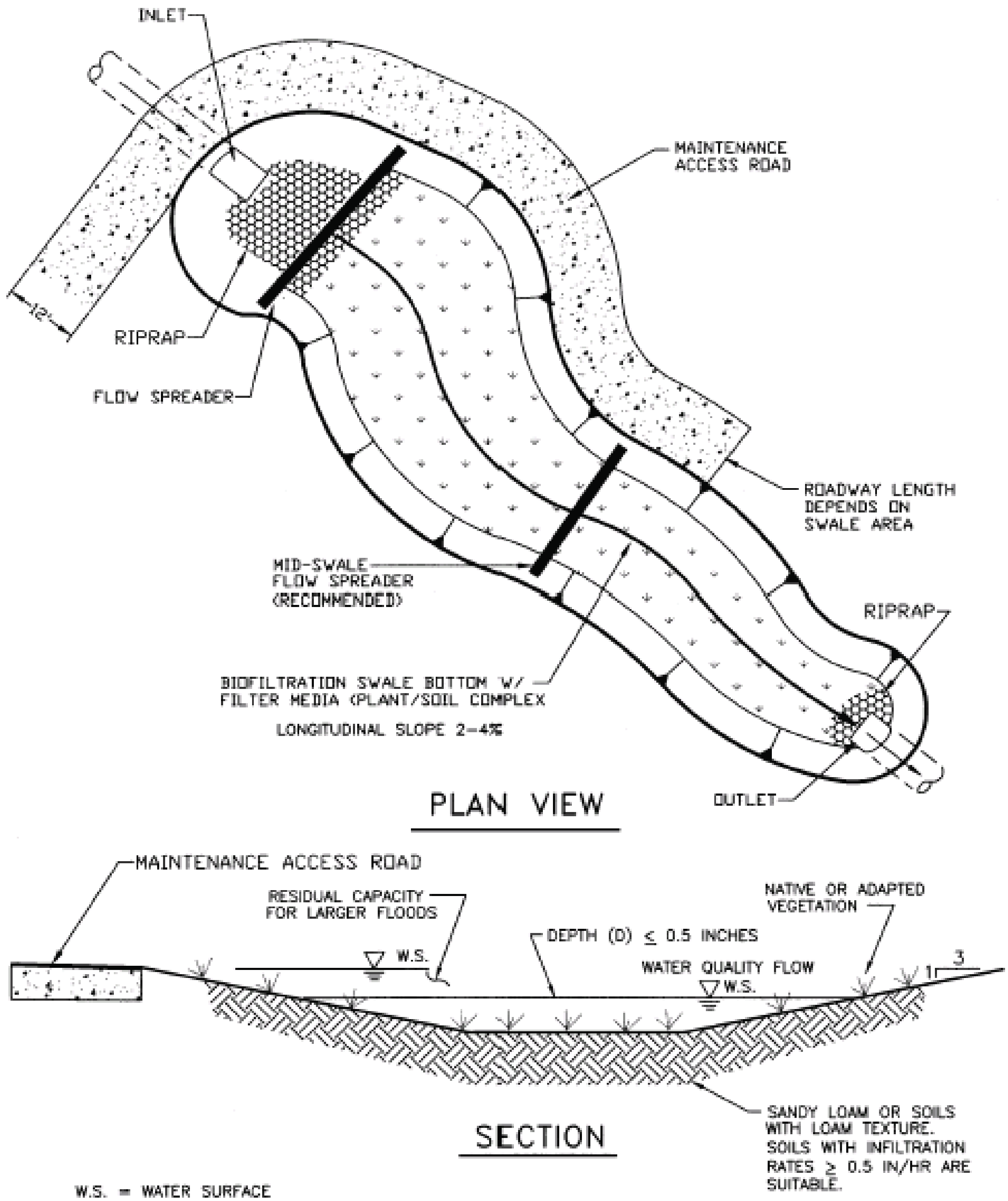

Figure 5.1. Biofiltration Swale.

BMP5.2: GRASS BUFFER STRIPS

A. Introduction

Grass buffer strips are used as a water quality pretreatment system for smaller sites.

B. Design

- The longest flow path from the area contributing sheet flow to the filter strip shall not exceed 150 feet.
- The lateral slope of the contributing drainage(parallel to the edge of pavement) shall be 2% or less.
- A hydraulic residence time of 9 minutes is required.
- A stepped series of flow spreaders installed at the head of the strip may be used to compensate for drainage areas having lateral slopes of up to 4%.
- The longitudinal slope of the contributing drainage area (parallel to the direction of flow entering the filter strip) shall be 5% or less.
- Grass buffer strips shall not be used when the contributing drainage areas has a longitudinal slopes steeper than 5% or energy dissipation and flow spreading should be provided up slope of the upper edge of the filter strip to achieve flow characteristics equivalent to those meeting the above criteria.
- The longitudinal slope of the strip (along the direction of flow) shall be between 1 - 20%.The lateral slope of the strip (parallel to the edge of pavement, perpendicular to the direction of flow) shall be less than 2 percent.
- The ground surface at the upper edge of the filter strip (adjacent to the contributing drainage area) shall be at least 1 inch lower than the edge of the impervious area contributing flows.
- Manning’s roughness coefficient (n) for flow depth calculations shall be 0.04.
- The maximum depth of flow through the filter strip for optimum water quality shall be 1.0 inch.
- The maximum allowable flow velocity for the water quality design flow (WQv) shall be 0.5 feet per second.

- Runoff entering the filter strip must not be concentrated. If the contributing drainage area is not smoothly graded to prevent concentrated flowpaths, a flow spreader shall be installed at the edge of the pavement to uniformly distribute the flow along the entire width of the filter strip. At a minimum, a gravel flow spreader (gravel-filled trench) shall be placed between the impervious area contributing flows and the filter strip. The gravel flow spreader shall be a minimum of 6" deep and shall be 18" wide for every 50' of contributing flowpath. Where the ground surface is not level, the gravel spreader must be installed so that the bottom of the gravel trench is level.

- Energy dissipaters are needed in the filter strip if sudden slope drops occur, such as locations where flows in a filter strip pass over a rockery or retaining wall aligned perpendicular to the direction of flow. Adequate energy dissipation at the base of a drop section can be provided by a rip rap pad.

C. Landscaping

Trees and shrubs should not be located within a grass filter strip.

D. Maintenance

Inspections should occur semi-annually to determine maintenance needs. Access shall be provided at the upper edge of the filter strip to enable maintenance of the inflow spreader throughout the strip width and allow access for mowing equipment.

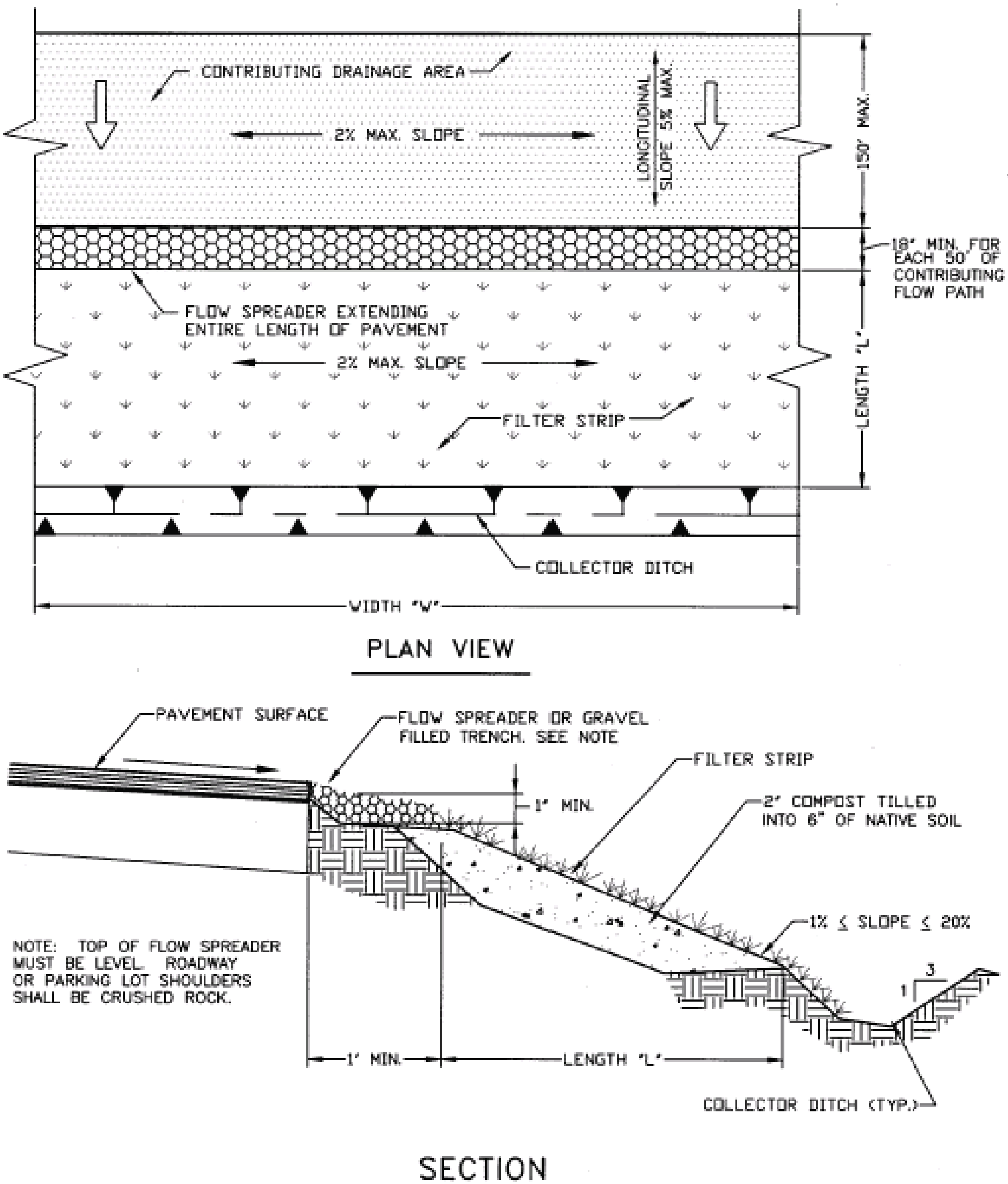

Figure 5.2. Grass Buffer Strip.

BMP6: SAND FILTERS

A. Introduction

Sand filters consist of self-contained beds of sand either underlain with underdrains or cells and baffles with inlets/outlets. Storm water runoff is filtered through the sand, and in some designs may be subject to biological uptake. The four most commonly used sand filter systems are the Austin Sand Filter, the Delaware Sand Filter, the Trench Filter, and the Pocket Sand Filter.

- Austin Sand Filter

  The Austin sand filter (Figure 6.1), or surface sand filter, consists of a sedimentation chamber or pond followed by a surface sand filter with collector underdrains in a gravel bed. Filtered runoff is conveyed to a storm sewer or channel by gravity flow of pumping.

- Delaware Sand Filter

  The Delaware sand filter (Figure 6.2), or perimeter system, consists of parallel sedimentation and sand filter trenches connected by a series of level weir notches to assure sheet flow onto the filter. Filtered runoff is conveyed to a storm sewer by gravity flow or pumping.

- Underground Sand Filter

  The underground sand filter (Figure 6.3) is place underground but maintains essentially the same components as the Austin sand filter. The filter consists of a 3 chamber vault. A 3' deep wet sedimentation chamber is hydraulically connected by an underwater opening to provide pretreatment by trapping grit and floating organic material. The second chamber contains as 18-24" sand filter bed and an under drain system including inspection/cleanouts wells. A layer of plastic filter cloth with a gravel layer can be placed on top of the sand bed to act as a pre-planned failure plane which can be replaced when the filter surface becomes clogged. The third chamber collects the flow from the under drain system and directs flow to the downstream receiving drainage system.

- Pocket Sand Filter

  The Pocket sand filter (Figure 6.4) is a simplified and low cost design suitable for smaller sites. Runoff is diverted within a catch basin. Pre-treatment is provided by a concrete flow spreader, a grass filter strip, and a plunge pool. The filter bed is a shallow basin and contains the sand filter layer. The surface of the filter bed may contain either a soil layer or grass cover crop.

B. Application and Limitations

Sand filters may be designed as trench systems to receive and treat parking lot runoff, and have been used to replace oil/water separators for pre-treatment. The storm water runoff is discharged or conveyed to another BMP for further treatment or disposal. Depending on soil types, sand filters may be designed as a stand-alone BMP to infiltrate all or a portion of treated runoff. Subsurface disposal restrictions will apply to this application.

The typical drainage area to be served by a sand filter should range from 0.5 to 10 acres. Depending on design, the contributing drainage area may be up to 50 acres.

C. Sizing

Sizing should be based on anticipated sediment accumulation and maintenance. Sand filters shall be sized using the following criteria:

- The sand filter shall be sized for water quality design storm requirements if it will be used as an off-line treatment facility.
- The maximum depth of water over the sand shall be 1'.
- Calculate the sand filter surface area using Darcy's Law or the filtration rate.
- The sand filter shall be designed to completely drain in a 24 hours or less.
- The filtration rate shall be 2" per hour.

D. Pretreatment

Sand filters should be preceded by pretreatment to allow for the settling of coarse sediment that may clog the sand filter and reduce its effectiveness. Pretreatment systems that may be used are sedimentation basins, grass buffer strips, biofiltration swales, or catch basin inserts.

E. Design

The sand bed shall include a minimum of 18" of 0.02-0.04" diameter sand or ASTM C-33 sand. If infiltration into the underlying soil is not desired, the bottom of the system shall be lined with one of the following impermeable layers:

- a minimum 12" thick layer of clay

- a concrete liner with approved sealer or epoxy coating, at least 5", reinforced with steel wire mesh (use 6 gauge or larger wire and 6" x 6" smaller mesh, or a geomembrane layer).

The bed of the filter should be composed of gravel, measuring at least 4-6"; 2" drain rock may also be used.

When sand filters are designed as off-line BMPs, they should be sized for the water quality design storm and the storm water conveyance should be fitted with flow splitters or weirs to route runoff to the sand filter. Excess runoff bypasses the sand filter and continues to another BMP for water quantity control. The inlet structure should be designed to spread the flow uniformly across the surface of the filter; use flow spreaders, weirs, or multiple orifices.

F. Design Life

Final ownership of the system may affect the design, layout and materials used in a system. The designer should specify the materials for the system and at a minimum, the system should be designed for a 50-year life.

G. Setbacks and Separation Distances

When sand filters infiltrate to the subsurface, the following requirements apply:

- Sand filters must be a minimum of 100' from public and private wells.

- There shall be a 5' vertical separation distance between the infiltration surface and bedrock.

- There shall be a 100' separation distance from surface water supplies used as drinking water and a 50' separation distance from surface water supplies not used as drinking water.

- There shall be a minimum 3' vertical separation distance from the infiltration surface and the seasonal high ground water table.

H. Maintenance

- For the first few months after construction, the sand filters should be inspected after every storm. Thereafter the sand filters should be inspected semi-annually to determine maintenance needs.

- The sand filters should be raked periodically to remove surface sediment, trash, and debris.

- Sediments shall be disposed of in accordance with local, state, and federal regulations.

- The top layer of sand should be replaced annually, or more frequently when drawdown does not occur within 36 hours after the presettling basin has emptied.

- The water level in the filter chamber should be monitored on a quarterly basis and after large storms during the first year.

- The sedimentation chamber should be pumped out or extracted when the sediment depth reaches 12".

- Oil on the surface should be removed separately and recycled. The remaining material may be removed by a vacuum pump and disposed of according to local, state, and federal regulations.

I. Maintenance Access

- Unobstructed access shall be provided over the entire sand filter by either doors or removable panels.

- Access to the sand filter should be provided for maintenance, including inlet pipe and outlet structure.

- Ladder access is required when vault height exceeds 4'. Access openings should have round solid locking lids with ½" diameter allen head screw locks.

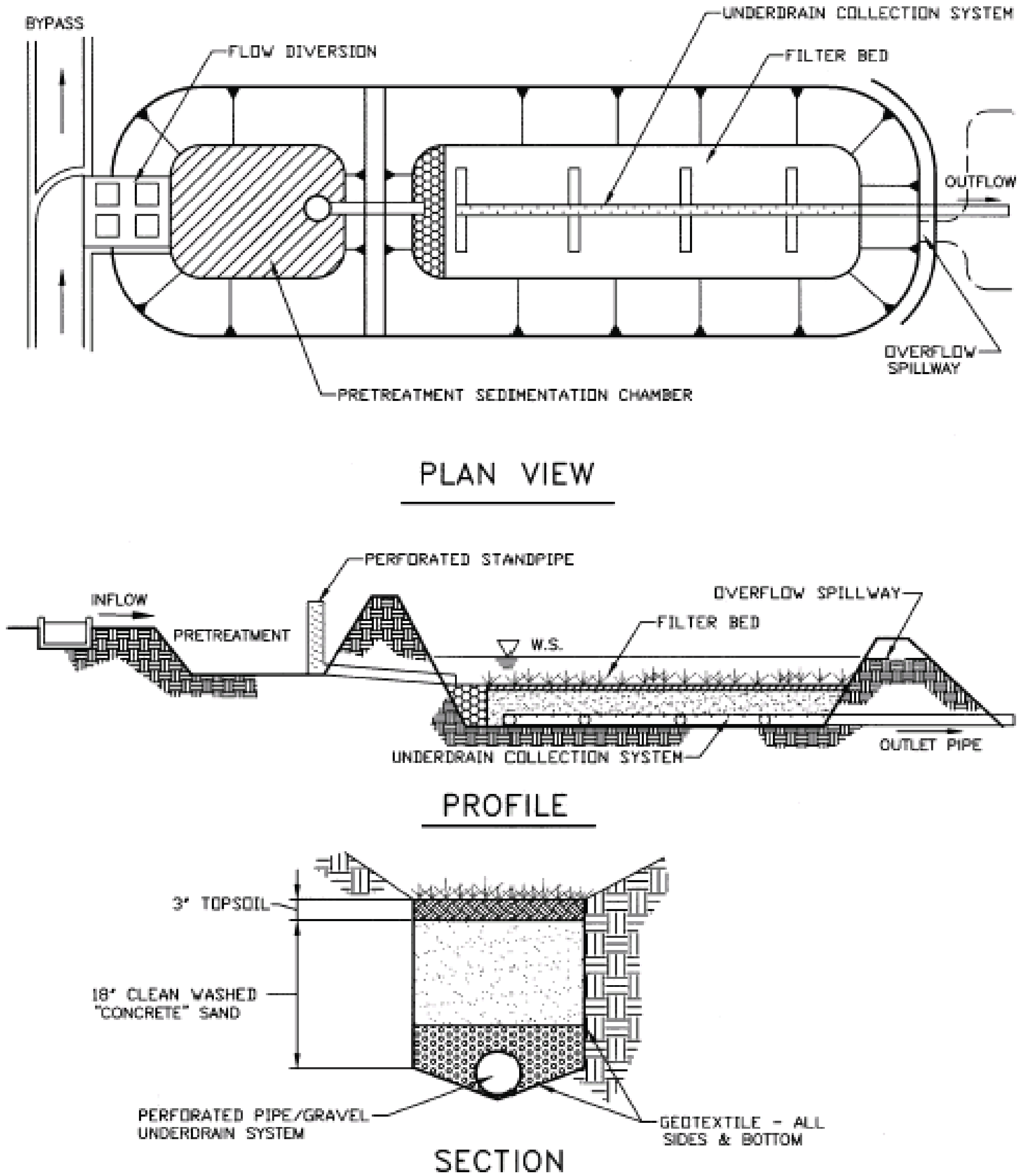

Figure 6.1. Austin Sand Filter.

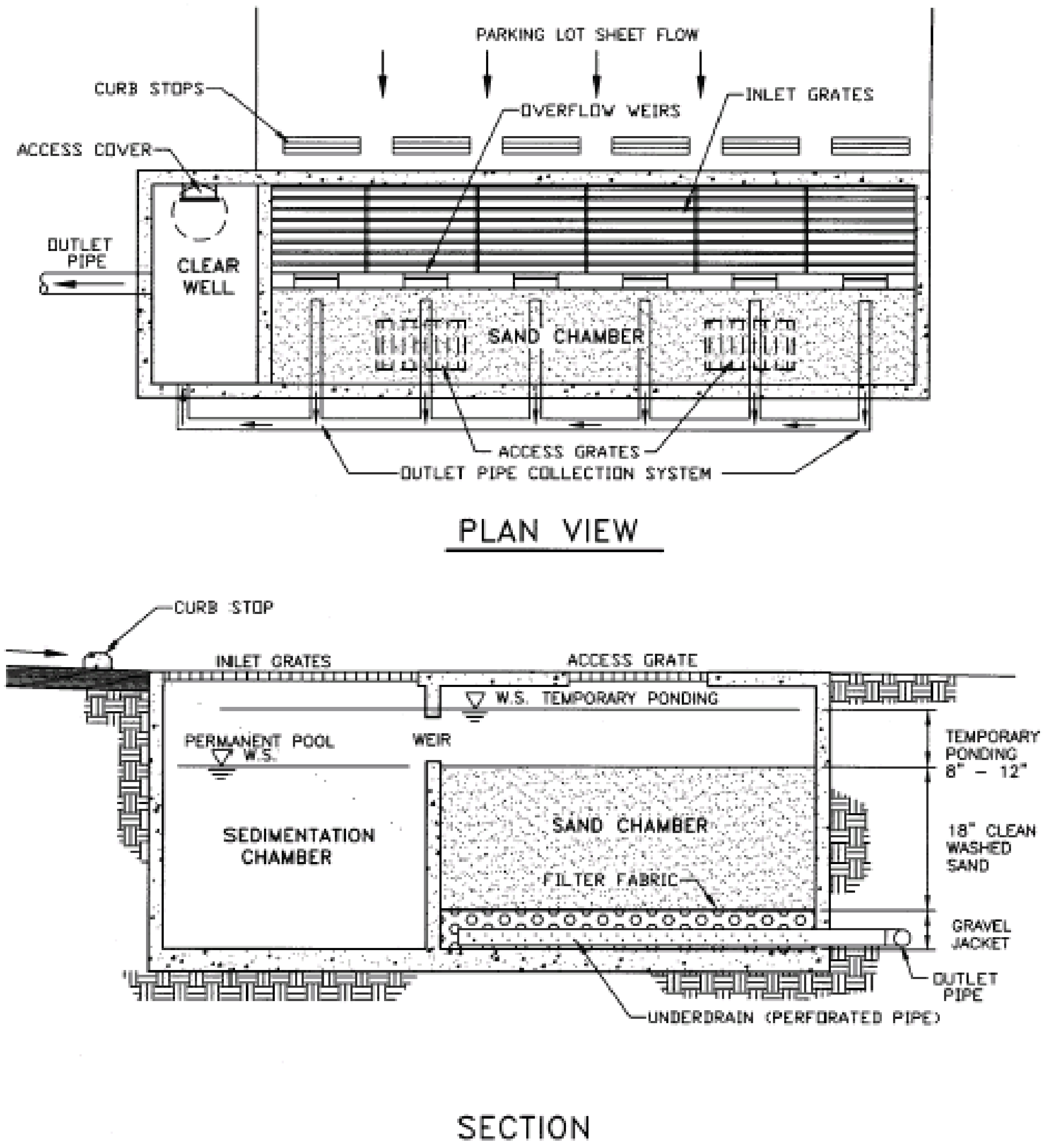

Figure 6.2. Delaware Sand Filter.

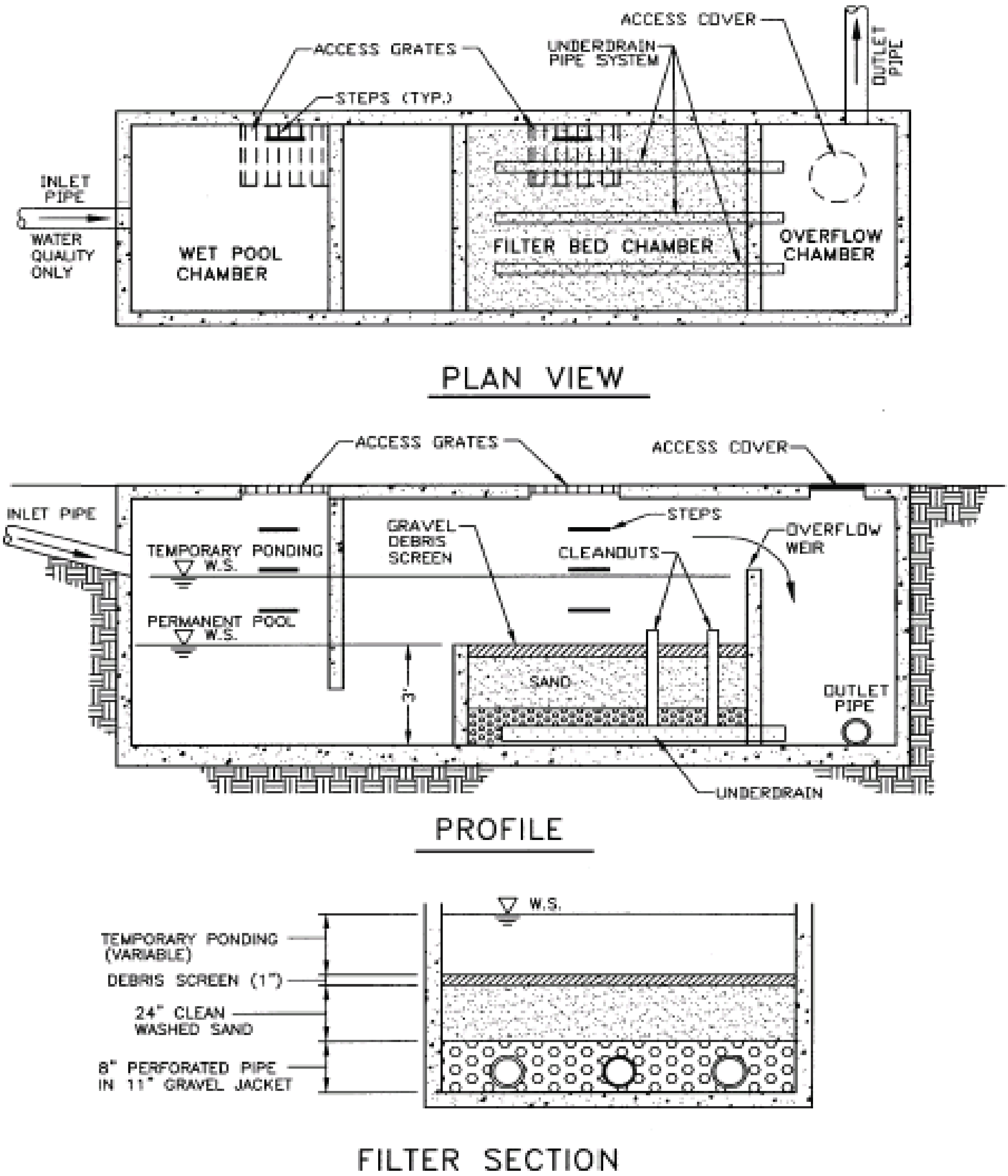

Figure 6.3. **Underground Sand Filter.**

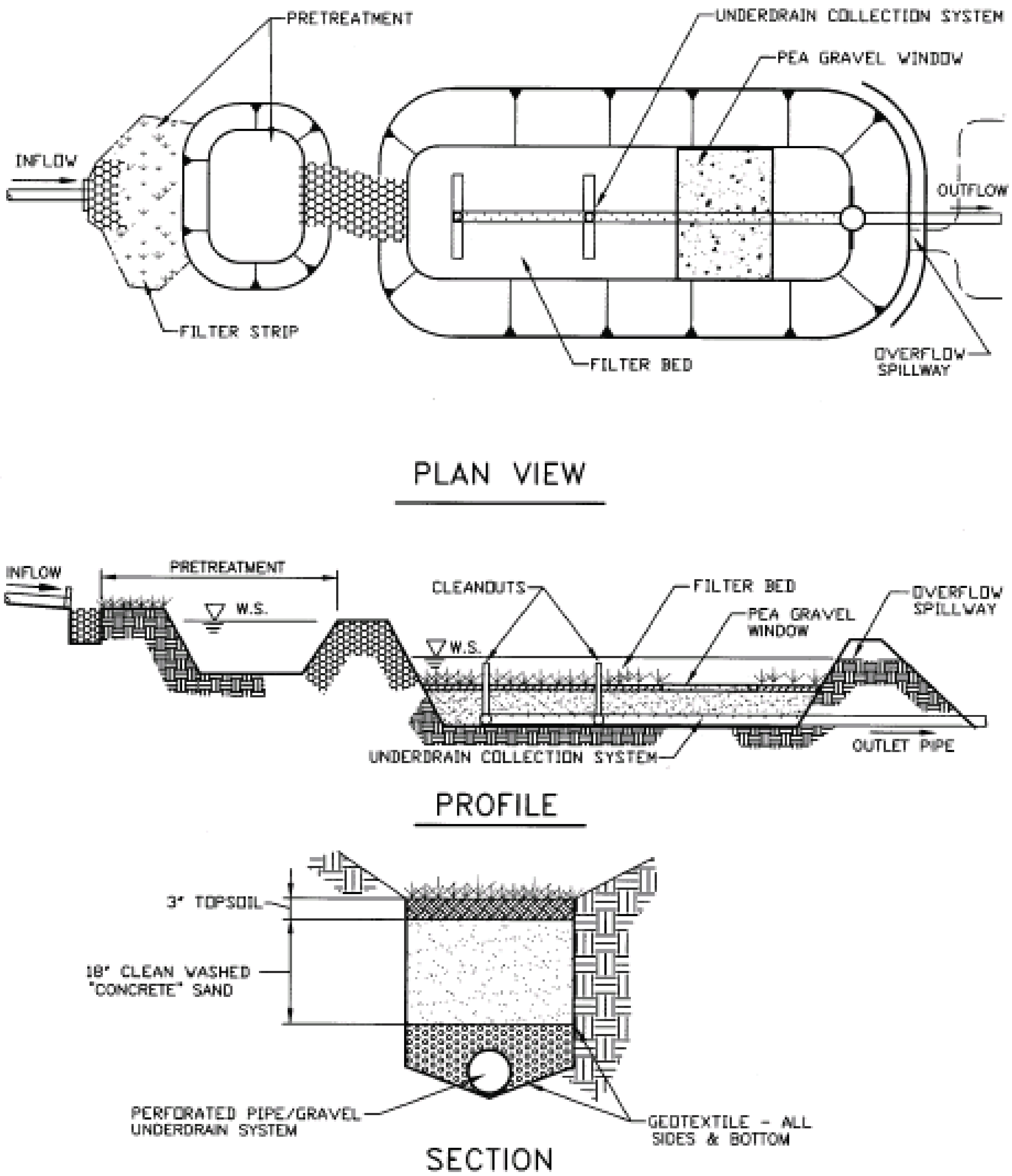

Figure 6.4. Pocket Sand Filter.