

# **STANDARD OPERATION MANUAL**

**For**

## **Water Quality Filter Strips and Bio-slopes**

**Implemented: October 2018**



**Figure 1: Typical installation of a bio-slope**

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## 1. Introduction and Purpose

The purpose of this manual is to:

- define water quality filter strips and bio-slopes
- identify types of filter strips and bio-slopes
- describe the operation of filter strips and bio-slopes

## 2. Definitions

**Drainage Facility Identification (DFI)** – A unique number assigned to ODOT water quality facilities. The DFI is used to link the water quality facility to an O&M manual and asset management systems. ODOT's Geo-Environmental Hydraulic Engineering Program Lead assigns DFI numbers.

**Filter Strip** – Filter strips are flow-through water quality facilities located along the right-of-way parallel to the road. They are designed to treat sheet flow from adjacent impervious surfaces and consist of a relatively flat cross slope to maintain sheet flow over the entire width of the strip. Treatment occurs as the stormwater runoff flows through the grass and soil surface.

**Bio-slope** – Bio-slopes are flow-through water quality facilities incorporated into roadside embankments. They are located between the edge of pavement and a downstream conveyance system. Bio-slopes use a variety of physical, biological, and chemical treatment processes to provide stormwater treatment.

**Flow Spreader** – A design feature used to increase the surface area of the flow. Flow spreaders change flow type from convergence flow to sheet flow. The flow is spread out over a broader area using berms, weirs, or aggregate. The aggregate shoulder typically acts as the flow spreader for filter strips and bio-slopes.

**Rill** – A shallow channel created by erosion and overland flow. Rills should be mitigated by tilling the soil to maintain sheet flow conditions.

**Sheet Flow** – A type of runoff flow characterized by its sheet-like appearance. Sheet flow moves downslope in a thin, continuous film. It does not channelize into features larger than rills.

### 3. Overview

ODOT utilizes water quality filter strips and bio-slopes to treat stormwater runoff sheet flow from adjacent roadways. Water quality filter strips and bio-slopes target pollutants such as sediment, oils, grease, and metals through a variety of processes. The standard operational plans for water quality filter strips and bio-slopes are provided in Appendix A. The plans illustrate and describe the typical footprint, configuration, and components associated with the facilities.

#### What is a filter strip?

A water quality filter strip is an area of vegetation or media that provides pretreatment for stormwater runoff. Vegetation, such as grasses and native plantings, are used in temperate climates. In arid areas, aggregate media may be used instead of vegetation if the underlying soil supports infiltration. The underlying soil can be amended to create an approved water quality mix if the existing soil does not meet infiltration standards. Filter strips tend to be rectangular in design and consist of the right-of-way parallel to the road with a relatively flat cross slope to maintain sheet flow of stormwater runoff over the entire width of the strip. Filter strips are recommended for highway application because of their minimal maintenance requirements.

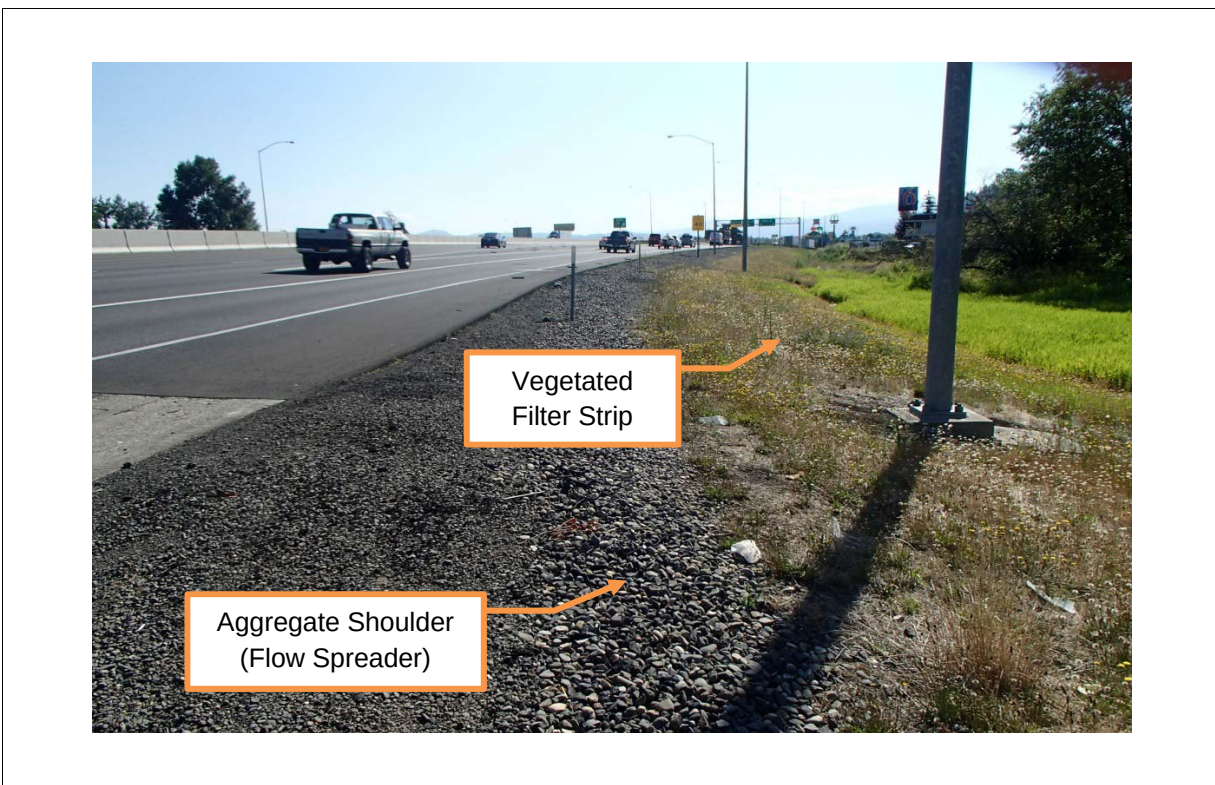


Figure 2: Example of a vegetated filter strip



## What is a bio-slope?

Bio-slopes are often used in conjunction with water quality filter strips. Bio-slopes are flow-through stormwater treatment facilities incorporated into roadside embankments. A bio-slope uses an ecology mix to provide treatment for stormwater. Bio-slopes are recommended for highway application because of their minimal right-of-way requirements and minimal maintenance requirements. Synonyms for bio-slopes include ecology embankments and media filter drains.

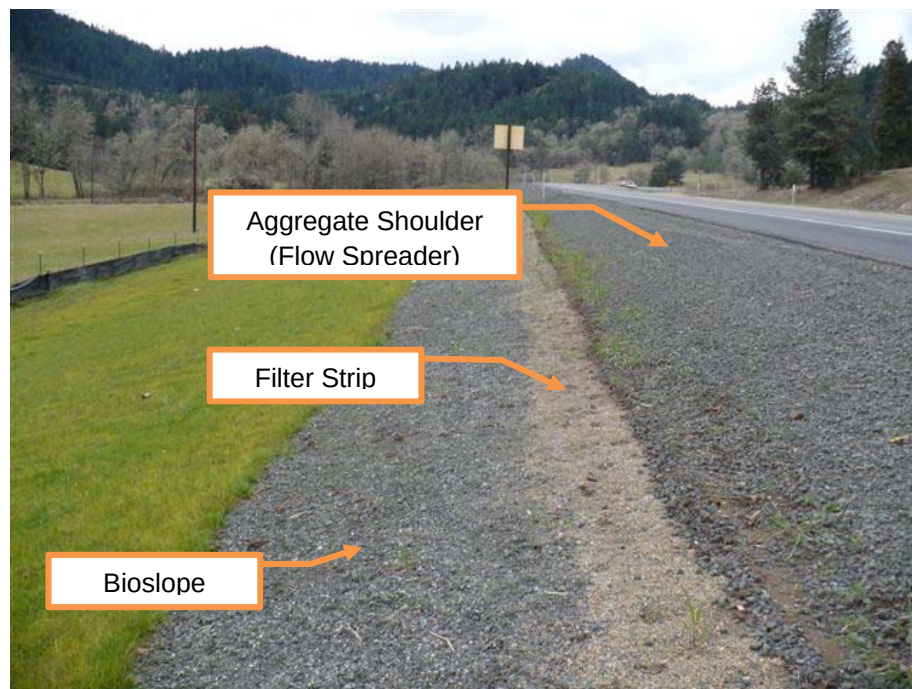


Figure 3: Example of a bioslope with filter strip

## How to identify water quality facilities in the field:

ODOT's Geo-Environmental Section maintains a stormwater facility inventory. Facility location is listed by highway and mile post. Water quality facilities are indicated in the field by type S1 and/or type S2 markers (Figure 4, Figure 5).

- Red type S1 marker: indicates the beginning of the facility maintenance area
- Green type S1 marker: indicates the end of the facility maintenance area
- Type S2 marker: white paddle with a blue stripe and the assigned DFI number

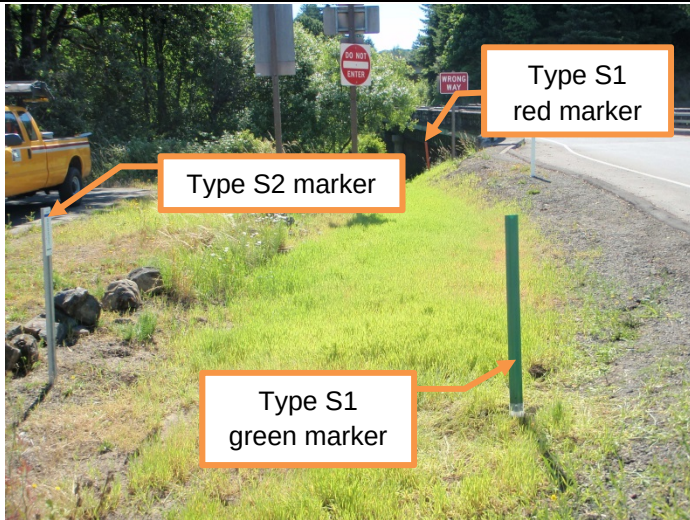


Figure 4: Water quality facility field markers



Figure 5: Type S2 marker detail

Water quality facility field markers are included on standard and site specific operational plan drawings (Figure 6).

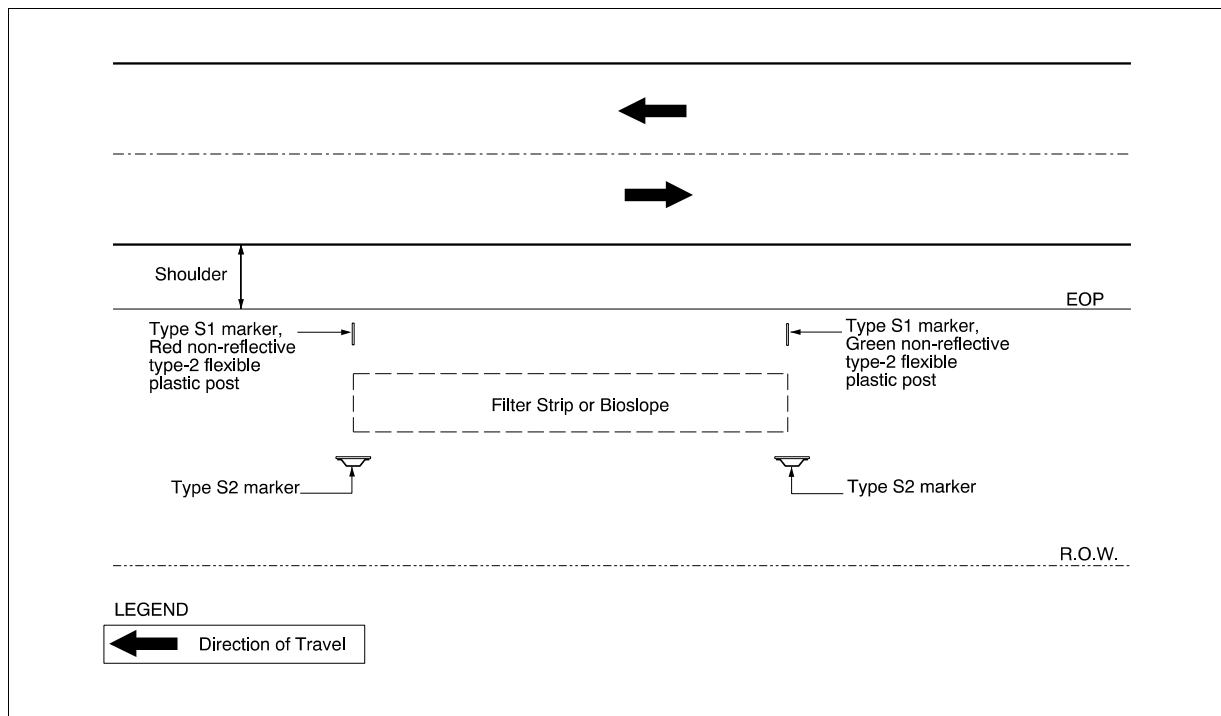


Figure 6: Field location of S1 and S2 markers

## How to locate water quality facilities using TransGIS:

TransGIS may be used to locate water quality facilities. TransGIS is a web-based, interactive mapping service available to all internet users. The facility location (highway, mile post, district, region), type of facility, DFI number, and an electronic version of the O&M manual can be viewed using TransGIS. **NOTE: Facility mile posts are determined from the V-file, and may vary from the TransGIS mile posts.**

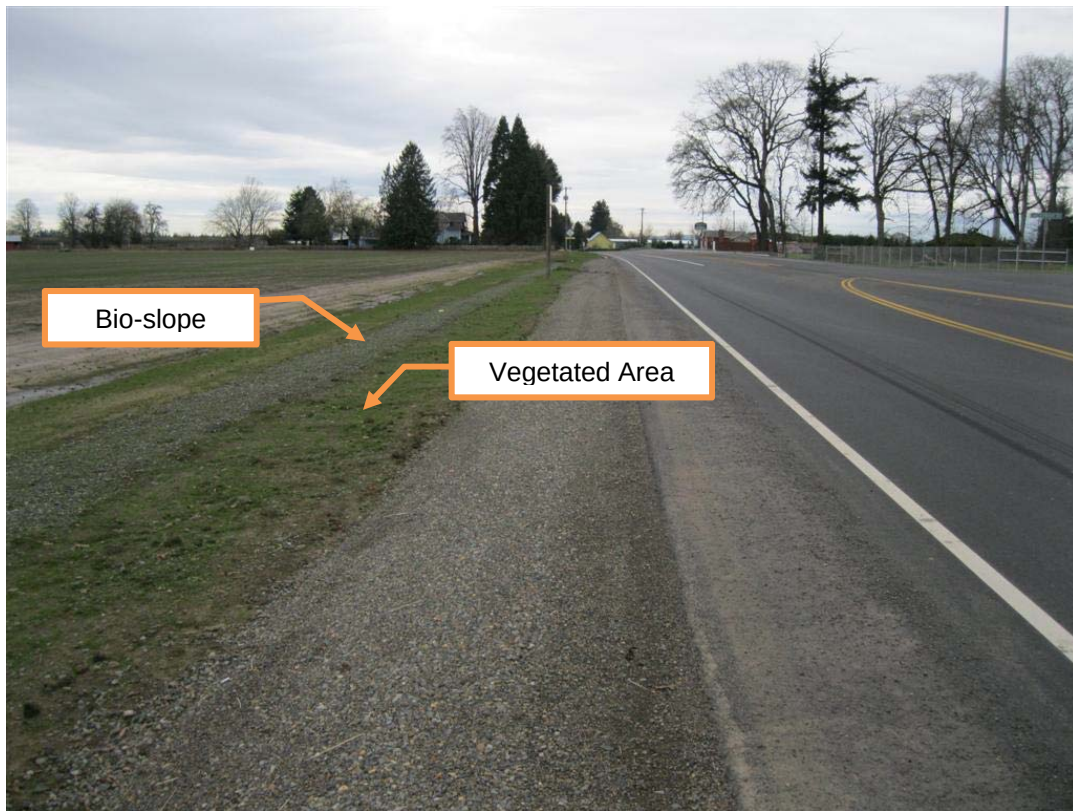
Link to TransGIS: <https://gis.odot.state.or.us/transgis/>

## How to view O&M Manuals in TransGIS

- Select “Drainage” from the Layer Catalog menu on the left
- Select “Stormwater Management Facilities”
- Click “Apply” on the bottom left of the screen
- Select the “Identify Features”  button on the toolbar above the map
- Click on any facility  button on the map to identify features
- A dialog box appears with facility information and links to the O&M manual and maintenance tables

## How does a filter strip operate?

Water quality filter strips provide treatment for sheet flow as the stormwater runoff flows through the grass, media, or soil surface (Figure 7). A flow spreader is used between the roadway pavement and filter strip to ensure that runoff is evenly distributed across the filter strip. This function is generally performed by the gravel shoulder. As the stormwater moves through the facility, the filter strip removes pollutants via physical trapping of particulates, settling, sorption, and some minor biological uptake. If the existing soil does not meet standards for filter strips, soils can be amended to create an approved water quality mix. The treated stormwater exits the facility and either continues downslope to the receiving outfall or enters a downslope bioslope for additional water quality treatment.



**Figure 7: Example of a bio-slope**



## How does a bio-slope operate?

Bio-slopes provide treatment for sheet flow from adjacent impervious surfaces (Figure 8). Stormwater sheet flow moves through a filter strip for pretreatment in route to the bio-slope. Runoff is filtered through the bio-slope. The bio-slope is composed of layered shoulder aggregate, ecology mix, granular drain backfill material, and drainage geotextile. Ecology mix is composed of aggregates, perlite, dolomite, and gypsum (Figure 11). Dolomite and gypsum provide a buffer for acidic pH conditions and provide treatment for heavy metals. Perlite increases the moisture retention rate, which aids in the treatment of particulates, metals, and nutrients. Treated runoff exits the facility via a layer of granular drain backfill material below the ecology mix. A perforated drain pipe may be located in the granular drain backfill material to facilitate conveyance. In soils that support infiltration, the perforated pipe may be omitted. Drainage geotextile envelops the granular drain backfill material layer to remove soil fines from the inflow. This filters the inflow and helps reduce clogging in the perforated drain pipe.



**Figure 8: Example of a bio-slope during construction and 6 years after construction**

## 4. Facility Components

The following summary outlines the common facility components that are used to facilitate:

- removal of sediments, metals, and other pollutants from stormwater,
- conveyance,
- infiltration, and/or
- reduction of flow velocities to minimize erosion

An ID number is assigned to each facility component and is used to identify and define these components.

The facility components are organized into the following sub-categories:

- (1) Facility Inlet
- (2) Ground Cover
- (3) Underground Components
- (4) Structures
- (5) Facility Outlet
- (6) Outfall Type
- (7) Outfall components

**Table 1: Facility Inlet**

| Facility Component         | ID # | Description                                                                                                                                        |
|----------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------|
|                            |      |                                                                                                                                                    |
| <b>Pavement Sheet Flow</b> | B1   | Overland flow drains directly into a water quality filter strip from the adjacent impervious area as pavement sheet flow.                          |
| <b>Shoulder Aggregate</b>  | B2   | The aggregate shoulder is installed between the roadway pavement and filter strip to ensure that sheet flow is maintained across the filter strip. |

**Table 2: Ground Cover**

| Facility Component            | ID # | Description                                                                                                                                                      |
|-------------------------------|------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                               |      |                                                                                                                                                                  |
| <b>Vegetated Filter Strip</b> | B3   | Grasses and native plantings help filter suspended solids from stormwater and minimize erosion of the underlying soil.                                           |
| <b>Aggregate Media Slope</b>  | B4   | Aggregate media helps filter suspended solids from stormwater and minimize erosion of the underlying soil in arid climates that do not support vegetated slopes. |

**Table 3: Underground Components**

| Facility Component                      | ID # | Description                                                                                                                                                                                                                                                                                                                                                                                  |
|-----------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                         |      |                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Water Quality Mix</b>                | B5   | Filter strip soils can be amended to create an approved water quality mix if the existing soil does not meet standards for filter strips. Water quality mix of approximately 8-inches in depth is added below the vegetated filter strip. Pollutants are removed from any stormwater runoff infiltrating through the water quality mix. Refer to <a href="#">Special Provision 1014.10</a> . |
| <b>Ecology Mix</b>                      | B6   | Ecology mix is composed of aggregates, perlite, dolomite, and gypsum. Dolomite and gypsum provide a buffer for acidic pH conditions and provide treatment for heavy metals. Perlite increases the moisture retention rate, which aids in the treatment of particulates, metals, and nutrients. Refer to <a href="#">Special Provision 1013</a> for the material mixing ratios.               |
| <b>Granular Drain Backfill Material</b> | B7   | Granular drain backfill material is used as a layer below ecology mix in a bioslope to disperse and regulate outflow. Refer to Standard Specification 00430.11.                                                                                                                                                                                                                              |
| <b>Geotextile Fabric</b>                | B8   | Woven or non-woven fabric. It is wrapped around the granular drain backfill material to filter soil fines from the inflow and reduce clogging of the underdrain. Refer to Standard Specification 02320.                                                                                                                                                                                      |
| <b>Geocell Grid</b>                     | B9   | A honeycomb grid structure that can be filled with aggregates and soils. A geocell grid promotes infiltration and provides slope stability for maintenance equipment access.                                                                                                                                                                                                                 |



**Table 4: Structures**

| Facility Component | ID # | Description                                                                                                                                                                                              |
|--------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    |      |                                                                                                                                                                                                          |
| <b>Curb/Berm</b>   | B10  | A curb or berm may be used to prevent stormwater runoff from laterally bypassing the filter strip. Curbs and berms are installed along the sides of the filter strip, parallel to the direction of flow. |
| <b>Check Dam</b>   | B11  | A check dam may be installed on filter strips with lateral slopes greater than 5% to prevent erosion before the vegetation has been established.                                                         |
| <b>Cleanout</b>    | B12  | An access point to a drain pipe that allows for inspection and maintenance.                                                                                                                              |

**Table 5: Facility Outlet**

| Facility Component             | ID # | Description                                                                                                                                                                                                                                                                     |
|--------------------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                |      |                                                                                                                                                                                                                                                                                 |
| <b>Perforated Drain Pipe</b>   | B13  | A perforated drain pipe allows for positive outflow for runoff at the toe of the bioslope. The small holes in the perforated pipe allow for infiltration into the underlying soil. Stormwater that does not infiltrate is conveyed to an acceptable discharge point.            |
| <b>Open Slope Outlet</b>       | B14  | An open slope outlet is a continuation of the slope downgrade of the treatment facility.                                                                                                                                                                                        |
| <b>Open Channel Outlet</b>     | B15  | An open channel outlet is located downslope of the facility. It transports stormwater runoff from the facility to an outfall.                                                                                                                                                   |
| <b>Storm Drain Outlet Pipe</b> | B16  | The storm drain outlet pipe transports stormwater runoff from the facility to an outfall. The storm drain outlet pipe is surrounded by either granular backfill material if it is a corrugated metal pipe (CMP) or has a mitered end with slope paving if it is a plastic pipe. |

**Table 6: Outfall Type**

| Facility Component        | ID # | Description                                                                                                                                                                |
|---------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Waterbody</b>          | B17  | Stormwater draining from a facility can drain directly into a waterbody. The waterbody can be a creek, lake, or ocean.                                                     |
| <b>Outfall Channel</b>    | B18  | Stormwater exiting a facility can drain directly into an outfall channel. The channel can be an existing ODOT channel or an adjacent property channel with proper consent. |
| <b>Storm Drain System</b> | B19  | Stormwater draining from a facility can drain directly into an ODOT storm drain system or into a local agency storm drain system.                                          |

**Table 7: Outfall Components**

| Facility Component   | ID # | Description                                                                                                                                                                                                                                                                                                               |
|----------------------|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Pervious Berm</b> | B20  | A pervious berm can be used with a filter strip or bioslope to create a shallow, temporary ponded area. Berms are typically 6-12 inches in height and are constructed from sand, gravel, and sandy loam. An optional outlet pipe or overflow weir may be installed to ensure that the ponded area drains within 24 hours. |
| <b>Riprap Pad</b>    | B21  | Riprap rock placed at the end of a storm drain pipe or along the bottom of a drainage channel to reduce water flow velocities and minimize soil erosion. The length and depth of the riprap pad depends on the ground slope, water flow velocity, and size of rock used to create the riprap pad.                         |

## Operational Plan

Two standard operational plans for water quality filter strips and bioslopes are provided in Appendix A. These are the most common installations.

- (1) Operational Plan A: Illustrates a typical filter strip installation
- (2) Operational Plan B: Illustrates a typical bioslope installation

The purpose of an operational plan is to illustrate and provide the following general information:

- typical footprint configuration
- standard facility components used to treat stormwater, minimize erosion, or convey stormwater
- general field marking types and where they are placed
- how stormwater drains into, along, and out of the facility

Notes are included on each sheet to explain how the facility operates.

## **A      Appendix A – Standard Operational Plans**

This appendix provides standard operational plans for the most common installations of water quality filter strips and bioslopes.

|                                                    |     |
|----------------------------------------------------|-----|
| Figure A-1: Operational Plan A – Sheet 1 of 2..... | A-3 |
| Figure A-2: Operational Plan A – Sheet 2 of 2..... | A-4 |
| Figure A-3: Operational Plan B – Sheet 1 of 2..... | A-5 |
| Figure A-4: Operational Plan B – Sheet 2 of 2..... | A-6 |

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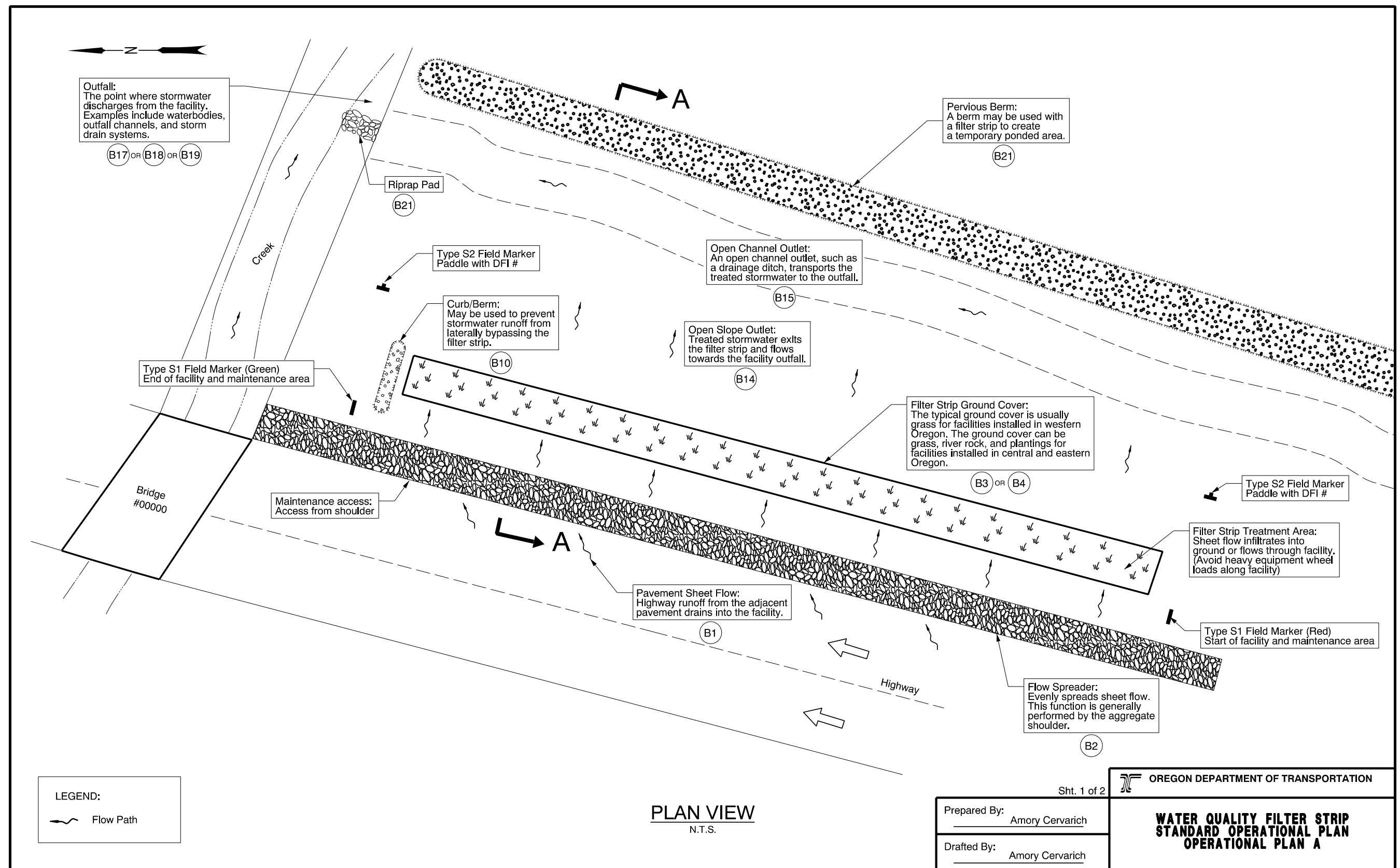
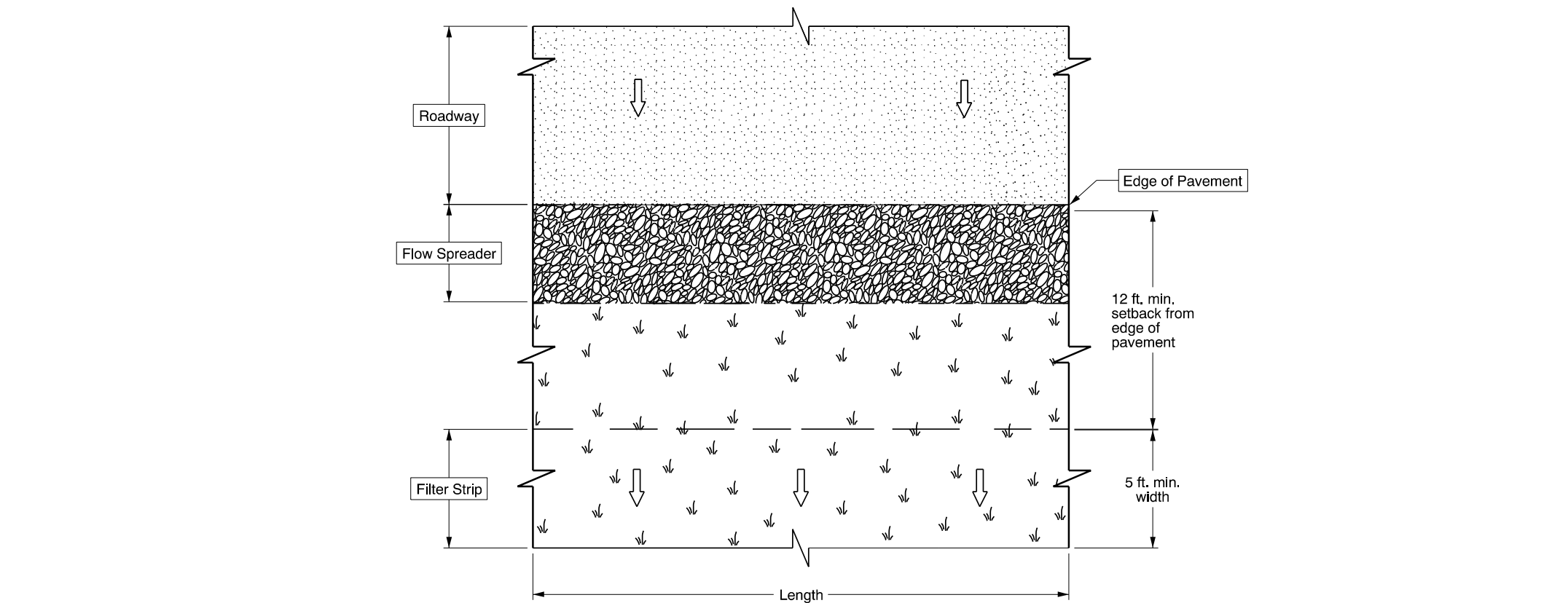
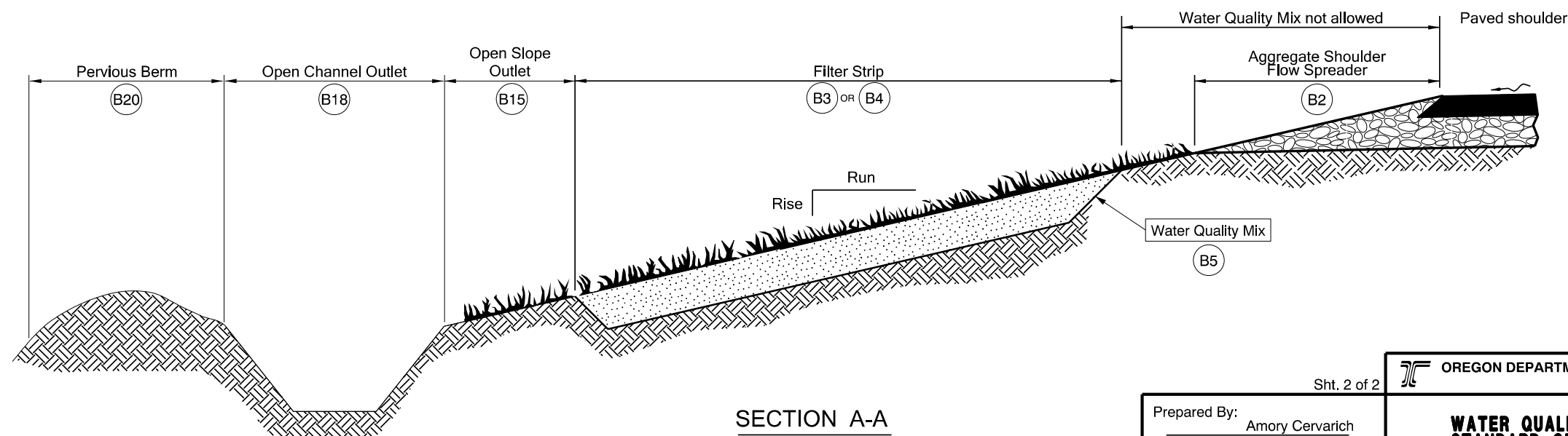


Figure A-1: Operational Plan A – Sheet 1 of 2



**PLAN VIEW DETAIL**  
N.T.S.



**SECTION A-A**  
N.T.S.

Sht. 2 of 2



OREGON DEPARTMENT OF TRANSPORTATION

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Drafted By: Amory Cervarich

**WATER QUALITY FILTER STRIP  
STANDARD OPERATIONAL PLAN  
OPERATIONAL PLAN A**

Figure A-2: Operational Plan A – Sheet 2 of 2

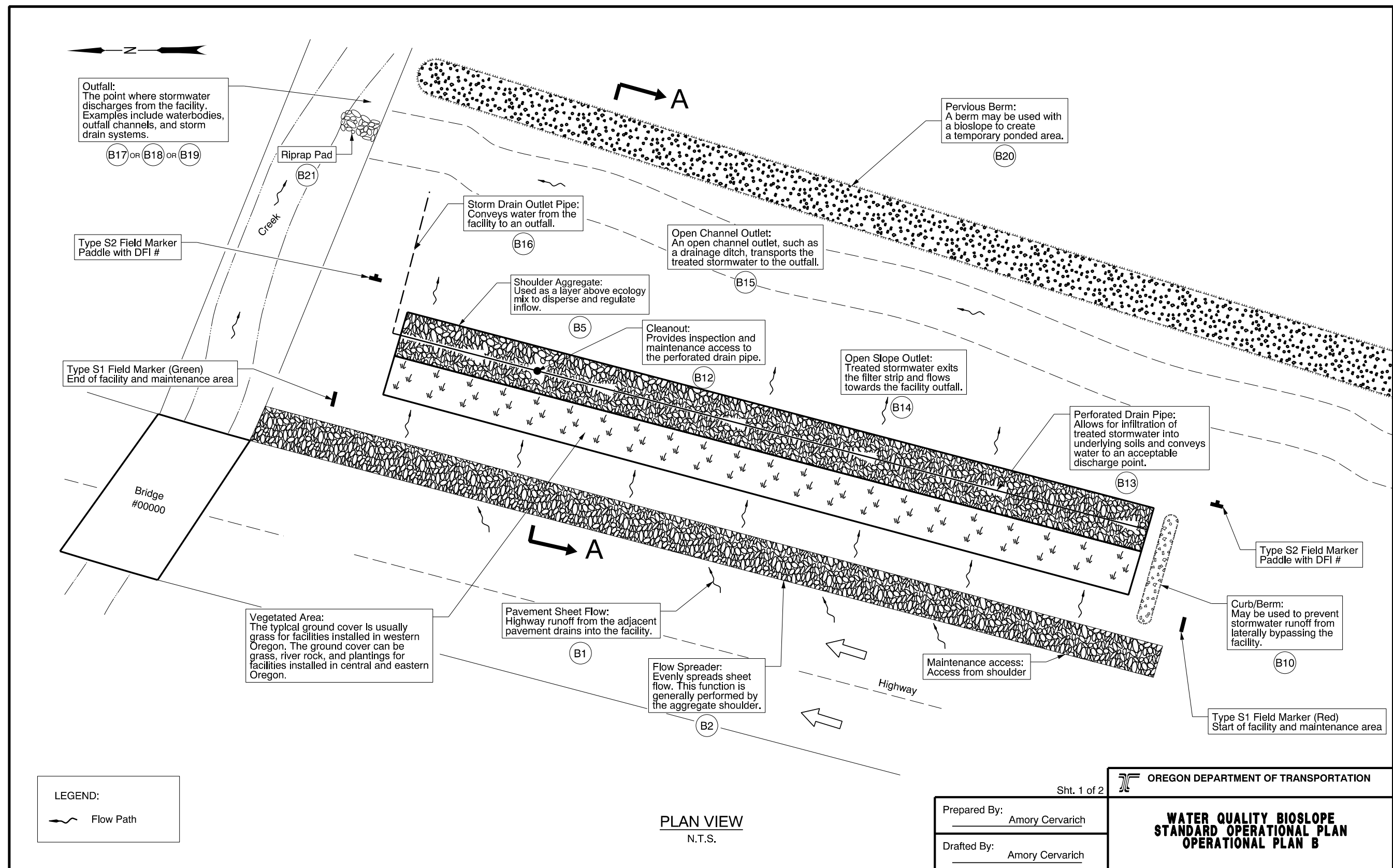
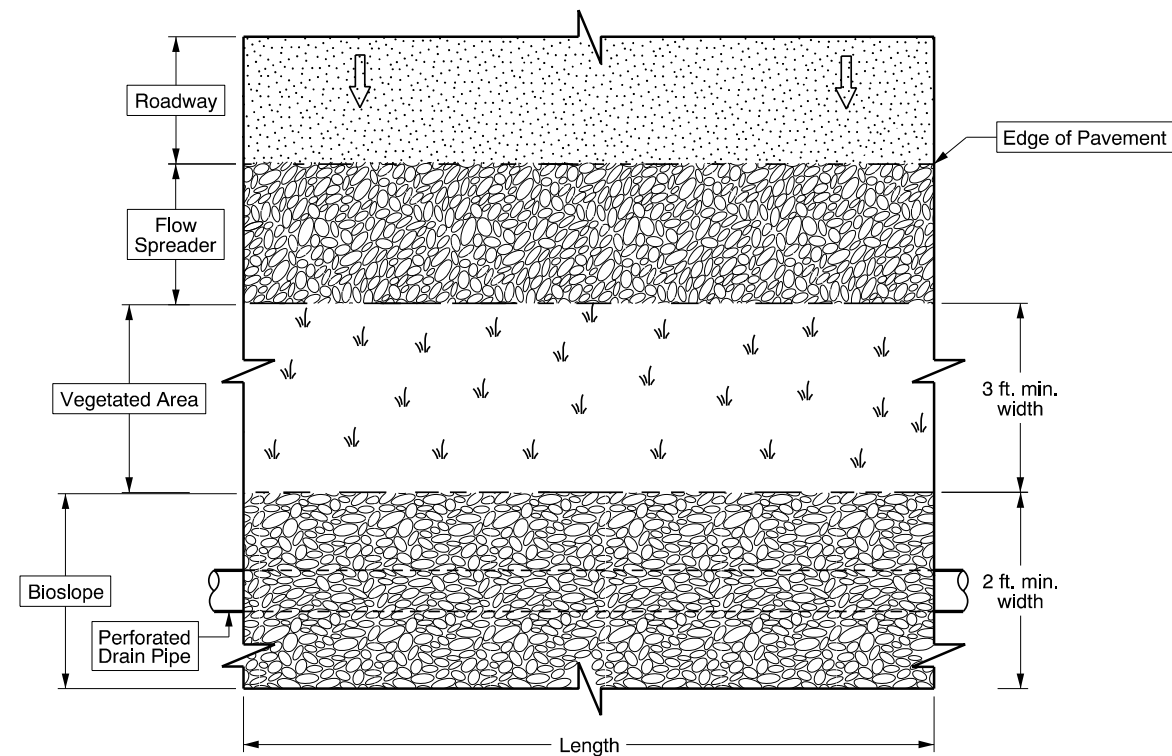
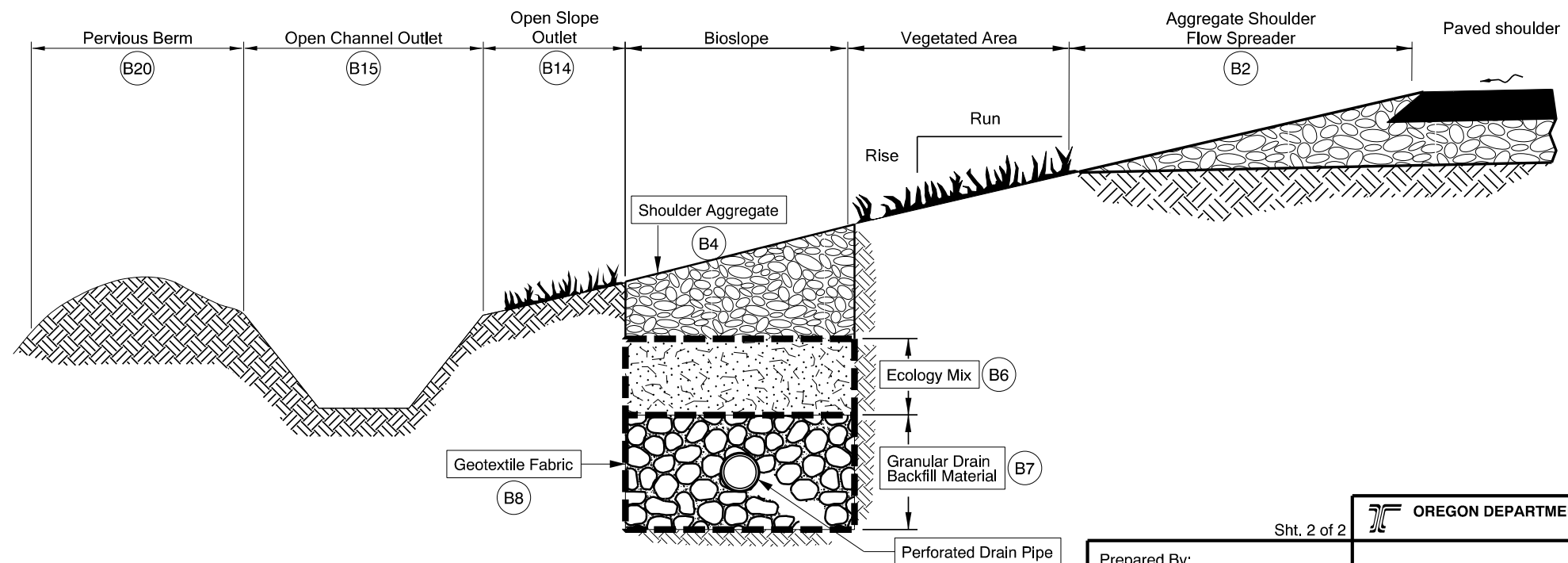


Figure A-3: Operational Plan B – Sheet 1 of 2



**PLAN VIEW DETAIL**  
N.T.S.



**SECTION A-A**  
N.T.S.

|              |                 |                                                                                                                           |
|--------------|-----------------|---------------------------------------------------------------------------------------------------------------------------|
| Sht. 2 of 2  |                 |  OREGON DEPARTMENT OF TRANSPORTATION |
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| Drafted By:  | Amory Cervarich | <b>WATER QUALITY BIOSLOPE<br/>STANDARD OPERATIONAL PLAN<br/>OPERATIONAL PLAN B</b>                                        |

Figure A-4: Operational Plan B – Sheet 2 of 2

**B      Appendix B – Facility Component Details**

This appendix contains details and descriptions of the facility components.

Figure B- 1: Facility Inlet Components..... B-2

Figure B- 2: Ground Cover Components ..... B-3

Figure B- 3: Ecology Mix (B6) ..... B-4

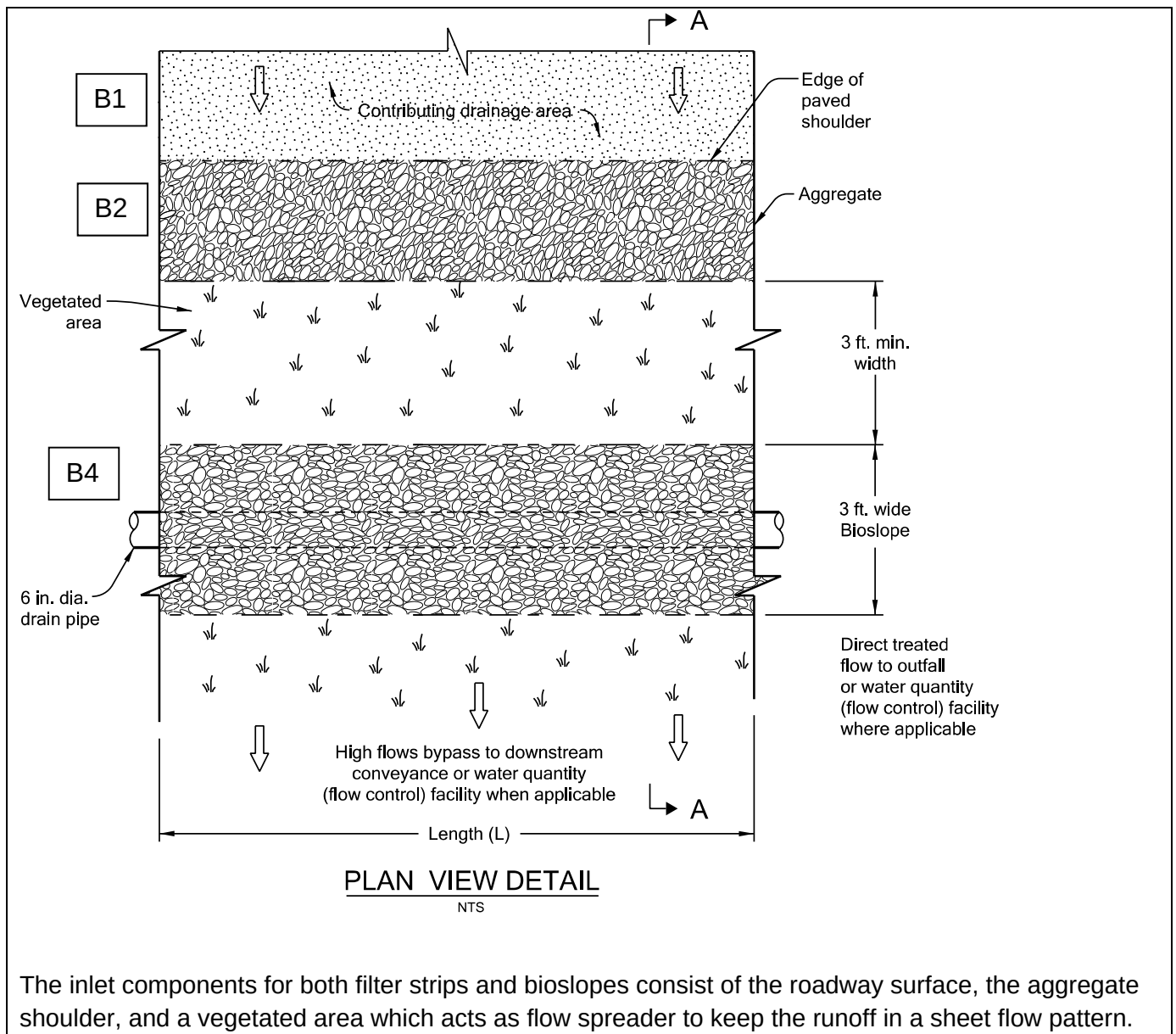
Figure B- 4: Geotextile Fabric (B8) ..... B-5

Figure B- 5: Geocell Grid (B9) ..... B-5

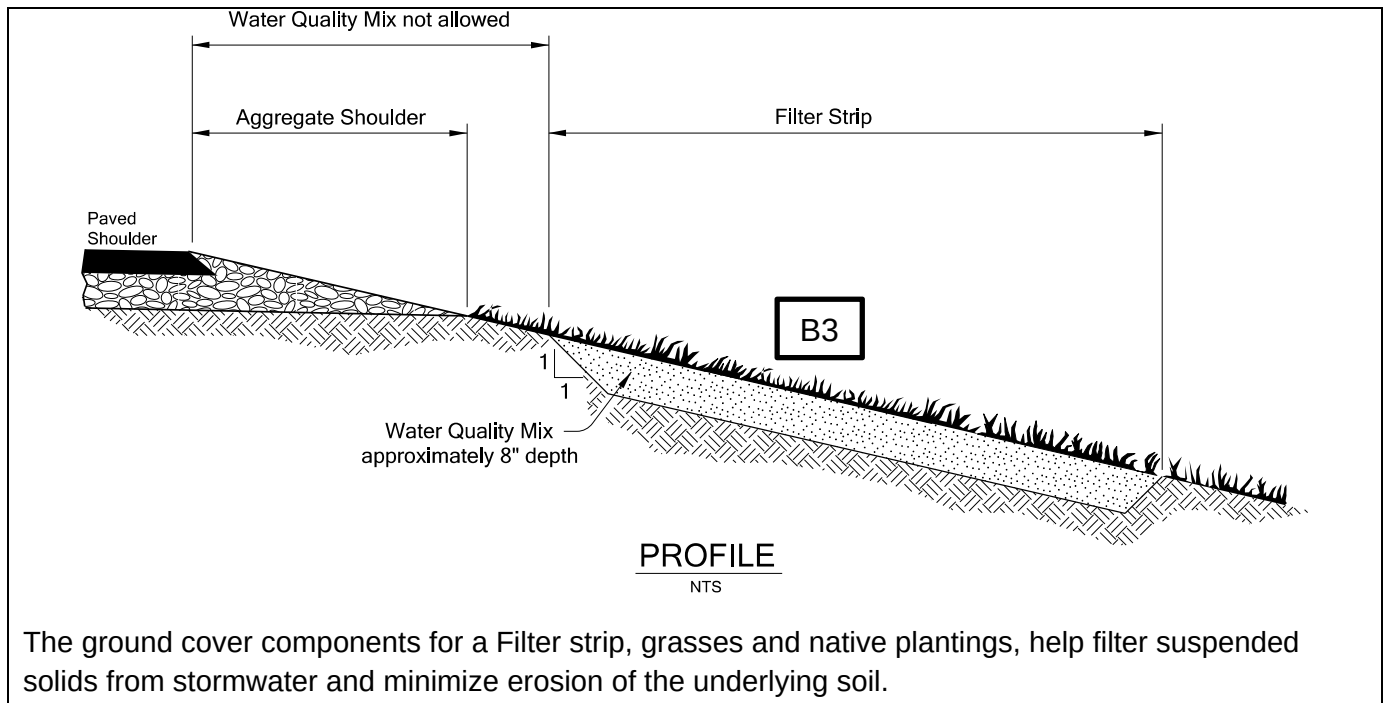
Figure B- 6: Clean out (B12)..... B-6

Figure B- 7: Perforated drain pipe (B13)..... B-6

Figure B- 8: Typical Biofilter drain outlet (B16) ..... B-7



**Figure B- 1: Facility Inlet Components**



**Figure B- 2: Ground Cover Components**





Aggregate



Dolomite



Gypsum



Perlite

Ecology mix is composed of aggregates, perlite, dolomite, and gypsum. Dolomite and gypsum provide a buffer for acidic pH conditions and provide treatment for heavy metals. Perlite increases the moisture retention rate, which aids in the treatment of particulates, metals, and nutrients. Refer to [Special Provision 1013](#) for the material mixing ratios.

**Figure B- 3: Ecology Mix (B6)**



Woven or non-woven fabric. It is wrapped around the granular drain backfill material to filter soil fines from the inflow and reduce clogging of the underdrain. Refer to Standard Specification 02320.

**Figure B- 4: Geotextile Fabric (B8)**



A honeycomb grid structure that can be filled with aggregates and soils. A geocell grid promotes infiltration and provides slope stability for maintenance equipment access.

**Figure B- 5: Geocell Grid (B9)**





An access point to a drain pipe that allows for inspection and maintenance.

**Figure B- 6: Clean out (B12)**



A perforated drain pipe allows for positive outflow for runoff at the toe of the bioslope. The small holes in the perforated pipe allow for infiltration into the underlying soil. Stormwater that does not infiltrate is conveyed to an acceptable discharge point.

**Figure B- 7: Perforated drain pipe (B13)**



The storm drain outlet pipe transports stormwater runoff from the facility to an outfall. The storm drain outlet pipe is surrounded by either granular backfill material if it is a corrugated metal pipe (CMP) or has a mitered end with slope paving if it is a plastic pipe.

**Figure B- 8: Typical Bio-slope drain outlet (B16)**