BEFORE THE BOARD OF COMMISSIONERS

FOR MARION COUNTY, OREGON

In the matter of adopting stormwater quality)
treatment engineering standards effective)
February 15, 2023.)

ORDER No. 22-106

This matter came before the Marion County Board of Commissioners at its regularly scheduled public meeting on October 5, 2022.

WHEREAS, the Board of Commissioners adopted the Post-Construction Runoff Control Ordinance of Marion County, the purpose of which is to reduce pollutants in and quality of stormwater reaching waterways, wetlands, and the public storm drainage and surface water system generated after the completion of development. This ordinance is codified in Marion County Code ("MCC") chapter 15.20; and

WHEREAS, the existing stormwater quality treatment engineering standards were adopted by board order no. 12-24 in February of 2012. The stormwater quality treatment engineering standards implement the Post-Construction Runoff Control Ordinance of Marion County; and

WHEREAS, the stormwater quality treatment engineering standards will be incorporated into the county engineering standards when the county engineering standards are revised; and

WHEREAS, the board wishes to update the stormwater quality treatment engineering standards at this time before the stormwater quality treatment engineering standards are incorporated into the county engineering standards; and

WHEREAS, the board wishes to set the effective date for the stormwater quality treatment engineering standards to be February 15, 2023, in order for the effective date of the stormwater quality treatment engineering standards to coincide with the effective date of proposed amendments to chapter 15.10 of the Marion County Code; now, therefore, IT IS HEREBY ORDERED that the Marion County Board of Commissioners adopt the stormwater treatment engineering standards attached hereto as Exhibit A and incorporated herein by this reference.

IT IS FURTHER ORDERED that the stormwater treatment engineering standards attached hereto as Exhibit A shall become effective on February 15, 2023.

DATED at Salem, Oregon, this 5th day of October 2022.

MARION COUNTY BOARD OF COMMISSIONERS

Chair

Commissioner

Commissioner

MARION COUNTY BOARD OF COMMISSIONERS

Board Session Agenda Review Form

Meeting date:	~~September 28th, 2022~~ October 5, 2022
Department:	Public Works
Agenda Planning Date:	Sept. 15th
Time required:	10 min
☐ Audio/Visual aids	
Contact:	Matt Knudsen
Phone:	(503) 365-3187
Department Head Signature:	

TITLE	Board Order to adopt Stormwater Quality Treatment Engineering Standards
Issue, Description & Background	The National Pollutant Discharge Elimination System Municipal Separate Storm Sewer Phase II permit, which is issued by DEQ to Marion County, requires that Marion County implement updated aspects to the stormwater quality treatment engineering standards. These requirements are primarily the reduction of the threshold from 1 acre of disturbed surface area to the creation or replacement of 1/4 of an acre of impervious areas and utilizing retention of stormwater on-site.
Financial Impacts:	There will be a financial impact to the public in the case of an increase in permits requiring fees. The fees for this permit support the cost of administering the permit. The financial impact to Public Works will be the long term operation and maintenance of new stormwater infrastructure.
Impacts to Department & External Agencies	The impacts will be an increase in stormwater permits issued by Public Works which will require staff time to review applications and plans as well as Inspect the sites during construction.
Options for Consideration:	1. Adopt the board order updating the stormwater quality treatment engineering standards 2. Modify the stormwater quality treatment engineering standards
Recommendation:	Staff recommends the adoption of the the board order updating the stormwater quality treatment engineering standards
List of attachments:	Board Order, Stormwater Quality Treatment Engineering Standards, MCSQ Treatment Engineering Standards Overview
Presenter:	Lani Radtke & Matt Knudsen & Max Hepburn

Copies of completed paperwork sent to the following: (Include names and e-mail addresses.)

Copies to:	Matt Knudsen - mknudsen@co.marion.or.us Max Hepburn, PE - mhepburn@co.marion.or.us Lani Radtke, PE - lradtke@co.marion.or.us

MARION COUNTY STORMWATER QUALITY

TREATMENT ENGINEERING STANDARDS

OVERVIEW OF CHANGES

MAJOR CHANGES

The purpose in these adjustments is to remain MS4 Phase II Compliant (reissued: March 2021).

The intent is to boost clarity and interpretive ability in the requirements.

A one-year implementation period with internal/external stakeholders (HBA, MWQAC, BOC, etc.)

POST CONSTRUCTION Proposed Changes

- Taking an approach that prioritizes retention first, then detention.
- Establishing a Public/Private maintenance standardization.
- The Maintenance Warranty Period reestablished to 2-year (all controls).

CONSTRUCTION Proposed Changes

- Standardizing thresholds with the removal of "high-risk" areas.
- The threshold for disturbed ground adjusted from 1 acre to areas above 1/4 acre.
- Continue to be a 1200-CN qualified program to better serve our customers.

Stormwater Quality Treatment Engineering Standards

Stormwater Engineering Standards Project

Pre-Permit Input to DEQ along with Home Builders Association

2018

NPDES MS4 Phase II Permit Renewal Issued

2020

Marion County contracted Brown and Caldwell to develop stormwater engineering Standards

2022

Marion County Board of Commissioner Board Session

TODAY

February 2023

DEQ deadline

Outreach Process

- Internal Review with Marion County Staff (Code Enforcement, Legal Counsel, PW Departments)
- Marion Water Quality Advisory Committee Review (Over 5 meetings on the updated changes)
  - HBA, Watershed Council, Developer, Agricultural, and At Large Members
- Board of Commissioners – Works Sessions and Management Updates

Process for adopting code and standards

Board Session for first reading of Construction Erosion Ordinance Amendment

(Today)

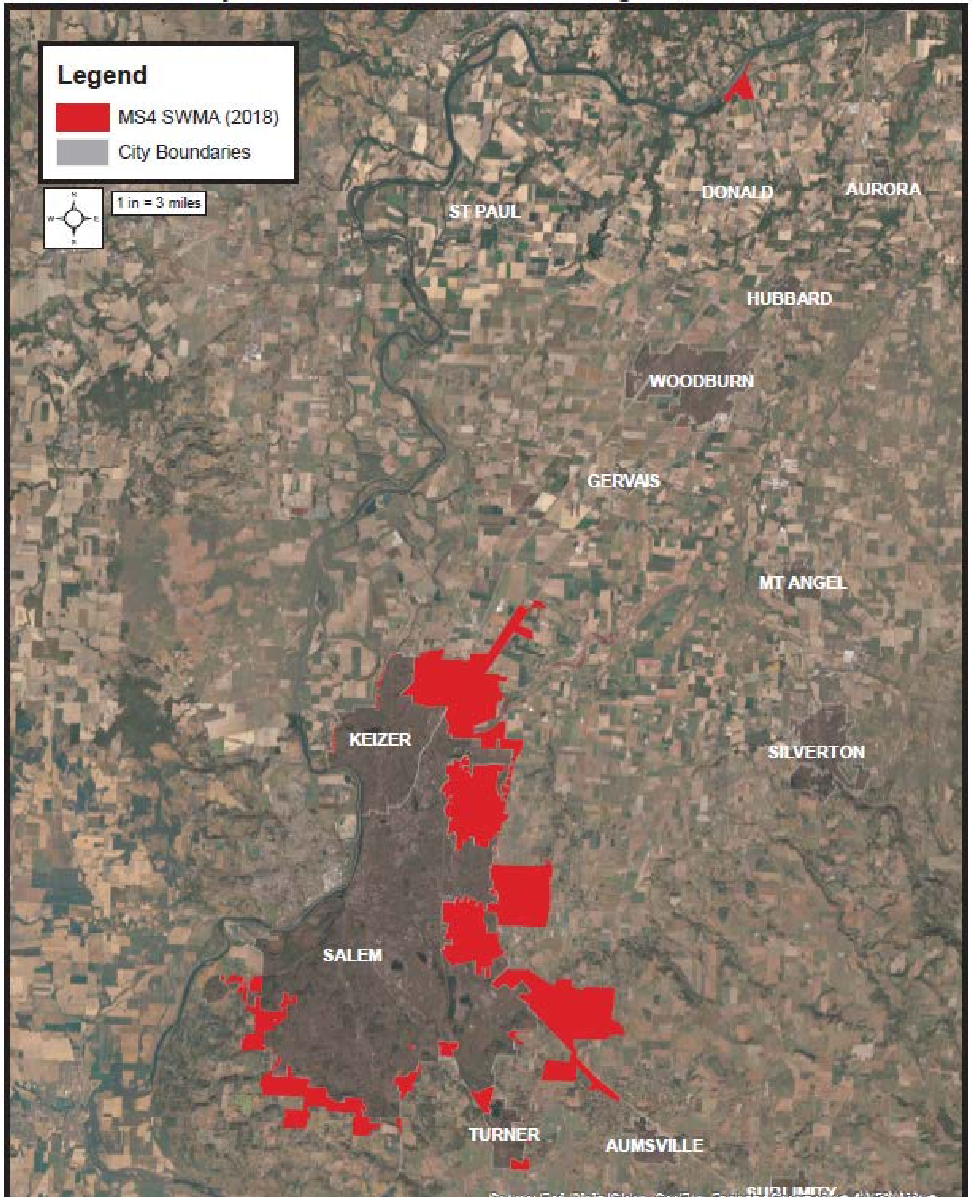
→

Board Session for 2nd reading of Construction Erosion Ordinance Amendment

Board Session for Board Order Adopting updated Stormwater Quality Treatment Engineering Standards

Stormwater Management Area

Marion County MS4 Stormwater Management Area

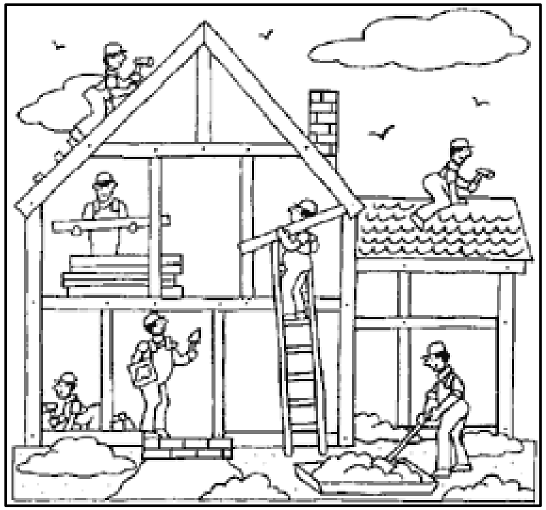


Stormwater Quality Treatment Systems

Lower left image from Contech website

Ordinance Background

- DEQ Required updated standards for Marion County Stormwater Management Area starting in 2012
- Reduction of pollutants from stormwater
  - (petroleum, metals, BOD)
- Draft order and standards prepared and reviewed by Brown and Caldwell, County Staff and the MWQAC



Existing Standards Highlights

- Permit and treatment required for all projects that disturb 1 acre or more of surface area within Stormwater Management Area
- 2-year warranty period applies to limited installations

Major Changes to Engineering Standards

- Treatment required at ¼ acre of new or replaced impervious surfaces within Stormwater Management Area
- Taking an approach that prioritizes retention first, then detention with treatment
- Refines Public/Private operation and maintenance standards
- 2-year Maintenance Warranty Period applies to all controls

Permit Process

- Permit required at ¼ acre of new or replaced impervious surface for development or redevelopment of a site
- Guided application and submittal process:
  - Site Assessment Checklist
  - Drainage Submittal Package
- For <u>only</u> projects creating or replacing 1 or more acres of impervious surfaces:
  - Downstream analysis
- Construction
  - Inspections ensuring proper construction, operation & maintenance
  - 2-year Maintenance Warranty Period
  - Permit close-out

Implementation

- Early Notification to builders (See implementation date)
- Easy implementation into already established development permit process

Marion County

Stormwater Quality Treatment Engineering Standards

June 2022

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Stormwater Quality Treatment Engineering Standards

Prepared for:

Marion County Public Works

Marion County, Oregon

June 2022

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Preface

This document supersedes the entirety of Marion County's February 2012 *Draft Interim Stormwater Quality Treatment Engineering Standards for the Storm Water Management Area (2012 Standards)*. The purpose of the update is to facilitate the County's compliance, as a designated MS4 National Pollutant Discharge Elimination System (NPDES) Phase II agency, with the most recent stormwater Oregon Department of Environmental Quality requirements. Consistent with the 2012 Standards, this update incorporates Marion County's April 1990 *Department of Public Works Engineering Standards* (or a future update) by reference as the 1990 Standards apply county-wide in regard to stormwater detention and flow control with the exception of prevailing city and states standards where applicable.

These updated Stormwater Quality Treatment Engineering Standards are anticipated to be implemented no later than February 28, 2023, in accordance with the MS4 NPDES Phase II General Permit.

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Definitions and Acronyms and Abbreviations

Unless the context specifically indicates otherwise, the following words and terms, as used in this document, shall have the meanings hereinafter designated:

Definitions	
Term	**Definition**
Agricultural Field Drain	Drainpipes, tiles, ditches, or other conveyances installed in agricultural fields to remove excess water.
Best Management Practice (BMP)	BMPs include stormwater management facilities, schedules of activities, prohibition of practices, maintenance procedures and other management practices designed to prevent or reduce pollution. BMPs also include treatment requirements, operating procedures, and practices to control stormwater runoff.
Building Envelope	A building envelope is the physical separator between the conditioned and unconditioned environment of a building including the resistance to air, water, heat, light and noise transfer.
Contractor	A person duly licensed or approved by the State of Oregon to perform the type of work to be done under a permit or contract.
County	Marion County
County Road	A public road under the jurisdiction of the County that has been designated as a county road through an order by the Board of Commissioners pursuant to Oregon Revised Statutes (ORS) 368.
Debris	Discarded objects that would not exist in an undeveloped stream corridor or wetland. Debris includes, but is not limited to, tires, vehicles, litter, scrap metal, construction waste, lumber, plastic, or Styrofoam.
Design Storm	The distribution of rainfall intensity over time (typically 24 hours), identified to have a probability of recurrence given in years (e.g., 5-year design storm).
Detention	The release of surface water runoff from a site at a slower rate than it is collected by the drainage system and/or stormwater management facility, the difference being held in temporary storage.
Development	Any human made change to improved or unimproved real estate, including but not limited to the addition of buildings or other structures, utility infrastructure, impervious surfaces, other structures or facilities; the activities of mining, dredging, paving, filling, or excavation; or the addition of any surface type that changes or impedes the natural flow of stormwater runoff. Development also includes partitions, subdivisions and redevelopment or modifications to the existing impervious surface footprint on a property. Development does not include the following: 1. Stream enhancement or restoration projects approved by the County. 2. Farm structures and private roads outside of the County's Stormwater Management Area. 3. Lot Line adjustments. 4. Measures to replace within the existing footprint, a structure(s) lost due to a catastrophic event such as fire, provided that such measures are consistent with County regulations. 5. Linear utility projects that replace existing impervious surface with equivalent material. 6. Non-pollution generating (i.e., not roads), linear projects (ex. Pedestrian pathways) that shed runoff onto green space. 7. Modular/temporary structures.
Director	Director of the Marion County Department of Public Works or their designee.
Discharge	Any addition of treated or untreated water, stormwater, wastewater, process water or any pollutant or combination of pollutants to waters of the State of Oregon, directly or indirectly, by actions of dumping, spilling, disposing, or physically connecting to the public storm system or natural drainage conveyance.
Disturbed Area (i.e., areas that are disturbed, undisturbed areas are present)	Areas of disturbance for activities defined under "Development", typically measured in acres or square feet. Disturbed area includes areas used for storage of equipment or materials that are used for these activities.
Engineer	A registered professional engineer licensed to practice in the State of Oregon, who is responsible for the design and construction of the site stormwater management plan. This person is also referred to as the project engineer or engineer.

Definitions	
Term	**Definition**
Erosion	The visual or measurable movement of soil particles resulting from the flow of, or pressure from, water, wind, or earth movement.
Fill	Any material such as, but not limited to, sand, soil, rock, or gravel that is placed in an excavated area or a wetland or floodplain for the purposes of development.
Flow Control Facility	A stormwater facility that provides temporary storage of increased surface water runoff resulting from development.
Freeboard	The vertical distance between the design maximum water surface elevation and the elevation of the facility's emergency overflow.
Geologically Hazardous Areas	Areas identified on the County zoning maps that, because of their susceptibility to landslide, erosion or other geological events, may have inherent geologic constraints relevant to the siting of commercial, industrial, or residential development consistent with public health or safety concerns. These concerns may be mitigated by special considerations in siting, design, or construction.
Geotechnical Report	A report prepared and stamped by a geotechnical engineer evaluating the site conditions and recommending design measures necessary to reduce the risks associated with development and to facilitate a safe and stable development. A geotechnical report must be prepared in accordance with the report requirements of these Standards. A geological assessment or engineering geology report may be incorporated into or included as an appendix to the geotechnical report.
Green Infrastructure (GI)	A specific type of stormwater control using vegetation, soils, and/or natural processes to manage stormwater. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems designed to mimic nature by reducing and/or storing stormwater through infiltration, evaporation, and transpiration. At the scale of city or county, green infrastructure refers to the patchwork of natural areas that provide flood protection and natural processes that remove pollutants from stormwater.
Impervious Surface	Any human made surface that changes, alters, prevents, or retards the existing surface infiltration or the natural hydrological cycle and/or prevents the entry of water into the soil and/or causes water to run off the surface in greater rate or quantity than natural conditions. Impervious surfaces may include, but are not limited to, rooftops, concrete or asphalt paving, sidewalk or paved walkways, patios, driveways, parking lots, oiled macadam, gravel, artificial turf, human made impervious surfaces, or other surfaces which similarly resist infiltration or absorption of moisture or changes, alters, or retards the existing surface or the natural hydrological cycle. Standing water areas of stormwater management facilities and wetlands shall be considered as impervious surfaces. Permeable pavement designed to mimic the natural hydrology of the site is considered an impervious surface for the purpose of determining project impervious surface area thresholds but may be used as a Stormwater Management Facility to mitigate the stormwater from the impervious surface area.
Infiltration	The process by which stormwater penetrates into soil.
Invasive Vegetation	A plant that is both non-native and able to establish on many sites, grow quickly, and spread to the point of disrupting plant communities or ecosystems.
Landscape Architect	A registered Landscape Architect licensed to practice in the State of Oregon.
Low Impact Development (LID)	A stormwater management approach that seeks to mitigate the impacts of increased runoff and stormwater pollution using a set of planning, design and construction approaches and stormwater management practices that promote the use of natural systems for infiltration, evapotranspiration, and/or reuse of rainwater, and can occur at a wide range of landscape scales (i.e., regional, community and site). Low impact development is a comprehensive land planning and engineering design approach to stormwater management with a goal of mimicking the pre-development hydrologic regime of urban and developing watersheds.
Maintenance Project	Projects that preserve and extend the service life of the existing roadway or structure. This includes, but is not limited to, minor non-structural overlays without widening, chip seals, recycle in place, Latex-Modified Concrete (LMC) overlays, crack sealing, bridge and rockfall screening, detector loop repairs, and drainage enhancement.

Definitions	
Term	**Definition**
Mitigation	The reduction of adverse effects of a proposed project by considering, in the following order: 1. Avoiding the impact altogether by not taking a certain action or parts of an action. 2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation. 3. Compensating for the impact by replacing or providing comparable substitute. 4. Rectifying the impact by repairing, maintaining, or restoring the affected environment.
Municipal Separate Storm Sewer System (MS4)	A storm drainage system(s) (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, human made channels, or storm drains) as defined in 40 Code of Federal Regulations (CFR) 122.26(b)(8).
National Pollutant Discharge Elimination System (NPDES) Permit	A permit issued pursuant to Chapter 402 of the Clean Water Act (40 CFR 122, 123, 124, and 504).
New Construction	Projects constructed in a new location, new alignments, major additions, or replacement of an existing facility with major vertical or horizontal alignment changes.
Nuisance Vegetation	Trees, plants, shrubs or vegetation or parts thereof which so overhang any sidewalk or street, or which are growing thereon in such manner as to obstruct or impair the free and full use of the stormwater facility and adjacent features (i.e., sidewalk or street) by the public are public nuisances. Grass, weeds, shrubs, bushes, trees or vegetation growing, or which have grown and died, and all vegetation upon any property and which are a fire hazard or menace to public health, safety or welfare, are likewise public nuisances.
Owner	The owner(s) of record title or the purchaser(s) under a recorded sale agreement and other persons having an interest of record in the described real property.
Pervious Pavement	Surface to walk, drive or park on that may reduce stormwater runoff by allowing water to soak/infiltrate into the ground. Examples are porous asphalt, pervious concrete and pervious pavers.
Pollutant	Stormwater pollutants that can harm rivers, streams, lakes, and coastal waters are generally separated into the following categories: suspended solids/sediment (i.e., trash), oxygen-demanding pollutants, temperature, bacteria, organic carbon, organic matter (i.e., leaves, flowers, twigs, pollen), hydrocarbons, metals (i.e., lead, copper, zinc, and cadmium), nutrients (i.e., nitrogen and phosphorous), pathogens (i.e., animal feces, leaking sewers) and toxins (i.e., pesticides, chemical toxins).
Predevelopment Hydrologic Function	The hydrology of a site reflecting the local rainfall patterns, soil characteristics, land cover, evapotranspiration, and topography. The term predevelopment as used in predevelopment hydrologic function is consistent with the term predevelopment as discussed in Federal Register Volume 64, Number 235 and refers to the runoff conditions that exist onsite immediately before the planned development activities occur. Predevelopment is not intended to be interpreted as the period before any human-induced land disturbance activity has occurred.
Project	A project includes all infrastructure related items for both development and redevelopment conditions. Projects include the organized effort to construct a building or structure and associated utilities and amenities. In the fields of civil engineering and architecture, construction projects involve the process that consists of tangibly assembling infrastructure or buildings.
Proprietary Stormwater Treatment Device	A manufactured stormwater treatment device, in which stormwater receives treatment before being discharged to the storm drainage system, to a stormwater management facility, or to the receiving water. This is a broad category of stormwater management facilities with a variety of pollutant removal mechanisms and varying pollutant removal efficiencies.
Public Road	A road which is within a public right-of-way. It may be maintained by either private or public funds (state, city, county).
Reconstruction	Projects that are undertaken to upgrade a County facility to acceptable geometric standards, and as a result, provide greater roadway width. The improvements may be in the form of additional lanes and/or wider shoulders and produce an improvement of level of service. This normally includes the following types of works: projects that alter the original subgrade, constructing a major widening that results in the addition of a new continuous lane, channelization for signal or left-turn refuges when not part of an overlay project, structure replacement, and/or similar projects.

Definitions	
Term	**Definition**
Redevelopment	Any proposed development (see definition of development above) on a previously developed site that creates or replaces impervious surface. Redevelopment does not include: ordinary maintenance activities, remodeling of existing building footprint, resurfacing of existing paved areas, exterior changes or improvements which do not materially increase or concentrate stormwater runoff, or cause additional nonpoint source pollution, or construction activities conducted to ameliorate a public health or safety emergency or natural disaster; and/or construction activities within an existing footprint to repair or replace a site or a structure damaged by a public health or safety emergency or natural disaster. New, existing, and modified connections to the public storm system are considered redevelopment if they increase the discharge of stormwater runoff from new or existing impervious surfaces that were previously not connected.
Retention	The process of collecting and holding surface water runoff from a specified design storm with no surface outflow.
Right-of-way	A legal right of passage over a piece of land, generally established by an easement or ownership.
Rural	Those County areas which do not meet the definition of urban.
Sensitive Areas	Sensitive areas include: 1. **Existing or created wetlands**, including all mitigated wetlands. Limits defined by wetland reports approved by the Oregon Department of State Lands (ODSL), or the County. 2. **Rivers, streams, sloughs, swamps, creeks**. Limits defined by the top of the bank or first break in slope measured upland from the mean high-water line. 3. **Impoundments (lakes and ponds)**. Limits defined by the top of the bank or first break in slope measured upland from the mean high-water line. Sensitive areas shall not include stormwater management facilities including constructed wetlands, rain gardens, detention ponds, vegetative buffers adjacent to sensitive areas, or water features, such as lakes, constructed during an earlier phase of a development for specific purposes such as recreation.
Soil	The upper layer of earth in which plants grow which is a black or dark brown material typically consisting of a mixture of organic remains, clay, and rock particles.
Soil Disturbance	The excavation of soils for construction, landscaping, or other reasons.
Stormwater or Stormwater Runoff	Includes snow melt runoff, and surface runoff and drainage, and is defined in 40 CFR §122.26(b)(13). "Stormwater" means that portion of precipitation that does not naturally percolate into the ground or evaporate, but flows via overland flow, interflow, channels, or pipes into a defined surface water channel or a constructed infiltration facility.
Stormwater Management	A program to provide surface water quality and quantity controls through structural and nonstructural methods. Examples of structural controls include swales, planters, rain gardens, detention, and retention basins as well as structural source controls (e.g., covers and awnings, curbs for isolation, spill control manholes, and shut-off valves). Nonstructural controls include maintenance of surface water facilities, maintenance of roads (e.g., street sweeping, inlet cleaning), public education, implementation of intergovernmental agreements to provide for regional coordination, inspections, and preparation of water quality control ordinances and regulations.
Stormwater Management Facility (SMF)	Any facility that is designed, constructed, and maintained to collect, treat, filter, retain, or detain stormwater runoff during and after a storm event for the purpose of controlling flows and/or reducing pollutants. SMFs include, but are not limited to constructed wetlands, rain gardens, water quality swales, stormwater planters, infiltration facilities, and ponds.
Stream	A surface concentration of flow in an open channel in which flow of water occurs either perennially or intermittently. For the purposes of this manual, streams refer to drainageways that are determined to be jurisdictional by ODSL or the United States Army Corps of Engineers (USACE).
Structure	A building or other major improvement that is built, constructed, or installed, not including minor improvements—such as fences, utility poles, flagpoles, or irrigation system components—that are not customarily regulated through zoning codes.
Time of Concentration	Travel time for a drop of water to travel from the most hydrologically remote location in a defined catchment to the outfall for the catchment where remoteness relates to time of travel rather than distance.
Underground Injection Control (UIC)	Structures built for the purpose of discharging runoff into subsurface soils through infiltration and under the force of gravity.

Definitions	
Term	**Definition**
Urban	Those areas relating to, characteristic of, or constituting a city, such as lot sizes smaller than one acre.
Waters of the State	Those waters defined in ORS Chapter 468B.005 or as amended. which include lakes, bays, ponds, impounding reservoirs, springs, wells, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Pacific Ocean within the territorial limits of the State of Oregon, and all other bodies of surface or underground waters, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters which do not combine or effect a junction with natural surface or underground waters), which are wholly or partially within or bordering the state or within its jurisdiction.
Wetlands	Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands are those areas identified and delineated by a qualified wetlands specialist as set forth in the Federal Manual for Identifying and Delineating Jurisdictional Wetlands, January 1987, or by an ODSL/USACE 404 permit. Wetlands may also consist of: 1. **Constructed Wetlands**. Wetlands developed as a water quality or quantity facility, subject to change and maintenance as such. These areas must be clearly defined and separated from naturally occurring or created wetlands. 2. **Created Wetlands**. Created wetlands are wetlands developed in an area previously identified as a non-wetland to replace, or mitigate, wetland destruction or displacement. A created wetland shall be regulated and managed the same as an existing wetland. 3. **Existing Wetlands**. Existing wetlands are those identified and delineated as set forth in the Federal Manual for Identifying the Delineating Jurisdictional Wetlands, January 1987, or as amended, by a qualified wetlands specialist.

Acronyms and Abbreviations

ASTM	American Society of Testing Materials
BMP	Best Management Practice
cfs	cubic feet per second
CEG	Certified Engineering Geologist
CN	Curve Number
County	Marion County
CWA	Clean Water Act
EPA	Environmental Protection Agency
EPSC	Erosion Prevention and Sediment Control
FEMA	Federal Emergency Management Agency
GI	Green Infrastructure
GIS	Geographic Information System
GULD	General Use Level Designation
HDPE	High Density Polyethylene
HEC-RAS	Hydrologic Engineering Center River Analysis System
HGL	Hydraulic Grade Line
HSG	Hydrologic Soil Group
LID	Low Impact Development
MCC	Marion County Code
MEF	Maximum Extent Feasible
MS4	Municipal Separate Storm Sewer System
NPDES	National Pollutant Discharge Elimination System
NRCP	Non-reinforced Concrete Pipe
NRCS	Natural Resources Conservation Service
O&M	Operations and Maintenance
ODEQ	Oregon Department of Environmental Quality
ODOT	Oregon Department of Transportation
ODSL	Oregon Department of State Lands
ORS	Oregon Revised Statutes
PAC	Porous Asphalt Concrete
PVC	Polyvinyl Chloride
PE	Professional Engineer
RCP	Reinforced Concrete Pipe
RE	Registered Engineer
SCS	Soil Conservation Service
SWMA	Stormwater Management Area
SWMM	Stormwater Management Model
TAPE	Technology Assessment Protocol Ecology
Tc	Time of Concentration
TR-55	Technical Release 55
TSS	Total Suspended Solids
UIC	Underground Injection Control
USACE	United States Army Corps of Engineers
WQF	Water Quality Flow
WQV	Water Quality Volume

Section 1

Introduction

These Stormwater Quality Treatment Engineering Standards (Stormwater Standards or Standards) were developed to accompany the stormwater requirements and enforcement procedures in Marion County Code (MCC) Sections *1.25: Enforcement*, *15.10: Construction Erosion and Sediment Control*, *15.15: Stormwater Discharge Quality Control* and *15.20: Post Construction Runoff Control*. These Standards specifically address the water quality treatment component of stormwater management, development stormwater related submittal requirements, erosion prevention and sediment control, and operation and maintenance.

Stormwater management is a key element to maintaining and enhancing livability within Marion County's (County) Stormwater Management Area. There is a direct link between stormwater runoff and the County's surface and groundwater quality and quantity. As land is developed, creation of new impervious surfaces and loss of vegetation increases stormwater runoff during rainfall events, altering the natural hydrologic cycle. Without stormwater management, the increase in flows erodes stream channels and limits groundwater recharge. In addition, runoff that flows over roadways, parking areas, rooftops, and other impervious surfaces collects pollutants that are transported to streams, rivers and groundwater resources. Properly managing stormwater is vital to protecting the County's and other local water resources for many reasons, including the protection of aquatic habitats, and keeping waters safe for recreation and drinking water.

The Federal Clean Water Act (CWA) of 1972 established a national commitment to restore and maintain the chemical, physical, and biological integrity of the nation's waters. The CWA prohibits the discharge of pollutants into water of the United States unless the discharge is in compliance with the National Pollutant Discharge Elimination System (NPDES) Permit. The CWA requires jurisdictions, such as Marion County, to obtain an NPDES Permit for discharges from the Municipal Separate Storm Sewer System (MS4). The County's MS4 is comprised of catch basins, pipes, ditches, stormwater management facilities and other structures. The MS4 conveys runoff from private and public properties within the County and ultimately drains to the Willamette River. The Oregon Department of Environmental Quality (ODEQ) administers the state's NPDES program and issues NPDES permits on the federal government's behalf. Marion County was reissued its current NPDES MS4 Phase II Permit in March of 2021, which requires the County to implement a comprehensive stormwater management program, including establishing water quality controls for stormwater runoff from activities associated with construction and from developments post-construction.

The goal of the Stormwater Standards update is to provide local engineers, developers, builders and County staff clear guidance for planning and designing stormwater conveyance and management systems that are appropriate to the local climate, hydrogeology and geology.

These stormwater Standards are applicable to public and private projects within the Marion County Stormwater Management Area (SWMA) as designated by the ODEQ and are in addition to all applicable Standards specified for Drainage in Section V of the 1990 Marion County Engineering

Standards or most current version[1]. Some exemptions to these Standards apply to select County roadway maintenance projects.

These Stormwater Standards include the following sections:

- Section 2: Site Assessment and Development Conditions
- Section 3: Stormwater Quality
- Section 4: Hydrologic Analysis
- Section 5: Drainage Requirements
- Section 6: Drainage Submittals
- Section 7: Operation and Maintenance
- Section 8: Erosion Prevention and Sediment Control Measures During Construction

1.1 Jurisdiction

Oregon Revised Statutes (ORS) require the design and construction of all facilities within County rights-of-way be approved by the Board of Commissioners (ORS 374.305). Marion County Ordinance 671 (codified as MCC 11.15) empowered the Director of Public Works (Director) to undertake these activities on behalf of the Board of Commissioners. In addition, the Marion County Roads and Rights of Way and Zoning codes require compliance with certain applicable 1990 Marion County Engineering Standards or most current version on private property. Within the SWMA, certain County requirements may also apply. Please bring any apparent inconsistencies in these Stormwater Standards to the attention of the Director of the Marion County Department of Public Works or their designee, referred to as “Director” hereafter.

These Standards are intended to be consistent with the most currently adopted provisions of all applicable local, State, and Federal codes and regulations, and with the Marion County NPDES MS4 Phase II Permit issued by ODEQ. The MS4 Phase II Permit authorizes Marion County, as a regulated small municipal separate storm sewer system, to discharge stormwater to surface waters of the state, in accordance with the requirements, limitations, and conditions set forth in the Permit. These Standards are intended to satisfy the MS4 Permit requirements described in *Schedule A.3.d: Construction Site Runoff Control* and *Schedule A.3.e: Post-Construction Site Runoff for New Development and Redevelopment*.

The following drainage facilities within the SWMA must be constructed to meet these Standards:

- Publicly-owned and maintained storm drainage facilities within Marion County jurisdiction, including those associated with County-maintained roads in unincorporated Marion County (rural and within the urban growth boundary) and under County maintenance jurisdiction within incorporated local city limits (urban) required by Public Works policy
- Privately owned and maintained drainage facilities inside a county right-of-way or discharging to Marion County maintained facilities
- Drainage facilities outside the building envelope and within the SWMA
- Rural drainage facilities outside the building envelope

A current map of the Marion County SWMA can be found on the County’s Stormwater Management website: https://www.co.marion.or.us/PW/ES/waterquality/Pages/strmwtr.aspx. Boundaries may be subject to change, as defined by ODEQ or in the Marion County *Stormwater Management Plan*.

[1] The 1990 Marion County *Engineering Design Standards* (or most recent update) can be found on the Marion County Public Works website: https://www.co.marion.or.us/PW/Engineering/engineeringstandards

1.2 Applicability

The Marion County Stormwater Standards are intended for use by property owners, developers, design professionals, and County staff for all permanent publicly and privately-owned stormwater systems and publicly and privately maintained stormwater systems within the County's SWMA. Two types of stormwater management facilities are covered in these Standards including those facilities needed during construction (temporary) and those that are permanent.

All development that exceeds the thresholds as listed below is subject to stormwater review including, but not limited to developments that are subject to land use, design review and/or the building permitting processes. These processes generally include all land use proposals, site development and permit approvals within, or proposed to be within, the County's SWMA.

All private storm drains outside the building envelope shall be designed using these Standards, along with the Oregon Structural Code, Oregon Plumbing Code, the MCC, and/or other applicable codes as appropriate.

Construction stormwater management, including erosion controls, sediment controls, and waste materials management controls, is required to be used and maintained at all qualifying construction projects from initial clearing through final stabilization to reduce construction pollution in stormwater discharges to the MS4 and all environmental elements. Within the boundaries of the County's SWMA, any grading or soil disturbance associated with a development activity that disturbs 10,890 square feet (1/4 acre)[2] or more will require the developer to complete and implement an Erosion Prevention and Sediment Control Plan and obtain an Erosion Prevention and Sediment Control Permit from the County.

Post-construction stormwater management is required for new development and redevelopment, as defined herein, within the Marion County SWMA if the project site discharges stormwater to the MS4 and creates or replaces 10,890 square feet or more of impervious area(s). The following items are required for these new development and redevelopment sites:

- The use of structural stormwater controls (i.e., permanent stormwater facilities that are designed, constructed and operated to prevent or reduce the discharge of pollutants in stormwater).
- A site-specific stormwater management approach that targets natural surface or predevelopment hydrological function through the installation of long-term operation and maintenance of structural stormwater controls; and
- Long-term operation and maintenance of structural stormwater controls at project sites owned by a private entity.

This applies to the following types of projects in the SWMA:

- Transportation-related projects within the public right-of-way, including road construction and reconstruction, with an exemption for select maintenance related activities and repairs;
- Development associated with partitions and subdivisions;
- Parks and Recreation Projects, including new trails and playgrounds; and
- Commercial, industrial, and residential development and redevelopment.

The Director reserves the right to modify these Stormwater Standards herein on a case-by-case basis. Standards for drainage inside the building envelope are administered by the Marion County

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[2] Per the NPDES MS4 Phase II Permit, Marion County is identified as a "Small Community".

Building Official within Public Works and are not addressed within these Standards. Responsibility for review and approval of stormwater drainage design is typically separated into two categories:

- New and re-development projects that are funded by private sources or sources other than Marion County and are reviewed and permitted by the Land Development Engineering and Permits Section of Public Works.
- Projects funded by or through Marion County that are reviewed and approved by the Capital Projects Section of Public Works.

Exceptions to the Stormwater Standards requirements for both construction and post-construction include projects involving agricultural field drains that have discharges regulated by the United States Department of Agriculture (USDA).

The requirements presented in these Standards do not exclude or replace the requirements of other applicable codes or regulations, such as the industrial NPDES permitting program, or any other applicable federal or state regulations or permit requirements.

All development within Federal Emergency Management Agency (FEMA) regulated streams and floodplain overlay zones will be required to meet FEMA floodplain requirements and the requirements through the local planning and building authority.

Additional facilities or modifications may be required at the sole discretion of the Director if it is determined by the Director that stormwater management or stormwater drainage system facilities are necessary to effectively manage and protect natural resources, storm drainage systems, and/or private property.

1.3 Objectives

The objectives of these Standards include the following:

- Maintain and improve the water quality in the County's waterways, lakes, wetlands, and other natural resources.
- Meet the requirements associated with the County's NPDES MS4 Phase II Permit and other applicable laws and regulations.
- Construct facilities that are safe, economical to maintain, and have a long design life to minimize costs to Marion County.
- Preserve existing resources and consider sensitive areas and required buffers and setbacks.
- Minimize impervious surfaces through Low Impact Development (LID) site planning, and the use of impervious area reduction measures, such as green infrastructure (GI).
- Minimize site disturbance and soil compaction during construction, including protecting undisturbed vegetated areas from construction activities, and providing rainfall interception, evapotranspiration, and runoff rate attenuation.

1.4 Use with Public Works Engineering Standards

These Stormwater Standards are intended to work in conjunction with Section V of the 1990 Marion County Engineering Standards or most current version. Section V of the 1990 Standards specifies design requirements for all drainage facilities, including detention facilities, pipes, open channels, manholes, junction boxes and cleanouts, inlets, catch basins, drywells, and French drains. Section V also provides information on design storms and runoff coefficients and lists requirements for drainage facility plan submittals in addition to the submittal requirements in Section 6 of these Stormwater Standards. All projects must comply with Section V or most current version.

All requirements for flow control and the design of detention facilities are found in the 1990 Marion County Engineering Standards, Section V or most current version. As such, these Stormwater Standards do not discuss detention requirements or flow control standards, except when retention or treatment facilities are designed to also include flow control. The retention and treatment performance standards outlined in Section 3 are based on the Water Quality Design Storm. This is one single design storm specific to water quality standards. Individual components of stormwater management facilities may have design specifications that cite the “applicable design storm”, which refers to the various design storms and their applicability found in Section V of the 1990 Marion County Engineering Standards or most current version.

Section 2

Site Assessment and Development Considerations

These Stormwater Standards are intended to guide site-specific stormwater management improvements that prioritize retention/infiltration and green infrastructure (GI). Strategies for meeting the requirements of these Standards depend on several site factors including soil infiltration capacity, available infrastructure, and proposed development plans. To use these Standards effectively, applicants must demonstrate an understanding of development site conditions, the upstream and downstream impacts resulting from the proposed development, and the required stormwater management improvements.

The purpose of this section is to ensure that the physical attributes of the development site are reviewed and considered with respect to stormwater management and soil infiltration capability before construction of human made structures such as streets, parking lots, and buildings.

2.1 Site Assessment

The Applicant shall complete the Site Assessment Checklist found in Appendix A, which includes available site information and assessment maps as described below. The site assessment review and associated site mapping should be used to determine the location of Stormwater Management Facilities (SMFs) with maximum infiltration capability, while minimizing the impact of the project related to natural resources and steeper topography. The information documented in this section (Section 2) should be included in the Drainage Submittal Package. The Drainage Package submittal includes the Stormwater Management Report, the contents of which are detailed in Section 6.

2.1.1 Site Information

The Applicant shall provide the following required site information with reference to supporting documentation and maps, as appropriate:

A. Applicant's contact information

B. Project Location Address, including sensitive areas and natural resources (as mapped on the County's Sensitive Area Map[3]) and floodplain delineation, if applicable

C. Existing Use of Property Description

D. Project Description, including proposed development type (e.g., commercial, residential)

E. Size of project site and the proposed impervious (including semi-impervious) area(s) (created and replaced)

[3] Sensitive Area Maps can be found at https://www.co.marion.or.us/PW/ES/waterquality/Pages/sam.aspx

2.1.2 Site Assessment Elements

The Applicant shall complete the Site Assessment Checklist found in Appendix A, to include each of the following items detailed below.

- **Topography Map and Description:** Steep ground slopes greater than (>) 25 percent and setback areas around those steep ground slopes, as well as landslide hazard area (see *MCC 16.24: Geologically Hazardous Areas Overlay Zone*) related to infiltration as described later in this document. Infiltration is not allowed on steep ground slopes and slide-prone areas. Infiltrating stormwater on moderate ground slopes (10 percent or greater) requires a geologist's analysis or geotechnical engineering analysis to determine the appropriate strategies.
- **Soils and Groundwater:** Soil maps, which are available from the Natural Resources Conservation Service (NRCS) Soil Survey should be used to determine the site Hydrologic Soil Group (HSG), an indication of soil infiltration capacity. An assessment of the seasonal high groundwater table (SHGWT) is required to ensure proposed infiltration facilities meet minimum separation distances as outlined in these Standards.
- **Infiltration Assessment:** Stormwater management facilities that use infiltration shall be based on field tested infiltration rates. See Appendix B for specific infiltration testing requirements and methods. Infiltration testing shall be conducted at the location of the proposed stormwater management facility unless prior approval is granted for testing elsewhere.
- **Hydrology:** Indicate natural drainage features present on site, including channels, creeks, streams, and rivers. Identify, review and map any of the applicable features to the project site. Jurisdictional wetland(s), per Oregon Department of State Lands and U.S. Army Corps of Engineers, and/or 100-year floodplain, per FEMA mapping, should be reviewed and mapped.
- **Existing Drainage:** Constructed drainage features on and adjacent to the site, including pipes, ditches, and outfalls should be mapped.
- **Existing Vegetation and Land Cover:** Using aerial photos or survey, map all trees and vegetation. Show all existing trees on the site assessment map and mark areas of other vegetation types (e.g., shrubs, pasture). Existing trees and vegetation should be preserved to the extent practicable. Describe the current vegetation cover of the site. If the site is currently developed, describe the conditions of the developed site.
- **Existing Land Use and Zoning:** Document the land use zoning types as indicated in *MCC Title 16: Urban Zoning and Title 17: Rural Zoning.*
- **Proposed Future Land Use and Zoning:** Document the proposed future land use zoning types per the project plans, as indicated in *MCC Title 16: Urban Zoning and Title 17: Rural Zoning.*
- **Access and Parking:** Include a map that delineates proposed access points for all transportation modes, including emergency vehicle access. Indicate amount and area of required parking onsite if applicable.
- **Utilities to Site and Surrounding Areas:** Include a map with existing utilities including stormwater facilities, storm conveyance, sewer, water, electricity, phone/cable, gas, and any public storm system/facility downstream within 500' from the property boundary, as applicable.
- **Downstream storm drainage system:** Document the existing and proposed points of discharge for stormwater runoff leaving the site. See Section 5 for downstream analysis requirements.

2.2 Site Development Considerations

The County restricts the uncontrolled and untreated discharge of stormwater pollutants into any stormwater system and/or natural drainageway in the SWMA. These Stormwater Standards are intended to provide guidance for the reduction of pollutants into stormwater to the maximum extent feasible (MEF). The amount of stormwater pollutants can be significantly reduced by simple site development considerations and construction procedures, including methods and sequencing that retain or preserve natural hydrology.

The development site layout should consider the use of Low Impact Development (LID) strategies and strive to reduce the impervious areas proposed for the site. These strategies include reducing the volume of stormwater runoff and slowing the rate of runoff from built surfaces through green infrastructure (GI) facilities. Examples of LID site layout techniques include:

- Flexible lot size developments
- Reduced building setbacks
- Shared parking areas
- Planned unit developments
- Attached housing and clustered buildings that require fewer driveways and pathways
- Reduced parking stalls (number or size), especially in transit-served areas
- Adding floors to buildings or parking garages
- Reduced street width if allowed by local planning codes.

Applicants should evaluate which options are available through the County's local planning and zoning codes. In addition, LID strategies include considerations of existing site conditions and protecting/maximizing the benefits of those conditions for enhanced stormwater management. Sites subject to stormwater management requirements shall incorporate the low impact site development and road design considerations as listed below, which describes the low impact development techniques for site development and road design to be used to the MEF for site and project specific conditions and constraints:

1. *Preserve the natural vegetation on site to the maximum extent feasible. The developed area should be situated to minimize the clearing of existing groundcover, maximize the preservation of wetlands, buffer waterway corridors (riparian areas), and maintain the natural drainage pathways for seasonal and intermittent drainage. If feasible, the preserved area should be located down slope (downhill) from the developed area, since flow control and water quality are enhanced by flow dispersion through undisturbed soils and native vegetation.*
2. *Define distinct development envelopes and protected areas.*
3. *Minimize direct connections of impervious areas to underground drainage systems by allowing stormwater to permeate into the soil (within the confines of ODEQ Underground Injection Control (UIC) program regulations and prevailing site and soil conditions) and/or be filtered by vegetation before being collected into catch basins (i.e., biofiltration swales).*
4. *Use drainage facilities as a benefit to the site, including creating multi-use facilities and natural drainage pathways where possible, while avoiding diversion of stormwater runoff from one watershed to another.*
5. *Provide at least one foot of permeable soil in landscaped areas to disperse and infiltrate water, support plant growth and filter and decompose pollutants. Such dispersion must be carefully designed to avoid groundwater contamination, erosion, landslide hazards, building setbacks, and other similar features; and must adhere to ODEQ UIC program regulations.*
6. *Use construction techniques and landscape designs that minimize soil compaction. Provide protection from compaction by defining vehicle pathways; using appropriate landscape plant selection and placement; and using amendments such as organic matter, coarse sand, pumice, granulated rubber, and similar soil components.*
7. *Minimize use of impervious surfaces consistent with site design*

Other low impact development impervious area reduction strategies include the use of impervious area reduction facilities such as pervious pavement and/or green roofs. These Impervious area reduction facilities will reduce the impervious area requiring additional stormwater management retention/treatment facilities and hence reduce the size of required stormwater management facilities (see Section 3). The following section provides design guidelines for these impervious area reduction facilities.

2.3 Impervious Area Reduction Approaches

As stated in the previous section, the Applicant can reduce the amount of impervious area created or replaced and thus reduce the effort required to meet stormwater management requirements by installing impervious area reduction facilities such as pervious pavement and/or green roofs. The hydrologic calculations submitted for these facilities must reflect the current and proposed (created and replaced) pervious and impervious cover for the site. Guidelines for these impervious area reduction approaches are provided in the following subsections.

2.3.1 Pervious Pavement

Pervious pavement (*porous asphaltic concrete, pervious concrete or pervious pavers*) is a walking or driving surface designed to allow rainfall to percolate into the underlying soil or aggregate storage reservoir beneath the pavement. Pervious pavement shall be designed only as an impervious area reduction technique to manage direct rainfall. It shall not be designed as a Best Management Practice (BMP) that receives runoff from surrounding areas also referred to as “run-on”.

The wearing course (surface layer) of pervious pavement may be any of the following:

- **Porous asphaltic concrete (PAC)**[4] is open-graded asphalt that allows water to percolate or infiltrate into underlying soils.
- **Pervious concrete** omits fines in the aggregate to create stable air pockets that allow water to drain to the base below. There is an inverse relationship between porosity and strength. As porosity is increased, the structural strength is reduced.
- **Pervious Pavers** are generally suitable for pedestrian areas and low traffic parking areas. They are available in a variety of configurations such as rigid concrete or durable plastic grid filled with gravel or a mixture of gravel, sand, and topsoil suitable for vegetation.

Pervious pavement site design requirements include:

- Pervious pavement will not be allowed at sites with elevated risk of hazardous material spills such as a gas station.
- Pervious pavement design must meet all applicable State and County building codes.
- Proprietary pervious pavement systems must be installed per manufacturer specifications.
- Pervious pavements in the public right-of-way or on County maintained streets must be pre-approved by the Director.
- Pervious pavement will not be given full water quality treatment credit at ground slopes that exceed 3 percent.
- Pervious pavement design shall provide at least 3 feet separation below the bottom of the pervious pavement facility to the underlying seasonal high groundwater table; bedrock or other impermeable layer.

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[4] See ODOT *Standard Specifications for Construction*, Section 00743–Porous Asphalt Concrete (PAC) for additional specifications.

- Pervious pavement requires a minimum design soil infiltration rate of 0.50 in./hr.
- A designed overflow to an approved conveyance system and discharge point is required to prevent ponding in the event that the surface becomes clogged with sediment or debris.
- Installation of signs prohibiting seal coating of the pervious pavement must be part of the site design.
- Pavement design shall provide specifications to demonstrate that pavement structure has the structural strength for anticipated vehicle loadings.
- Not appropriate for construction over fill soils unless evaluated and approved by a geotechnical engineer and results are reported in the Geotechnical Report (See Section 6.6).

Other paving systems may be reviewed on a case-by-case basis for porous designation and appropriate use. They must show the ability to pass water through the pavement layer but not present a gravel or soil surface to traffic, which could generate dust.

Maintenance Considerations for the Operations & Maintenance Manual

The operations and maintenance (O&M) manual submitted with the site design must address frequency and type of pavement sweeping, cleaning and jetting. The County will not be responsible for maintaining pervious pavement on privately owned property. See Section 7 and Appendix E for O&M manual requirements.

2.3.2 Green Roofs

A green roof is a building roof that is partially or completely covered with vegetation and growing media atop a waterproof membrane; a green roof is also called an eco-roof or vegetated roof. Green roofs include the following elements: a thin, layered system of waterproofing, drainage layers, growing media, and planting to cover impervious roof areas and allow water to be absorbed, detained, and evaporated back into the atmosphere. Proprietary systems are also available using various layers or even modular trays that fit easily on an existing roof.

Green roofs are primarily designed for stormwater management, with aesthetics as a secondary goal. Green roofs are not designed for foot traffic or recreation. The structural integrity of the existing building should be reviewed when considering the installation of a green roof. Green roof site design requirements include:

- Green roof pitch (slope) should be less than or equal to 10 percent.
- A drain system and overflow to an approved conveyance system and discharge points is required.
- Waterproofing material (e.g., modified asphalt membranes or thermoplastic membranes) must be used on the roof surface.
- Soil of adequate fertility and drainage capacity at depths of 2 to 6 inches, and weight of 10 to 30 pounds per square foot, shall be applied. The building structure must be shown to be adequate to hold the additional weight.
- Soil coverage to prevent erosion shall be established immediately upon installation by using mulch, vegetation mats, or other approved protection methods.
- Temporary irrigation to establish plants is recommended. A permanent irrigation system using potable water may be used, but an alternative means of irrigation, such as air conditioning condensate or other non-potable sources is recommended.
- Alternative sources should be analyzed to determine if the irrigation source water has chemicals that might harm or kill the vegetation.

- Vegetation shall conform to the following:
  - Drought-tolerant, requiring little or no irrigation after establishment.
  - A growth pattern that allows the plant to thoroughly cover the soil. At least 90 percent of the overall surface shall be covered within 2 years.
  - Self-sustaining, without the need for fertilizers, pesticides, or herbicides.
  - Able to withstand heat, cold, and high winds.
  - Low maintenance, needing little or no mowing or trimming.
  - Perennial or self-sowing.
  - Fire resistant.
  - A mix of sedum/succulent plant communities is recommended because they possess many of these attributes. Herbaceous plants, grasses, and other low groundcovers can also be used to provide additional benefits and aesthetics; however, these plants may need more watering and maintenance to survive and keep their appearance.

2.3.3 Maintenance Considerations for the O&M Manual

The O&M Manual submitted with the site design must provide procedures for overflow maintenance, watering, control of invasive weeds, and vegetation reestablishment. See Section 7 and Appendix E for O&M Manual requirements.

2.3.4 Other Impervious Area Reduction Techniques

The Director may approve other techniques that reduce or disconnect impervious areas, such as vegetated filter strips, on a case-by-case basis when adequate hydrologic and engineering analysis have been provided.

Section 3

Stormwater Quality

For new and redevelopment projects as described in Section 1.2, stormwater quality management will be required according to this Section.

3.1 General Considerations

Methods used to reduce pollutants in stormwater and to preserve stormwater quality are referred to as Best Management Practices (BMPs). BMPs can be either operational practices or structural controls. This section provides design standards for BMPs that provide stormwater quality retention and treatment.

Stormwater pollutants are generally separated into the following categories: suspended solids/sediment, oxygen-demanding pollutants, temperature, organic carbon, organic matter (i.e., leaves, flowers, twigs, pollen), hydrocarbons, metals (i.e., lead, copper, zinc, and cadmium), nutrients (i.e., nitrogen and phosphorous), pathogens (i.e., bacteria, viruses, and protozoa from sources such as animal feces, leaking sewers, etc.) and toxins (i.e., pesticides, chemical toxins). These Stormwater Standards are intended to reduce the discharge of the above pollutants to waters of the state.

3.2 Water Quality Design Storm

The County's *Water Quality Design Storm* (Design Storm) is 1.38 inches per 24-hour period. This design storm was selected to represent 80 percent of the County's average annual runoff based on an evaluation of long-term rainfall data. Design flows and volumes for sizing stormwater management facilities shall be calculated based on the runoff from the Design Storm using an analytical method (see Section 4.1) acceptable to the Director.

3.3 Requirement Hierarchy

For projects requiring stormwater quality management as described in Section 1.2, stormwater management must be implemented according to the following hierarchy:

1. Projects that create or replace 10,890 square feet (1/4 acre) or more of impervious surface must retain the site runoff produced by the Design Storm of 1.38 inches in 24 hours to satisfy the performance requirements in Section 3.4; or:
2. For projects that demonstrate an inability to meet the retention requirement in Item 1 above (see Section 3.4), the remainder of the runoff generated by the Water Quality Design Storm must be treated prior to discharge from the project site. Treatment must be implemented to satisfy the performance requirements in Section 3.5; or:
3. If the retention and treatment performance requirements cannot be met, offsite mitigation may be allowed as an alternative compliance option for both public and private projects, in accordance with Section 3.8 and contingent upon Director approval.

3.4 Retention Performance Standards

Retention may be accomplished using green stormwater infrastructure that captures, infiltrates, and/or evapotranspirates stormwater. See Section 3.6 for a prioritized list of stormwater management facilities. To demonstrate that retention (i.e., infiltration) is infeasible, the developer must provide documentation in the Stormwater Management Report (see Section 6.6) that one of the following limiting conditions exist:

- The site has infiltration rates of less than 1 inch per hour as proven by infiltration testing or analysis. Infiltration testing requirements are listed in Appendix B.
- Stormwater management facilities would be located on fill (defined as any material such as, but not limited to, sand, soil, rock, or gravel that is placed in an excavated area or a wetland or flood area for the purposes of development).
- Site areas include steep slopes (>25 percent) and/or are located in Geologically Hazardous Areas Overlay Zones (per *MCC Section 17.182: Geologically Hazardous Areas Overlay Zones* and *MCC 16.24: Geologically Hazardous Areas Overlay Zones*). Note that a geotechnical engineering or geologist report and County approval is required for infiltration facilities on moderate ground slopes of greater than or equal to 10 percent.
- Projects proposing to use stormwater infiltration facilities may be required to perform a seasonal high groundwater table assessment to determine that the seasonal groundwater table is at least 3 feet below the proposed bottom elevation of the facility.
- The site contains contaminated soils. Sites that have contaminated soils must be evaluated by the Oregon Department of Environmental Quality (ODEQ) and/or the Environmental Protection Agency, to determine if areas on site are suitable for infiltration without the risk of mobilizing contaminants in the soil or groundwater. Documentation showing contamination assessment and determination must be submitted to the County for approval.

3.5 Treatment Performance Standards

For projects requiring treatment per the hierarchy in Section 3.2, treatment facilities shall be designed to capture and treat any portion of the runoff generated by the Water Quality Design Storm that is not retained. The facility (permanent) used for treatment must be designed to target removal of 80 percent of the influent total suspended solids (TSS) concentration. In choosing a facility to meet the treatment performance standards, green infrastructure (GI) must be utilized to the maximum extent feasible (MEF). Appendix C outlines the criteria that defines implementation of GI to the MEF. See Section 3.6 for a prioritized list of stormwater management facilities. Detention ponds designed solely for flow control purposes are not a sufficient stand-alone treatment method.

3.6 Stormwater Management Facility Design Standards

Stormwater management facilities, whether being used for retention or treatment, shall conform to the following standards. Acceptable retention or treatment stormwater management facilities, in order from most to least preferred, include:

1. Infiltration Planter Boxes and Infiltration Rain Gardens (retention)
2. Biofiltration Swales, Treatment Planter Boxes, and Treatment Rain Gardens (treatment)
3. Proprietary Stormwater Treatment Devices
4. Other (see Section 3.6.5)

3.6.1 General Facility Design Requirements

The following design requirements apply to all stormwater management facilities (permanent). Additional, facility-specific design criteria are included in Sections 3.6.2–3.6.5. Typical facility details are included in Appendix D.

- **Location and Setbacks:** Applicants must review local zoning, building, critical areas, floodplain overlay zoning, and plumbing code requirements to understand setback requirements for stormwater management facilities. In addition, stormwater facilities that incorporate an infiltration component must be located at least 10 feet from building foundations and may not be located immediately uphill (upslope) of building structures or pavement sections. A geotechnical report is required to determine setbacks from ground slopes for infiltration facilities installed near ground slopes ≥10 percent or within 200 feet of a Geologically Hazardous Overlay Zone.

  Outlet Structures: Orifices shall be located to prevent clogging and blockages. Outlet structures (orifices, weirs, overflow risers, etc.) shall be configured to operate as passive systems and shall not require adjustments during normal operation. Additional overflow design requirements are listed in the "Piping" section of 3.6.2 below.
- **Stormwater Facility Signage:** Stormwater facility signage is required. Signage may serve to educate people about the importance or function of the site's stormwater protection measures. It may also discourage behaviors that adversely affect stormwater protection measures. For example, if debris is a problem, a sign reminding people not to litter may partially solve the problem. Broken or defaced signs shall be replaced or repaired within 60 calendar days of written notice.

Proposals to place stormwater management facilities in a public right-of-way or require a setback variance must be approved by the Director. No stormwater management facilities will be allowed in the public right-of-way or in a setback variance area unless they are outside the footprint of the ultimate design section of the road.

3.6.2 Retention Facilities Design Requirements

Acceptable retention stormwater management facilities include:

- Infiltration Planter Boxes
- Infiltration Rain Gardens

Retention facilities, also called vegetated infiltration facilities, or bioretention facilities, include Infiltration Planter Boxes and Infiltration Rain Gardens. Both are flat-bottomed, shallow, depressed landscape areas designed to meet the retention performance standards detailed in Section 3.4. Infiltration Planter Boxes differ from Infiltration Rain Gardens in that they are structural reservoirs and typically are designed to receive less runoff than an Infiltration Rain Garden.

The design of a retention facility may provide detention for volumes exceeding the calculated Water Quality Design Storm volume and may be used for meeting flow control requirements. When used for this purpose, the design must provide flow control storage above the design water surface elevation of the facility, with flows bypassing the facility's infiltration function by overtopping into an inlet designed to restrict the peak flow for larger events to meet flow control requirements.

Design criteria for Infiltration Planter Boxes and Infiltration Rain Gardens are listed below.

Infiltration Planter Boxes

General

- An overflow to an approved conveyance system and discharge point is required. See design specifications for overflows in the “piping” subsection below.
- To meet retention performance standards, Infiltration Planter Boxes shall not have an underdrain and shall rely solely on infiltration. For infiltration testing requirements see Appendix B.

Sizing

- The size and depth of the facility shall be based on the area required to retain and infiltrate the runoff created by the Water Quality Design Storm.
- The square-footage is determined at the water surface elevation immediately prior to water reaching the design overflow elevation (top of freeboard).
- Facilities that receive runoff from impervious areas 10,000 square feet or less may be designed using the Simplified Method (see Table 3-1).
- Facilities not sized using the Simplified Method must be designed to drain the calculated design volume in less than 18 hours after the end of the 24-hour event. See Section 4.1 for calculation methods.

Inlets

- In streets or parking lots, stormwater may flow directly into the facility via curb openings.
- Energy dissipation must be provided for facilities with a point of collection (concentrated points) of inflow.

Dimensions

- Minimum bottom width shall be 30 inches.
- Minimum ponding depth shall be 6 inches.
- Maximum ponding depth shall be 12 inches.
- Minimum freeboard shall be 2 inches.

Piping

- Overflow pipes:
  - Overflow drains must have the capacity to convey the 50-year design storm, as specified in the County 1990 Public Works Engineering Standards, or most current version.
  - On private property, this overflow drain and piping shall direct excess stormwater to an approved discharge point as identified on the engineered design details.
  - Within the public street right-of-way, this overflow drain and piping must meet County Public Works Standards and shall direct excess stormwater to an approved discharge point.

Setbacks

- Infiltration facilities shall have a 10-foot minimum setback from building structures, a 5-foot minimum setback from property lines, and shall not be located immediately uphill (upslope) of building structures or pavement.
- The most stringent relevant building setback requirements shall prevail.

Soil Amendment and Mulch

- Amend the native soil such that the mix consists of one-part organic compost, one-part coarse sand, and one-part native soil.

- Minimum thickness of soil amendment layer shall be 18 inches.

Planting, Landscape and Irrigation Requirements

- The facility bottom area shall be planted with vegetation. Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions. For full planting requirements and a list of plants suitable to vegetated infiltration facilities, see Appendix H: *City of Salem Landscape Requirements and Plant Lists for Stormwater Facilities*, *Section 4B.5 – Stormwater Planters*.
- At full maturity, the height of facility plantings shall not impede the vision clearance area for any adjacent ROW. If the facility is within a vision clearance area as defined in *MCC 17.110.770* (for rural areas) and in *MCC 16.27.200* (for urban areas), the facility plantings may not exceed 30 inches in height above curb level, or street centerline when there is no curb.
- Warranty period requirements can be found in Section 7.4.
- Establishment procedures, such as control of invasive weeds, animal and vandal damage, mulching, re-staking, watering, and mesh or tube protection replacement, shall be implemented to the extent needed (as determined by the Director) to ensure plant survival.
- Facilities located in the public right-of-way are not permitted to use coniferous trees to meet landscaping requirements.
- The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.
- Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation.
- Plant establishment should meet the requirements in Section 7.4.

Maintenance Considerations for the O&M Manual

The site-specific O&M Manual submitted with the facility design must include an inspection and maintenance schedule and a program description that addresses vegetation management, sediment, and debris removal, erosion, pipe and orifice maintenance if applicable, and structural repair or replacement. Owners are required to provide all-weather access to the County and check their facilities regularly to determine maintenance needs. See Section 7 and Appendix E for O&M Manual requirements, including requirements of the 2-Year Maintenance Warranty Period Plan.

<u>Infiltration Rain Gardens</u>

General

- An overflow to an approved conveyance system and discharge point is required. See design specifications for overflows in the “piping” subsection below.
- To meet retention performance standards, Infiltration Rain Gardens shall not have an underdrain and shall rely solely on infiltration. For infiltration testing requirements see Appendix B.

Sizing

- The size and depth of the facility shall be based on the area required to retain and infiltrate the runoff created by the Water Quality Design Storm.
- The square-footage is determined at the water surface elevation immediately prior to water reaching the design overflow elevation (top of freeboard).
- Facilities that receive runoff from impervious areas 10,000 square feet or less may be designed using the Simplified Method (see Table 3-1 below).

- Facilities not sized using the Simplified Method must be designed to drain the calculated design volume in less than 18 hours after the end of the 24-hour event. See Section 4.1 for calculation methods.

Inlets

- In streets or parking lots, stormwater may flow directly into the facility via curb openings.
- Energy dissipation must be provided for facilities with a point of collection (concentrated points) of inflow.

Dimensions

- Minimum bottom width shall be 36 inches.
- Maximum side slope shall be 3H:1V.
- Minimum ponding depth shall be 6 inches.
- Maximum ponding depth shall be 12 inches.
- Minimum freeboard shall be 2 inches.

Piping

- Overflow pipes:
  - Overflow drains must have the capacity to convey the 50-year design storm, as specified in the County 1990 Public Works Engineering Standards, or most current version.
  - On private property, this overflow drain and piping shall direct excess stormwater to an approved discharge point as identified on the engineered design details.
  - Within the public street right-of-way, this overflow drain and piping must meet County Public Works Standards and shall direct excess stormwater to an approved discharge point.

Setbacks

- Infiltration facilities shall have a 10-foot minimum setback from building structures, a 5-foot minimum setback from property lines, and shall not be located immediately uphill (upslope) of building structures or pavement.
- The most stringent relevant building setback requirements shall prevail.

Soil Amendment and Mulch

- Amend the native soil such that the mix consists of one-part organic compost, one-part coarse sand, and one-part native soil. If there is surface ponding, add organic compost and sand and re-till until infiltration performance is enhanced.
- Minimum thickness of soil amendment layer shall be 18 inches.
- A 2-inch layer of shredded bark mulch (not bark dust or bark chips) shall be used over the amended soil and between the plantings. The use of artificial mulch is prohibited.

Planting, Landscape and Irrigation Requirements

- The facility bottom area shall be planted with vegetation. Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions. For full planting requirements and a list of plants suitable to vegetated infiltration facilities, see Appendix H: *City of Salem Landscape Requirements and Plant Lists for Stormwater Facilities*, *Section 4B.6 – Rain Gardens, Vegetated Filter Strip, and Vegetated Swales*.
- At full maturity, the height of facility plantings shall not impede the line-of-sight for any adjacent ROW. If the facility is within a vision clearance area as defined in MC 17.110.770, the facility plantings may not exceed 30 inches in height above curb level, or street centerline when there is no curb.

- Warranty period requirements can be found in Section 7.4.
- Establishment procedures, such as control of invasive weeds, animal and vandal damage, mulching, re-staking, watering, and mesh or tube protection replacement, shall be implemented to the extent needed (as determined by the Director) to ensure plant survival.
- Facilities located in the public right-of-way are not permitted to use coniferous trees to meet landscaping requirements.
- The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.
- Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation.
- Plant establishment should meet the requirements in Section 7.4.

Maintenance Considerations for the O&M Manual

The site-specific O&M Manual submitted with the facility design must include an inspection and maintenance schedule and a program description that addresses vegetation management, sediment, and debris removal, erosion, pipe and orifice maintenance if applicable, and structural repair or replacement. Owners are required to provide all-weather access to the County and check their facilities regularly to determine maintenance needs. See Section 7 and Appendix E for O&M Manual requirements, including requirements of the 2-Year Maintenance Warranty Period Plan.

3.6.3 Treatment Facilities Design Requirements

Acceptable treatment stormwater management facilities include:

- Biofiltration Swales
- Treatment Planter Boxes
- Treatment Rain Gardens

Treatment facilities, which include Biofiltration Swales, Treatment Planter Boxes, and Treatment Rain Gardens, are facilities designed to meet the Treatment Performance Standards detailed in Section 3.5 by conveying and treating stormwater runoff, allowing pollutants to settle and filter out as water flows through the facility. While these facilities may achieve some infiltration, they are typically used in areas not conducive to infiltration due to low soil infiltration rates or other retention infeasibility criteria as outlined in Section 3.4.

Biofiltration swales, are long, narrow grassy or vegetated channels. They may be seeded or planted with grasses (grassy swale) or other plants (vegetated swale). Treatment Planter Boxes and Treatment Rain Gardens have similar characteristics to Infiltration Planter Boxes and Infiltration Rain Gardens, but do not provide infiltration of the Full Water Quality Design Storm.

The design of a treatment facility may provide detention for volumes exceeding the calculated Water Quality Design Storm volume and may be used for meeting flow control requirements. When used for this purpose, the design must provide flow control storage above the design water surface elevation of the facility, with flows bypassing the facility's treatment function by overtopping into an inlet designed to restrict the peak flow for larger events to meet flow control requirements.

Design criteria for Biofiltration Swales, Treatment Planter Boxes, and Treatment Rain Gardens are listed below.

Biofiltration Swales

General

- An overflow to an approved conveyance system and discharge point is required. See design specifications for overflows in the “piping” subsection below.

Sizing

- Design flow shall be calculated based on Design Storm per Section 3.2.
- Minimum hydraulic residence time shall be 9 minutes.
- Maximum water quality design ponding depth (as shown in stormwater facility details) shall be as follows:
  - Grassy swales: 4 inches
  - Vegetated swales: 8 inches

Inlets

Provide an energy dissipater at the inlet to the swale, with a minimum length of 4 feet. Energy dissipater shall be designed to reduce velocities and spread flow across the swale cross section.

Dimensions

- Minimum longitudinal slope shall be 0.3 percent.
- Maximum longitudinal slope shall be 6 percent (for steeper sites over 6 percent, use check dams or similar features to slow flow velocity and create step pools to promote infiltration).
- Minimum freeboard shall be 6 inches.
- Minimum orifice size shall be 0.5 inches.
- For the Manning’s ‘n’ value (for sheet flow), reference Table 4-3 for “vegetated swale”.
- Maximum velocity shall be 1.0 feet per second at design flow, calculated using Manning’s equation or equivalent methods.
- Intermediate flow spreaders shall be installed at a minimum of 50-foot intervals.
- Minimum total bottom length shall be 100 feet.
- Minimum bottom width shall be 2 feet.
- Maximum side slope shall be 3H:1V.
- An approved outlet structure shall be provided for all flows up to the 50-year design storm flow.
- Where a biofiltration swale turns 180 degrees to form parallel channels, freeboard shall be provided between each of the parallel channels. A 1-foot (above ground surface) wall may be used above the treatment area to provide freeboard while enabling a narrower system. As an alternative, a soil-based berm may be used. The berm shall have a minimum top width of 1 foot and 2.5H:1V or flatter side slopes.
- Where swales are designed with ditch inlets and outlet structures and design of maintenance access to such structures may be difficult due to swale location, swales may be designed as flow through facilities with un-sumped inlet structures.

Soil Amendment

- Minimum depth of topsoil or amended soil shall be 12 inches to support plant growth.

Planting, Landscape, and Irrigation Requirements

- Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions. For full planting requirements and a list of plants suitable to vegetated infiltration facilities, see Appendix H: *City of Salem Landscape Requirements and Plant Lists* *for Stormwater Facilities*, *Section 4B.6 – Rain Gardens, Vegetated Filter Strip, and Vegetated Swales*.

- Plants, either from seed or pots, shall be established based on the requirements in Section 7.4. If this is not feasible, biodegradable erosion control matting (e.g., jute mat, coir) appropriate for expected flow velocities shall be installed in the flow area. No runoff shall be allowed to flow in the swale until either vegetation is established or matting has been provided. Trees and shrubs may be allowed in the flow path within swales if the swale exceeds the minimum length and widths specified; however, it is required that the applicant verify that trees and shrubs will not impede the flow of water if placed in the flow path.
- Establishment procedures, such as control of invasive weeds, animal and vandal damage, mulching, re-staking, watering, and mesh or tube protection replacement, shall be implemented to the extent needed (as determined by the Director) to ensure plant survival.
- Facilities located in the public right-of-way are not permitted to use coniferous trees to meet landscaping requirements.
- At full maturity, the height of facility plantings shall not impede the line-of-sight for any adjacent ROW.
- Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation.
- The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.

Maintenance Considerations for the O&M Manual

The site-specific O&M Manual submitted with the facility design must include an inspection and maintenance schedule and a program description that addresses vegetation management, sediment and debris removal, erosion, pipe and orifice maintenance as applicable, and structural repair or replacement. Owners are required to provide all-weather access to the County and check their facilities regularly to determine maintenance needs. See Section 7 and Appendix E for O&M Manual requirements, including requirements of the 2-Year Maintenance Warranty Period Plan.

- Inspect annually and after large flow events for debris and reduction in flow capacity.
- Remove and prevent establishment of invasive weeds. Avoid the use of pesticides, herbicides, and other chemicals in stormwater quality control facilities. If chemical control is necessary, use a licensed pesticide applicator.

<u>Treatment Planter Boxes</u>

General

- An overflow to an approved conveyance system and discharge point is required. See design specifications for overflows in the “piping” subsection below.

Sizing

- The square-footage is determined at the water surface elevation immediately prior to water reaching the design overflow elevation (top of freeboard).
- Facilities that receive runoff from impervious areas 10,000 square feet or less may be designed using the Simplified Method (see Table 3-1 below).

Inlets

- In streets or parking lots, stormwater may flow directly into the facility via curb openings.
- Energy dissipation must be provided for facilities with a point of collection (concentrated points) of inflow.

Dimensions

- Minimum bottom width shall be 18 inches.
- Minimum ponding depth shall be 6 inches.
- Maximum ponding depth shall be 12 inches.
- Minimum freeboard (vertical distance between the design maximum water surface elevation and overtopping the facility's outlet structure) shall be 2 inches.

Piping

- Underdrains:
  - Minimum depth of perforated pipe underdrain shall be 6 inches from the bottom of the growing medium. Minimum perforation spacing should be dictated by the manufacturer of the perforated pipe and is typically spaced 5" to 6" on center and 90 to 120 degrees around.
  - Minimum underdrain pipe diameter shall be 6 inches.
  - Minimum underdrain pipe spacing shall be 12 feet on center.
  - Cleanouts shall be provided to enable inspection and cleaning of the underdrain.
  - Minimum distance between cleanouts shall be 100 feet.
- Overflow pipes:
  - Overflow drains must have the capacity to convey the 50-year design storm, as specified in the 1990 County Public Works Engineering Standards.
  - On private property, this overflow drain and piping shall direct excess stormwater to an approved discharge point as identified on the engineered design details.
  - Within the public street right-of-way, this overflow drain and piping must meet County Public Works Standards and shall direct excess stormwater to an approved discharge point.

Setbacks

- Filtration facilities that are lined with waterproofed concrete or an impermeable liner generally do not have a required setback, though the most stringent relevant building setback requirements shall prevail.

Soil Amendment and Mulch

- Amend the native soil such that the mix consists of one-part organic compost, one-part coarse sand, and one-part native soil.
- Minimum thickness of soil amendment layer shall be 18 inches.
- A 2-inch layer of shredded bark mulch (not bark dust or bark chips) shall be used over the amended soil and between the plantings. The use of artificial mulch is prohibited.

Planting, Landscape and Irrigation Requirements

- The facility shall be planted with vegetation. Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions. For full planting requirements and a list of plants suitable to vegetated infiltration facilities, see Appendix H: *City of Salem Landscape Requirements and Plant Lists for Stormwater Facilities*, *Section 4B.5 – Stormwater Planters*.
- At full maturity, the height of facility plantings shall not impede the line-of-sight for any adjacent ROW.
- Warranty period requirements can be found in Section 7.4.

- Establishment procedures, such as control of invasive weeds, animal and vandal damage, mulching, re-staking, watering, and mesh or tube protection replacement, shall be implemented to the extent needed (as determined by the Director) to ensure plant survival.
- Facilities located in the public right-of-way are not permitted to use coniferous trees to meet landscaping requirements.
- The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.
- Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation.
- Plant establishment should meet the requirements in Section 7.4.

Maintenance Considerations for the O&M Manual

The site-specific O&M Manual submitted with the facility design must include an inspection and maintenance schedule and a program description that addresses vegetation management, sediment, and debris removal, erosion, pipe and orifice maintenance if applicable, and structural repair or replacement. Owners are required to provide all-weather access to the County and check their facilities regularly to determine maintenance needs. See Section 7 and Appendix E for O&M Manual requirements, including requirements of the 2-Year Maintenance Warranty Period Plan.

Treatment Rain Gardens

General

- An overflow to an approved conveyance system and discharge point is required. See design specifications for overflows in the “piping” subsection below.

Sizing

- The square-footage is determined at the water surface elevation immediately prior to water reaching the design overflow elevation (top of freeboard).
- Facilities that receive runoff from impervious areas 10,000 square feet or less may be designed using the Simplified Method (see Table 3-1 below).

Inlets

- In streets or parking lots, stormwater may flow directly into the facility via curb openings.
- Energy dissipation must be provided for facilities with a point of collection (concentrated points) of inflow.

Dimensions

- Minimum bottom width shall be 18 inches.
- Maximum side slope shall be 3H:1V.
- Minimum ponding depth shall be 6 inches.
- Maximum ponding depth shall be 12 inches.
- Minimum freeboard (vertical distance between the design maximum water surface elevation and overtopping the facility’s outlet structure) shall be 2 inches.

Piping

- Underdrains (required for filtration facilities):
  - Minimum depth of perforated pipe under facility surface shall be 18 inches.
  - Minimum underdrain pipe diameter shall be 6 inches.
  - Maximum underdrain pipe spacing shall be 20 feet on center.

    - Cleanouts shall be provided to enable inspection of the underdrain. Cleanouts can also be used to conduct an inspection (by camera) of the underdrain system to ensure that the pipe was not crushed or disconnected during construction. Minimum distance between cleanouts shall be 300 feet.
- Overflow pipes:
    - Overflow drains must have the capacity to convey the 50-year design storm, as specified in the 1990 County Public Works Engineering Standards.
    - On private property, this overflow drain and piping shall direct excess stormwater to an approved discharge point as identified on the engineered design details.
    - Within the public street right-of-way, this overflow drain and piping must meet County Public Works Standards and shall direct excess stormwater to an approved discharge point.

Setbacks

- Filtration facilities that are lined with waterproofed concrete or an impermeable liner generally do not have a required setback, though the most stringent relevant building setback requirements shall prevail.

Soil Amendment and Mulch

- Amend the native soil such that the mix consists of one-part organic compost, one-part coarse sand, and one part native soil.
- Minimum thickness of soil amendment layer shall be 18 inches.
- A 2-inch layer of shredded bark mulch (not bark dust or bark chips) shall be used over the amended soil and between the plantings. The use of artificial mulch is prohibited.

Planting, Landscape and Irrigation Requirements

- The facility bottom area shall be planted with vegetation. Selected plant materials should be appropriate for soil, hydrologic, and other facility and site conditions. For full planting requirements and a list of plants suitable to vegetated infiltration facilities, see Appendix H: *City of Salem Landscape Requirements and Plant Lists for Stormwater Facilities*, *Section 4B.6 – Rain Gardens, Vegetated Filter Strip, and Vegetated Swales*.
- At full maturity, the height of facility plantings shall not impede the line-of-sight for any adjacent ROW.
- Warranty period requirements can be found in Section 7.4.
- Establishment procedures, such as control of invasive weeds, animal and vandal damage, mulching, re-staking, watering, and mesh or tube protection replacement, shall be implemented to the extent needed (as determined by the Director) to ensure plant survival.
- Facilities located in the public right-of-way are not permitted to use coniferous trees to meet landscaping requirements.
- The design for plantings shall minimize the need for herbicides, fertilizers, pesticides, or soil amendments at any time before, during, and after construction and on a long-term basis.
- Plants shall be selected and planted to minimize the need for mowing, pruning, and irrigation.
- Plant establishment should meet the requirements in Section 7.4.

Maintenance Considerations for the O&M Manual

The site-specific O&M Manual submitted with the facility design must include an inspection and maintenance schedule and a program description that addresses vegetation management, sediment, and debris removal, erosion, pipe and orifice maintenance if applicable, and structural repair or replacement. Owners are required to provide all-weather access to the County and check their facilities regularly to determine maintenance needs. See Section 7 and Appendix E for O&M Manual requirements, including requirements of the 2-Year Maintenance Warranty Period Plan.

Table 3-1. Simplified Method Worksheet for Facilities Treating Runoff from Impervious Areas (10,000 square feet or less)

	Instructions	Site Information	
	Subbasin or tributary area or designation		
1	Enter the impervious area contributing flow to the vegetated facility.	(1) Impervious area required to be mitigated	________ sf
2	Select stormwater management facilities from Rows A through E in Column 1 below. Enter the square footage of impervious area that will flow into each facility type in Column 2.		
3	Multiply each impervious area from Column 2 by the corresponding sizing factor in Column 3 and enter the result in Column 4. This is the facility surface area required.		
4	Total Column 2, Rows A through D and enter the resulting Impervious Area Managed on Line (5)	(4) Total Impervious Area Managed	________ sf
5	Subtract (4) from (1) and enter the result in line (5). This must be zero or less. Submit this form with the Stormwater Management Report.	(5) Remaining Impervious Area	________ sf

	Column 1	Column 2	Column 3		Column 4
	Stormwater Management Facility	Impervious Area Managed	infiltration rate *	sizing factor	Facility Surface Area
A	Infiltration Planter Boxes	________ sf	0.75 - 1.25 in./hr.	.09	________ sf
		________ sf	1.25 - 1.75 in./hr.	.07	________ sf
		________ sf	>1.75 in./hr.	.06	________ sf
B	Treatment Planter Boxes	________ sf		.06	________ sf
C	Infiltration Rain Garden	________ sf	0.75 - 1.25 in./hr.	.09	________ sf
		________ sf	1.25 - 1.75 in./hr.	.07	________ sf
		________ sf	>1.75 in./hr.	.06	________ sf
D	Treatment Rain Gardens	________ sf		.06	________ sf
E	Total	________ sf			

3.6.4 Proprietary Devices

Proprietary Stormwater Treatment Devices (Proprietary Devices) should only be used if infiltration or filtration facilities are not feasible for the project. Proprietary Devices are manufactured technologies used to address the stormwater quality impacts of land development, including removing pollutants through a variety of physical, chemical, or biological treatment processes. The use of proprietary devices is permitted on a case-by-case basis with approval by the Director.

Proprietary Devices include hydrodynamic separators, cartridge filters, and other emerging treatment technologies that are designed to remove pollutants from stormwater. Proprietary Devices are generally grouped by their use for pretreatment, oil removal, enhanced treatment, basic treatment, phosphorus removal and construction pollutant management. There are numerous manufacturers that build proprietary devices. The devices shall be sized in accordance with the manufacturer's recommendations to meet the relevant performance standards specified in Sections 3.4 and 3.5.

Stormwater treatment technologies are reviewed and certified by several agencies. The County follows the Technology Assessment Protocol Ecology, also known as the TAPE program, administered by the Washington State Department of Ecology (Ecology). The County allows the use of proprietary devices that have the General Use Level Designation (GULD) for basic, dissolved metals, or phosphorus treatment as stormwater management facilities. *Pilot Use* Level Designation or *Conditional Use* Level Designation are not permitted. The County may require pretreatment facilities to improve the performance of proprietary stormwater treatment devices.

Technical submittals from the manufacturer are required, including hydraulic design criteria, particulate removal efficiency, O&M requirements and schedules, and an installation list of similar uses in Western Oregon and Western Washington.

Site Requirements

- Proprietary Devices shall not be located downstream of flow control facilities.
- Proprietary Devices may be located on a range of site conditions. Site requirements vary by system type. Review the manufacturer's restrictions and recommendations when selecting an appropriate treatment device and configuration for the development and site conditions.
- Proprietary devices shall have a minimum setback of 5 feet from structures.
- Proprietary devices that are publicly maintained and require staff to enter shall provide a minimum of 78 inches of head room.
- There shall be an approved overflow route, as determined during permit review.

Dimensions

- Proprietary devices may be configured as inline systems or offline systems with high flow bypasses, in accordance with manufacturer specifications.
- Proprietary devices shall be designed to treat the calculated peak flow or total volume resulting from the Water Quality Design Storm.
- Calculations to determine the required size, number, or configuration of the proprietary device must be based on the design guidelines specified in the GULD approval documents from Ecology. When sizing proprietary devices for water quality treatment, applicants shall use the treatment flow rates identified in the TAPE approval documents.

Maintenance Considerations for the O&M Manual

- Facilities shall be accessible by maintenance vehicles and in accordance with manufacturer recommendations.
- Inspect and perform maintenance according to manufacturer's recommendations.

3.6.5 Other Treatment Facilities

The Director may, on a case-by-case basis, accept stormwater management facilities other than those listed in Sections 3.6, including ponds and constructed wetlands, designed pursuant to the standards specified by the City of Portland BES, City of Eugene, or Clean Water Services (in Washington County). See Section 9 for a list of references.

3.7 Detention Applications for Stormwater Management Facilities

Historically, detention facilities have been used primarily for the management of stormwater discharge flow rate. However, as stated in Section 3.6.2, retention facilities may be designed to provide a combined benefit of controlling both stormwater quality and quantity. In order for retention facilities to be allowed to address detention and flow control requirements (Section V of the 1990 Engineering Standards or most current version) in addition to retention and/or water quality treatment performance standards, green infrastructure facilities must be prioritized. For this option, the design must provide flow control storage above the water quality design water surface elevation of the facility, with flows bypassing the facility's retention/water quality treatment functions by overtopping into an inlet designed to restrict the peak flow for larger events to meet flow control requirements.

3.7.1 Detention Ponds

Detention Ponds shall have an access road suitable (i.e., size and durability) for maintenance equipment to safely access the interior bottom of the pond for the purposes of sediment removal. Minimum access road requirements include the following:

- The interior pond access will begin at the edge of the required pavement or all-weather surface access road and end within 3 vertical feet and 10 horizontal feet of the lowest elevation of the pond.
- The minimum access road requirements are at least 12 feet wide with longitudinal slopes no steeper than 15 percent. Curved alignments shall be a minimum 15 feet wide. The minimum outside turning radius shall be 40 feet and the inside minimum radius shall be 25 feet to accommodate equipment.
- Access roads longer than 300 feet from a public right-of-way shall provide for a truck turn-around area.
- Bollards shall be installed to limit vehicle access. Bollards shall consist of fixed bollards on each side of the access road and two lockable, removable bollards equally located between the fixed bollards.
- The pond interior access shall be constructed of a landscape block surface by removing all unsuitable material, laying a geotextile fabric over the native soils, placing landscape block, filing the honeycombs with topsoil, and planning appropriate zone grass. Other materials may be reviewed and approved on a case-by-case basis, provided they do not create additional impervious surface and will meet vehicle wheel load requirements.
- Fences are required for all publicly maintained stormwater management facilities that exceed 24 inches in water storage depth, if the interior side slope is steeper than 3 feet horizontal to 1 foot vertical (3h:1v), including walls. Fencing for privately maintained facilities must conform to local and state zoning and building codes. Include facility signage per Section 3.6.1.

3.8 Offsite Mitigation

As a last resort, offsite stormwater mitigation may be needed when the numerical retention (Section 3.4) and treatment requirements (Section 3.5) cannot be fully met on site. Depending on the results of the design analysis, the applicant may request to provide offsite mitigation measures to be approved by the Director. Offsite mitigation must be designed to meet performance standards for retention and treatment as outlined in Sections 3.4 and 3.5. The application for approval of offsite mitigation must provide written technical justification documenting the infeasibility or site constraints that prevent the onsite retention or treatment of the runoff amount. The written technical justification must be in the form of a site-specific hydrologic or design analysis conducted and signed and sealed by an Oregon registered Professional Engineer or Oregon Certified Engineering Geologist. Where necessary, the offsite mitigation will be of a type to be determined by the Director.

Section 4

Hydrologic Analysis

Section 4 presents standards for conducting a hydrologic analysis using Hydrograph Methods. **Hydrograph methods must be used to size retention and treatment facilities.** The Rational Method is only allowed to size other types of drainage facilities including detention facilities, per the 1990 Marion County Engineering Standards or most current version; therefore, Rational Method information is included in Appendix I.

4.1 General Runoff Calculations

Stormwater quality design flows and volumes required in accordance with Section 3 shall be conducted according to the methods described in this Section.

- Drainage Areas: All designs shall identify drainage areas within and upstream of the development. In undeveloped urban drainage areas, drainage calculations shall separately consider existing drainage patterns and anticipated post-developed drainage patterns.
- Analytical Methods: The engineer is not limited to any one method for calculating runoff. For drainage areas less than 10 acres in size, the Rational Method may be used for sizing drainage facilities other than retention and treatment facilities described in Section 3. Areas 10 acres or more must be analyzed using a method acceptable to the Director, such as the Santa Barbara Urban Hydrograph (SBUH) Method, Natural Resource Conservation Service (NRCS) TR-20 or TR-55, Environmental Protection Agency Stormwater Management Model (SWMM) or other similar methods.

4.2 Hydrograph Methods

Hydrograph methods may be used for all projects and include methods acceptable for use on projects with a drainage area over 10 acres. The SBUH is the primary acceptable hydrograph method. However, other acceptable methods include the NRCS TR-20 method, TR-55 method, SWMM method, or other similar methods. If a software package is used, documentation of the software's processing and methodology shall be submitted with the results.

The physical characteristics of the site and the design storm shall be used to determine the magnitude, volume and duration of the runoff hydrograph. All input and assumptions shall be clearly documented. The typical inputs needed for hydrograph methods are:

- 24-hour rainfall distribution
- Total 24-hour rainfall depth
- Basin Area Characteristics
- Curve Number (CN)
- Time of Concentration

4.2.1 Rainfall Distribution

The rainfall distribution to be used within the County is the design storm of 24-hour duration based on the NRCS 24-hour Type 1A rainfall distribution Table 4-1 below. The 24-hour rainfall totals for the given return intervals shall be in accordance with the rainfall depths shown in NOAA Atlas 2. Precipitation-Frequency Atlas of the Western United States. Volume X–Oregon.

Table 4-1. NRCS 24-Hour Type A1 Rainfall Distribution											
Time from start of storm, minutes	% Rainfall	Cumulative % Rainfall	Time from start of storm, minutes	% Rainfall	Cumulative % Rainfall	Time from start of storm, minutes	% Rainfall	Cumulative % Rainfall	Time from start of storm, minutes	% Rainfall	Cumulative % Rainfall
10	0.40	0.40	370	0.95	22.57	730	0.72	67.40	1090	0.40	86.00
20	0.40	0.80	380	0.95	23.52	740	0.72	68.12	1100	0.40	86.40
30	0.40	1.20	390	0.95	24.47	750	0.72	68.84	1110	0.40	86.80
40	0.40	1.60	400	0.95	25.42	760	0.72	69.56	1120	0.40	87.20
50	0.40	2.00	410	1.34	26.76	770	0.57	70.13	1130	0.40	87.60
60	0.40	2.40	420	1.34	28.10	780	0.57	70.70	1140	0.40	88.00
70	0.40	2.80	430	1.34	29.44	790	0.57	71.27	1150	0.40	88.40
80	0.40	3.20	440	1.80	31.24	800	0.57	71.84	1160	0.40	88.80
90	0.40	3.60	450	1.80	33.04	810	0.57	72.41	1170	0.40	89.20
100	0.40	4.00	460	3.40	36.44	820	0.57	72.98	1180	0.40	89.60
110	0.50	4.50	470	5.40	41.84	830	0.57	73.55	1190	0.40	90.00
120	0.50	5.00	480	2.70	44.54	840	0.57	74.12	1200	0.40	90.40
130	0.50	5.50	490	1.80	46.34	850	0.57	74.69	1210	0.40	90.80
140	0.50	6.00	500	1.34	47.68	860	0.57	75.26	1220	0.40	91.20
150	0.50	6.50	510	1.34	49.02	870	0.57	75.83	1230	0.40	91.60
160	0.50	7.00	520	1.34	50.36	880	0.57	76.40	1240	0.40	92.00
170	0.60	7.60	530	0.88	51.24	890	0.50	76.90	1250	0.40	92.40
180	0.60	8.20	540	0.88	52.12	900	0.50	77.40	1260	0.40	92.80
190	0.60	8.80	550	0.88	53.00	910	0.50	77.90	1270	0.40	93.20
200	0.60	9.40	560	0.88	53.88	920	0.50	78.40	1280	0.40	93.60
210	0.60	10.00	570	0.88	54.76	930	0.50	78.90	1290	0.40	94.00
220	0.60	10.60	580	0.88	55.64	940	0.50	79.40	1300	0.40	94.40
230	0.70	11.30	590	0.88	56.52	950	0.50	79.90	1310	0.40	94.80
240	0.70	12.00	600	0.88	57.40	960	0.50	80.40	1320	0.40	95.20
250	0.70	12.70	610	0.88	58.28	970	0.50	80.90	1330	0.40	95.60
260	0.70	13.40	620	0.88	59.16	980	0.50	81.40	1340	0.40	96.00
270	0.70	14.10	630	0.88	60.04	990	0.50	81.90	1350	0.40	96.40
280	0.70	14.80	640	0.88	60.92	1000	0.50	82.40	1360	0.40	96.80
290	0.82	15.62	650	0.72	61.64	1010	0.40	82.80	1370	0.40	97.20
300	0.82	16.44	660	0.72	62.36	1020	0.40	83.20	1380	0.40	97.60
310	0.82	17.26	670	0.72	63.08	1030	0.40	83.60	1390	0.40	98.00
320	0.82	18.08	680	0.72	63.80	1040	0.40	84.00	1400	0.40	98.40
330	0.82	18.90	690	0.72	64.52	1050	0.40	84.40	1410	0.40	98.80
340	0.82	19.72	700	0.72	65.24	1060	0.40	84.80	1420	0.40	99.20
350	0.95	20.67	710	0.72	65.96	1070	0.40	85.20	1430	0.40	99.60
360	0.95	21.62	720	0.72	66.68	1080	0.40	85.60	1440	0.40	100.00

4.2.2 Basin Area Characteristics

To obtain the highest degree of accuracy in hydrograph analysis, proper selection of homogeneous basin areas is required. Significant differences in land use within a given basin must be addressed by dividing the basin area into subbasin areas of similar land use and/or runoff characteristics. Hydrographs should be computed for each subbasin area and superimposed to form the total runoff hydrograph for the basin.

All pervious and impervious areas within a given basin or subbasin shall be analyzed. This may be done by either computing separate hydrographs or computing the precipitation excess. The total precipitation excess is then used to develop the runoff hydrograph. By analyzing pervious and impervious areas separately, the cumulative errors associated with averaging these areas are avoided and the true shape of the runoff hydrograph is better approximated.

4.2.3 Runoff Curve Numbers

Runoff Curve numbers were developed by the NRCS (formerly referred to as the Soil Conservation Service (SCS)) after studying the runoff characteristics of various types of land. Curve numbers (CN) were developed to consolidate diverse characteristics such as soil type, land usage, and vegetation into a single variable for computing runoff.

The approved runoff curve numbers are included in Table 4-2.

The following are important criteria/considerations for selection of CN values.

- Many factors may affect the CN value for a given land use. For example, the movement of heavy equipment over bare ground may compact the soil so that it has a lower infiltration rate and greater runoff potential.
- CN values can be area-weighted when they apply to pervious areas of similar CN (within 20 CN points). However, high CN areas should not be combined with low CN areas (unless the low CN areas are less than 15 percent of the subbasin).
- Antecedent soil moisture values should be considered. A normal Antecedent Moisture Condition (also known as AMC II) should generally be assumed for design.
- Soil types shall be derived from the NRCS Soil Survey for Marion County. Use of City of Salem Pre-development CN values should be considered when appropriate.

Table 4-2. Runoff Curve Numbers					
Cover Description		CN for Hydrologic Soil Group			
		A	B	C	D
Urban Areas [a]					
Open space	% Impervious				
Poor condition (grass cover <50%)	–	68	79	86	89
Fair condition (grass cover 50% to 75%)	–	49	69	79	84
Good condition (grass cover >75%)	–	39	61	74	80
Impervious Areas					
Paved parking lots, roofs, driveways (excluding right-of-way)	–	98	98	98	98
Streets and roads					
Paved: curbs and storm sewers (excluding right-of-way)	–	98	98	98	98
Paved: open ditches (including right-of-way)	–	83	89	92	93
Gravel (including right-of-way)	–	76	85	89	91
Dirt (including right-of-way)	–	72	82	87	89
Urban districts					
Commercial and Business	85	89	92	94	92
Industrial	72	81	88	91	93
Residential districts by average lot size					
1/8 acres or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Agricultural Lands [b]					
Pasture, grassland, or range- continuous forage for grazing	Hydrologic Condition				
<50% ground cover or heavily grazed with no mulch	Poor	68	79	86	89
<50 to 75% ground cover and not heavily grazed	Fair	49	69	79	84
>75% ground cover and lightly or only occasionally grazed	Good	39	61	74	80
Meadow–continuous grass, protected from grazing and generally mowed for hay	–	30	58	71	78
Brush–weed-grass mixture with brush as the major element	–				
<50% ground cover	Poor	48	67	77	83
<50 to 75% ground cover	Fair	35	56	70	77
>75% ground cover	Good	30	48	65	73
Woods–grass combination (orchard or tree farm)	Poor	57	73	82	86
Woods					
Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning	Poor	45	66	77	83
Woods are grazed but no burned, and some forest litter covers the soil	Fair	36	60	73	79
Woods are protected from grazing a, and litter and brush adequately cover the soil	Good	30	55	70	77

Table 4-2. Runoff Curve Numbers					
Cover Description		CN for Hydrologic Soil Group			
		A	B	C	D
Impervious Surface Reduction Facilities [c]					
Pervious Pavement		76	85	89	n/a
Trees	Hydrologic Condition				
New and/or existing evergreen	-	36	60	73	79
New and/or existing deciduous	-	36	60	73	79
Green roof	Good	n/a	61	n/a	n/a
Roof Garden	Good	n/a	48	n/a	n/a
Contained Planter box	Good	n/a	48	n/a	n/a
Infiltration and Flow-through Planter box	Good	n/a	48	n/a	n/a

a. Source: NRCS TR55 Table 2-2a (1986)

b. Source: NRCS TR55 Table 2-2c (1986)

c. Source: Portland Stormwater Management Manual (2008)

n/a = not applicable

4.2.4 Time of Concentration “Tc”

The Rational Method and SBUH Method require the calculation of time of concentration as an input parameter. The time of concentration is defined as the time needed for water to flow from the most remote point in a watershed to the watershed outlet. Time of concentration is calculated as the sum of the travel times for each discrete segment of the longest flow path. Calculations for time of concentration should be divided into segments: sheet flow, shallow concentrated flow, and channel/pipe flow.

In calculating the total Tc, the following limitations will apply:

- The flow segment used for the sheet flow component shall not extend for more than 100 feet.
- The use of a total distance of less than 200 feet on a pre-developed land use will require supporting documentation (see Section 6), such as a map showing the shallow concentrated flow path.
- For segments of the Tc route that flow through closed storm drainage system facilities, such as pipes and culverts, use standard hydraulics formulas for establishing velocity and travel time.
- For segments of the Tc route that flow through lakes or submerged wetlands, travel time is normally very short. The travel time can be determined using an appropriate storage routing technique, or it can be assumed to be zero.

Overland sheet flow is shallow flow over a plane surface. It occurs in the furthest upstream segment of the drainage path, which is located immediately downstream from the drainage divide. The length of the overland sheet flow segment is the shorter of (1) the distance between the drainage divide and the upper end of a defined channel, or (2) a distance of 100 feet. The sheet flow time of concentration can be calculated with overland flow kinematic wave equation, using roughness coefficients shown in Table 4-3. Extreme care should be given to determining the true travel time for the sheet flow component of the Tc.

Table 4-3. Manning's Roughness Coefficient "n" for Sheet Flow	
Surface Type	**n value**
Impervious Areas	0.014
Gavel Pavement	0.02
Developed: Landscaped areas (except Lawns)	0.08
Developed: Lawns	0.24
Developed: Biofiltration Swales	
Mowed grass	0.20
Unmowed grass	0.24
Other dense vegetation	0.30
Undeveloped: Meadow, pasture, or farm	0.15
Undeveloped: Mixed	0.30
Undeveloped: Woodland and Forest	0.40

For overland flow distances greater than 100 feet, sheet flow typically becomes shallow concentrated flow until it finds a defined channel. The average velocity is a function of watercourse slope and surface type and can be approximated using Figure 4-1.

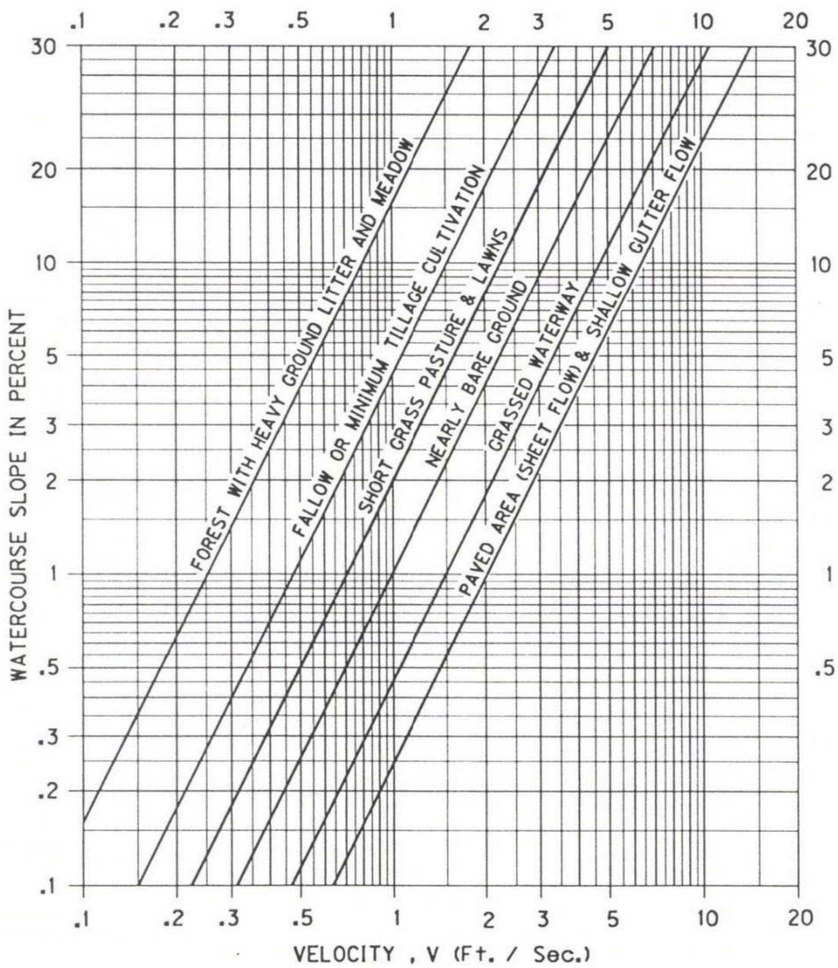

Figure 4-1. Average Velocity of Shallow Concentrated Flow

For slopes less than 0.5 percent, the following equations can be used to determine the average flow velocity of the shallow concentrated flow.

For paved surfaces

$$V = 20.3282 \; x \; S\text{^}0.5$$

Equation 4-1. Time of Concentration "Tc" for Paved Surfaces

For unpaved surfaces

$$V = 16.1345 \; x \; S\text{^}0.5$$

where: V = Velocity in feet per second

S = Slope in feet per foot

Equation 4-2. Time of Concentration "Tc" for Unpaved Surfaces

Manning's equation for channelized flow shall be used to calculate velocities in channels and pipes. Manning's roughness ('n'-value) coefficients for pipes and open channels are shown in Table 4-4 and Appendix G, respectively.

It should be noted that new PVC or HDPE pipe likely have a manufacturer's 'n' value of approximately 0.009. However, regardless of pipe material, sand, grit, and slime will build up on pipe walls. This results in true 'n' values over time of approximately 0.013. Consequently, a Manning's roughness coefficient of 0.013 shall be used for design of PVC or HDPE piping systems. If an alternative piping material is approved, either the pipe manufacturer's recommended coefficient shall be used or an 'n' value of 0.013, whichever is greater.

Table 4-4. Acceptable Pipe Materials, Applications, and Characteristics

Material Type	Allowed Sizes, inches	Minimum Cover, inches	Allowed Slope	Minimum Manning's 'n'	Other Considerations
Corrugated Aluminized Steel (unlined)	54 and greater	18 (design required)		0.025	Soil resistivity
Ductile Iron	All	6		0.013	
Smooth Bore HDPE*	Up to 18	18	1% Min.	0.013	Water-tight joints
Non-Reinforced Concrete (NRCP)	Up to 18	12		0.013	Water-tight joints
Reinforced Concrete (RCP)	All	12		0.013	Water-tight joints
Polyvinyl Chloride (PVC) ASTM 3034	Up to 15	18		0.013	No sun exposure
ASTM F679/IB	From 18 to 60	18		0.013	No sun exposure

*Larger diameters and flatter slopes may be used on private property

Section 5

Drainage Requirements

All projects must comply with the 1990 Marion County Engineering Standards (or most current version), Section V. Section V specifies design requirements for all drainage facilities, including detention facilities, pipes, open channels, manholes, junction boxes and cleanouts, inlets, catch basins, drywells, and French drains. Section V also provides information on design storms and runoff coefficients and lists requirements for plan submittals for drainage facilities in addition to submittal requirements in Section 6. In addition, projects will require a downstream analysis as outlined in this section.

5.1 Downstream Analysis

The downstream analysis is a field investigation of the existing downstream storm drainage system to determine the capacity of the storm drainage system. Downstream analysis is a mechanism to verify the existing or proposed storm drainage system has adequate capacity to safely convey the stormwater runoff discharged from the development. The analysis will also provide the County with a better understanding of the storm drainage system, so that the County can add problem areas to maintenance work orders or to potential capital project needs.

A downstream analysis is required for all projects that create or replace one (1.0) acre or more of impervious surface in addition to the required stormwater management plan designed by a registered Professional Engineer, as dictated by Section 1.2. The applicant shall complete the Qualitative Analysis in Section 5.1.1. Depending on the results of the Qualitative Analysis, the County may require an extension of the analysis further downstream, a Quantitative Analysis (Section 5.1.2), and/or offsite mitigation measures (Section 3.8).

When required, the downstream analysis shall evaluate the offsite storm drainage system to the location where the project site contributes less than 10 percent of the upstream drainage area contributing to a public storm drainage system line or drainage channel, or a location 1,500 feet (approximately 1/4 mile) downstream of the discharge point from the project site, whichever is greater. The downstream analysis may be stopped shorter than the required distance if the analysis reaches a stream, or river, or a point that is determined at the sole discretion of the County on a case-by-case basis.

5.1.1 Qualitative Downstream Analysis

The Qualitative Analysis shall consist of a drainage system map, storm drainage system and outfall inspection, storm drainage system description, and potential problem identification. Depending upon the presence of existing or predicted flooding, erosion or water quality problems, the County may require a Qualitative Analysis further downstream, mitigation measures, or a Quantitative Analysis.

- Drainage System Map. A drainage area map delineating the onsite and offsite contributing drainage areas upstream and downstream for the site shall be provided. The drainage system map shall be to a defined scale and must show the extent of the drainage system in the downstream analysis area. The drainage system map should also show general land use, topography, and other features impacting the onsite and downstream drainage system. Maps printed from GIS websites may be used as a base for the drainage system map.

- **Storm Drainage System and Outfall Inspection.** The applicant shall physically, if legally possible, inspect the existing onsite and offsite drainage systems of the study area for each discharge location for existing or potential problems and drainage features. The applicant shall only enter property that they have legal access to, and if it is safe for the inspector to conduct the inspection. An inspection and investigation shall include the following:
  - Collect information on pipe sizes, channel characteristics, and drainage structures.
  - Note date and weather at time of inspection.
  - Take photographs of the existing condition of onsite and downstream drainage features.
  - Identify existing and potential problem areas.
- **Storm Drainage System Description.** For each drainage system component (e.g., pipe, culvert, outfall, ditch, open channel, tributary, stream), a written description shall be provided of the location, physical description, size, material, flow direction, and field observations. The description shall document points of inflow from adjacent drainage systems. The description shall also identify and describe points where water enters the downstream storm drainage system and the approximate tributary area at each contributing location. The tributary area shall account for upstream, onsite, and downstream contributions.
- **Existing and Potential Drainage Concerns.** All existing drainage concerns or potential impacts from the proposed development or redevelopment activity identified during the storm drainage system and outfall inspection shall be documented and described. Drainage concerns include constrictions or capacity deficiencies in the drainage system, existing or potential flooding problems, failing infrastructure, erosion, scouring, or bank sloughing in open channels, and erosion or scoring at outfalls.

  The following information shall be provided for each existing or potential drainage concern:
  - Magnitude of, or damage caused
  - Assumed frequency and duration
  - Return frequency of storm or flow when the issue occurs
  - The pre- and post-construction water elevations
  - Possible cause(s)
  - Current mitigation
  - Whether the proposed development or redevelopment activity is likely to aggravate or mitigate the concern

The descriptions shall be used to determine whether adequate mitigation can be identified or whether more detailed quantitative analysis is necessary, as approved by the Director.

If the downstream stormwater drainage system does not have the capacity to convey runoff according to the design standards, the Applicant shall be required to mitigate the situation using a Director-approved method. The Applicant may elect to mitigate the storm drainage system concerns by either correcting the deficiencies in the downstream storm drainage system (piped and/or open channel systems) or by providing additional onsite flow control (i.e., additional storage volume and more restrictive flow control) beyond what is required in the 1990 Marion County Engineering Standards or most current version, to the point where downstream infrastructure is no longer deficient.

5.1.2 Quantitative Analysis

Upon review of the qualitative analysis, the County may require a quantitative analysis, depending on the presence of existing or predicted flooding, erosion, or water quality problems and on the proposed design of the onsite drainage facilities. The quantitative analysis includes a hydrologic and hydraulic analysis of each component of the downstream storm drainage system to the extension point noted in Section 5.1. The analysis may be performed through tailwater calculations or by preparing a hydraulic model of the downstream system.

As-built details may be used to obtain structure information for the quantitative analysis. If as-built details are used, the engineer is responsible for verifying that all elevations are in the same datum. The County may require a field survey of the existing storm drainage system in the downstream analysis area to inform the quantitative analysis.

The quantitative analysis of the downstream storm drainage system shall assume the following:

- Project site is developed as proposed with the land use application.
- The surrounding drainage area is developed at future build out conditions, using the best zoning information available, or a conservative assumption of future build out conditions.
- Full functionality of the proposed onsite stormwater management facilities.
- The design storm for analysis shall be consistent with the storm drainage system design storms listed in the 1990 Marion County Public Works Engineering Standards or most current version.

The following shall be included as part of the quantitative downstream analysis:

- Upstream and downstream drainage area maps showing the flow route for both onsite and offsite stormwater.
- Description of hydrologic calculation parameters and design flows used in the analysis.
- Capacity and percent full during the design storm in each storm drainage system element.
- Velocity in each storm drainage system element during the applicable design storm.
- Headwater and tailwater assumptions.
- The hydraulic grade line (HGL) elevation for the design flow in each storm drainage system component.
- All calculation assumptions, equations, and outputs used in the analysis. If calculation assumptions are different than typical standards of practice, justification of the parameters is required. When the downstream system includes older or deteriorated pipes, the Manning's n roughness coefficient should be adjusted to account for increased pipe roughness.

If the applicant is proposing mitigation measures to change the capacity of the downstream storm drainage system, the quantitative analysis shall include calculations for both the existing and proposed storm drainage system.

5.2 Upstream Impacts

Modifications to the existing onsite storm drainage patterns shall not restrict flows and, thereby, create backwater onto offsite property to levels greater than the existing situation, unless approved by the affected offsite property owner(s) and the County. When approved, the offsite property owner(s) shall agree to and sign a permanent easement legally describing the location of the backwater storage and authorizing the use of their property for stormwater drainage and detention purposes. The easement shall be approved by the County.

Section 6

Drainage Submittals

Submittals for an on-site stormwater discharge permit must include the information specified in this section. Note that additional permits may apply (see Section 6.2).

6.1 Drainage Submittal Package Requirements

The Drainage Submittal Package requirements include:

- Plan Set, including Demolition Plan and Proposed Improvements Site Plan
- Temporary Erosion and Sediment Control (TESC) Plan
- Landscape Plan
- Existing Site Stormwater Drainage Plan
- Proposed On-site Stormwater Drainage Plan, including construction details associated with stormwater improvements
- Supporting Data, including a Stormwater Management Report as described in Section 6.6.
  - Complete checklist of calculations to be included in the Stormwater Management Report (see Table 6-1)
  - Infiltration Testing Report (if applicable; see Section 3.4 and Appendix B)
  - Required information for proprietary facilities, if applicable (see Section 3.6.4)
- O&M Manual Submittal (see Section 7)

The County may require a geotechnical report on sites with steep slopes or shallow groundwater (see Section 3.4), in order to evaluate the suitability of the proposed stormwater management facilities and their locations.

Facilities must be designed using hydrologic analysis methods described in Section 4 or the Simplified Method allowed in Section 3 to meet the water quality requirements in Section 3. All hydrologic submittals shall include the information listed in Table 6-1 below, as applicable, and all data necessary to facilitate the County's review.

Table 6-1. Checklist of Calculations to be Included in the Stormwater Management Report

Facility (Permanent) Key	A: Biofiltration swale	B: Proprietary engineered device	C: Pervious pavement	D: Infiltration Rain Gardens and Planter Boxes	E. Treatment Rain Gardens and Planter Boxes	F: Green roof
Parameter or Calculated Value to be Included in the Stormwater Report	**Facility Type**					
	A	**B**	**C**	**D**	**E**	**F**
Site Variables						
Site soil type (A, B, C, or D)	Yes	Yes	Yes	Yes	Yes	Yes
Contributing area (acres)	Yes	Yes	Yes	Yes	Yes	Yes
Pre-developed curve number CN	Yes	Yes	Yes	Yes [a]	Yes [a]	Yes
Pre-developed time of concentration (Tc, minutes)	Yes	Yes	Yes	Yes [a]	Yes [a]	Yes
Post-developed curve number CN	Yes	Yes	Yes	Yes [a]	Yes [a]	Yes
Post-developed time of concentration (Tc, minutes)	Yes	Yes	Yes	Yes [a]	Yes [a]	Yes
Infiltration rates from on-site testing and design infiltration rate			Yes	Yes		
Distance from ground surface to max. height of seasonal groundwater (feet)				Yes	Yes	
Hydrographs						
Post-developed hydrograph for the WQ design storm, including peak rates and total volumes, if routed through the facility, at each design or discharge point	Yes	Yes		Yes	Yes	
Facility Geometry:						
Table showing area and volume of the facility every 6 inches in elevation				Yes [a]	Yes [a]	
Side slopes (horizontal to vertical, H:V or %)	Yes			Yes	Yes	
Longitudinal slope (H:V or %)	Yes			Yes	Yes	
Bottom width and length (feet)	Yes			Yes	Yes	Yes
Overall width and length (feet)	Yes			Yes	Yes	Yes
Hydraulic Controls						
Orifice or weir descriptions, sizes, and elevations, including by-pass facilities				Yes	Yes	
Elevation, size, and type of overflow spillway or pipe				Yes	Yes	Yes
Calculated Values:						
Water quality flow	Yes	Yes	Yes			
Water quality volume				Yes [a]	Yes [a]	Yes

a. Unless the Simplified Method is used for facility sizing. In those cases, include a completed Simplified Method Table for each facility (see Table 3-1 in Section 3.6.3).

6.2 Additional Permits and Approvals Disclaimer

Additional permits may apply, such as those required by the Oregon Department of State Lands, Oregon DEQ, and United States Army Corps of Engineers. It is the responsibility of the Applicant to determine what additional permits are required for the project. Prior to construction, the developer must obtain all necessary permits and licenses, including all required permits. Issuance of a County permit does not imply that the developer has fulfilled all permit obligations. The developer must comply with all orders and permits issued by a government authority, whether local, State, or Federal.

6.3 Landscape Plan Requirements

Landscape plans shall be submitted for all stormwater management facilities. The landscape plan and facility design must include elements that ensure landscape plant survival and overall stormwater facility functional success. Construction specifications and/or details need to include the following elements:

- Existing vegetation to be preserved and protective construction fencing location
- Areas of stormwater management facilities to be designated with construction fencing to protect from construction traffic and compaction
- Location of stockpiles. Topsoil stockpile location (erosion protection measures must be shown on the Erosion Prevention and Sediment Control Plan), including source of topsoil, if imported
- Final ground contours at a minimum of 2-foot contour intervals
- Location of top and toe of slope
- Limits of embankment designed to impound water
- Irrigation system to be used for the establishment period of approximately 2-years and as long as needed to ensure plant health *(Note that public SMFs shall be designed so permanent long-term irrigation systems are not needed)*
- Landscape plan showing the location of landscape elements, including size and species of all proposed plantings
- Limit of areas to receive amended topsoil and growing medium
- Plant list or table, including scientific name, size at time of planting, quantity, type of container, coniferous or deciduous, appropriate planting season, native to northwestern United States, and other information in accordance with the facility-specific planting section and landscape industry standards
- Location of maintenance access, if applicable.

6.4 Existing Site Stormwater Drainage Plan Requirements

Existing site stormwater drainage plans must be signed and stamped by a licensed Professional Engineer registered in the State of Oregon. A map clearly defining existing site drainage conditions, at a minimum including:

- Existing contours of the land at 2-foot intervals or, as approved by the Director, with the location of existing buildings, structures, and public and private utilities on the property
- Location of any existing building or structure on adjacent property which is within 15 feet of a proposed public stormwater facility
- Existing land cover and soil types of all areas included in the hydrologic calculation
- All areas within 250 feet of the site, improved or unimproved, lying upstream and draining to or through the proposed development
- Location of existing stormwater facilities which transport surface water or collect groundwater onto, across, or from the site, including natural watercourses, artificial channels, drainpipes, or culverts
- Location of *Sensitive Areas (as defined in the Definitions)*
- Locations of springs or other subsurface water outlets
- Arrows indicating stormwater direction of flows on all public and private property and for all hydraulic conveyance systems
- Outlines of and labels on areas and subbasins included in the hydrologic analysis

- Longest flow path, if used to determine time of concentration, in each subbasin
- Infiltration Testing Location(s)

6.5 Proposed On-Site Stormwater Drainage Plan Requirements

Proposed on-site engineered stormwater drainage plans must be signed and stamped by a licensed Professional Engineer registered in the State of Oregon. A grading and drainage plan (or plan sheets) clearly defining proposed conditions:

- Outline of areas that will be disturbed during project construction.
- Proposed contours of the land after completion of the project at 2-foot intervals or as required to clearly show topography. This shall include elevations, dimensions and location, extent, and slopes of all grading work proposed to be done.
- Identify cut and fill areas, erosion prevention and sediment control facilities, retention, detention and/or water quality facilities, interceptor waterways (channels), velocity check dams, soils, topography, vegetation, and areas of proposed reseeding.
- Proposed land cover for all areas included in the hydrologic calculation.
- Outlines of, and labels on, areas and subbasins included in the hydrologic analysis.
- Proposed point of discharge.
- Proposed catch basins and/or collection points.
- Proposed overland overflow location in the event of facility failure.
- Longest flow path location in each subbasin, if used to determine time of concentration.
- Location of proposed stormwater management facilities which transport surface water across or from the site, including natural watercourses, artificial channels, underdrain pipes, and culverts.
- Boundaries of all areas that will be paved or otherwise altered in a manner that will increase surface water runoff and boundaries of all areas to remain in an existing or natural condition.
- For subdivisions, the approved point of discharge (i.e., curb, pipe, or waterway) shall be identified for each proposed lot.
- Set-back measurements.
- General stormwater construction notes.

6.6 Supporting Data

The Stormwater Management Report shall accompany the proposed on-site engineered stormwater drainage plans to complete documentation of the design and design intent. The Stormwater Management Report shall be prepared, signed, and stamped by a licensed Professional Engineer registered in the State of Oregon. The Professional Engineer shall ensure that the Stormwater Management Report matches the design displayed on the proposed onsite-engineered stormwater drainage plans.

The Stormwater Management Report shall contain the following information:

- Cover sheet
- Table of contents
- Vicinity map
- Drainage area maps
- Project Description
- Required Permits

- References to relevant reports
- Existing Conditions
- Receiving Waters
- Developed Site Drainage Conditions
- Impervious Area Table
- Contributing Areas
- Hydraulic Design Computations
- Emergency Overflow
- Downstream Storm Drainage System Analysis
- Erosion Prevention and Sediment Control
- Maintenance Strategy
- Landscape Plan
- Geotechnical Report (if applicable)

Time of concentration calculations (see Section 4.2.4) shall be submitted along with a map showing the assumed flow path, drainage basins areas and their pre- and post-development characteristics, rainfall depth, duration, intensity, and recurrence interval, and other necessary information.

Background computations for sizing water quality facilities, other than those sized using the Simplified Method (see Section 3), shall include:

- Peak discharge, rate of runoff and/or volume that will be generated within the subject property due to the design storm event after development or redevelopment activity occurs.
- Peak discharge, rate of runoff and/or volume that will be generated by the design storm event at all naturally occurring points of discharge from the property (cubic feet per second, predevelopment and post-development.)

Stormwater facility As-Built plans will be submitted to the county prior to final inspection. As-built details are necessary to assure the project was constructed per the approved plans and/or meet the requirements of these Standards. The Engineer of Record is responsible for record keeping, inspection, and preparation of the as-built details. Final as-builts details will be submitted in the following manner: CAD files, and PDF files.

When applicable, the Geotechnical Report must be prepared and stamped by a geotechnical engineer evaluating the site conditions and recommending design measures necessary to reduce the risks associated with development and to facilitate a safe and stable development. A geotechnical report must be prepared in accordance with, but is not limited to, the report requirements listed below. A geological assessment or engineering geology report may be incorporated into or included as an appendix to the geotechnical report. Additional elements required in the Geotechnical Report are:

- Location and surface conditions: specific address, current use, surface coverings, elevation, drainage, etc.
- Subsurface exploration data: soil profile, exploration logs, lab or in-situ test results, ground water conditions
- Interpretation and analysis of data, including infiltration testing results, if applicable.
- Engineering recommendations for design, including allowances for infiltration (if applicable) on the site.
- Anticipated problems and discussed solutions: slope stability, seismic considerations, etc.
- Any recommended geotechnical special provisions

- Include other types of geotechnical reports: foundation report, centerline soil report, landslide study report, etc.

Section 7

Operation and Maintenance

The purpose of the County's O&M program is to assure perpetual maintenance of stormwater facilities within the boundaries of the Stormwater Management Area[5] (SWMA) as required in the County's NPDES MS4 Phase II Permit. The program is required to provide a mechanism to ensure long-term functionality of constructed stormwater management facilities.

The O&M requirements in this section apply to all stormwater management facilities constructed as a requirement of these Standards. Maintenance activities, including routine maintenance, and restorative maintenance are required to ensure the long-term function and effectiveness of stormwater management facilities and infrastructure. Initial site planning must incorporate provisions for adequate access and space to perform maintenance activities for all stormwater management facilities.

The County is responsible for ensuring the O&M of stormwater management facilities within the SWMA boundary. All stormwater management facility (permanent) designs will be held to the same standards regardless of the organization or entity that has accepted responsibility for the maintenance. There are two categories of maintenance for stormwater management facilities: privately maintained and publicly maintained.

7.1 Operation and Maintenance Submittals

O&M Manuals are required for all permanent stormwater management facilities to ensure that they function as designed. The purpose of an O&M Manual is to provide guidance to those who are responsible for the long-term inspection and maintenance of the facility.

To ensure functionality of the stormwater management facilities, owners are required to inspect facilities regularly per the approved O&M Manual to determine maintenance needs. Routine inspection and maintenance can help to keep overall maintenance costs low by detecting problems early and avoiding large repair or replacement costs.

The stormwater management facility design and maintenance specifications in Appendix E can be used to create the O&M Manual. If the proposed facility types do not match the stormwater management facilities in Appendix E, the applicant and design engineer will be responsible for creating any details, maintenance specifications, and an inspection checklist to be incorporated into the O&M Manual.

The O&M Manual for privately owned/maintained facilities shall be recorded with the County and runs with the land in perpetuity (passing with a transfer or sale of a property). The O&M Manual and associated agreements, covenants, and easements will be reviewed as part of the County's overall plan review and approval process. Information on the components of the O&M Manual is included in Appendix E.

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[5] A current map of the Marion County SWMA can be found on the County's Stormwater Management website: https://www.co.marion.or.us/PW/ES/waterquality/Pages/strmwtr.aspx. Boundaries may be subject to change, as defined by ODEQ or in the Marion County Stormwater Management Plan.

7.1.1 Privately Maintained Facilities

Generally, stormwater management facilities that convey private stormwater to the benefit of a single owner or entity shall be privately-owned and maintained. They include residential, multi-family, commercial, and industrial types of developments, including associated building and driveway impervious surfaces. These stormwater management facilities require a maintenance covenant recorded with the title that describes the types of stormwater management facilities and necessary maintenance.

All stormwater management facilities to be maintained privately require an O&M Manual that is reviewed and approved as part of the overall plan review process.

O&M packets for privately maintained facilities shall include the following components for each permit application:

- Agreement that runs with the land (per Marion County Post-Construction Runoff Control ordinance 1324 §1, 2012); and
- Permanent Facility specific O&M Manual, including a site plan.

The Agreement identifies the property as having a stormwater management facility on the property. The Agreement must be reviewed and accepted by Marion County Public Works, signed, notarized, and recorded at Marion County Clerk's Office. The property description on the Agreement must be a full legal description of the property and may not be a tax lot number. Legal descriptions may be obtained from the County Assessor's office. All costs to record are bore by the Applicant.

Both the Agreement and the O&M Manual must be submitted and approved prior to issuance of the on-site stormwater drainage permit that includes a stormwater management facility. If it is determined that the O&M Manual requires modification to maintain the functionality of the facility, then modifications to the O&M Manual shall be submitted to the County's Public Works Department for review and approval. Written approval from the Director is required prior to modifying the O&M Manual. The approved modified plan shall be recorded.

7.1.2 County-Maintained Facilities

Generally, publicly-owned and maintained stormwater management facilities are facilities that convey Public Stormwater and serve multiple property owners or the general public. Publicly-owned stormwater management facilities can serve any type of development (residential, multi-family, commercial, industrial). Publicly-owned facilities may be constructed by the County, or they may be constructed by private parties, with maintenance responsibilities transferred to the County following the 2-year maintenance warranty period (see Section 7.4).

Following the 2-year warranty period, at the County's discretion, the applicant may be required to prepare a modified O&M Manual for public stormwater management facilities. If it is determined that the O&M Manual requires modification to maintain the functionality of the facility, then modifications to the O&M Manual shall be submitted to the County for review and approval prior to the release of the warranty surety.

All publicly-owned stormwater management facilities shall be located in a public right-of-way or separate tract that is transferred to the public agency ownership. New facilities intended for public maintenance responsibly shall not be located on private property, regardless of the presence of an access easement.

The Director may establish maintenance fees for publicly maintained stormwater management facilities that serve multiple private owners. When separate maintenance fees are established, they will be distributed proportionally among the owners that utilize the facility for stormwater management.

A permanent facility-specific O&M Manual must be prepared for County-maintained (as described in Section 7.2, including those maintained by the East Salem Service District) stormwater management facilities. For facilities constructed under a Public Works Permit, the plan must be submitted before construction as part of the Public Works Permit application. See Section 7.4.1 for further information on the Public Works Permit.

7.2 Operation and Maintenance Responsibilities

Maintenance of stormwater facilities shall be the responsibility of the private property owner unless the facility is in a public right-of-way or in an easement or tract of land dedicated to, and formally accepted by, the County or appropriate government body.

The County will maintain stormwater management facilities as follows:

- A stormwater management facility that is within a public right-of-way shall typically be County maintained. However, there may be circumstances under which the County will not be responsible for maintenance of facilities within the right-of-way (for instance, if the right-of-way is not a County-maintained Road). In those cases, a separate maintenance agreement assigning maintenance responsibility may be required.
- The County shall maintain stormwater management facilities serving residential developments provided an easement or tract of land dedicated for stormwater management and inclusive of site access is conveyed to the County, the facilities are constructed under a Public Works Permit, adequate access is provided, and the facility goes through a warranty period prior to transfer to County maintenance.

Table 7-1 lists the types of stormwater management facilities the County will maintain within a stormwater easement or tract of land if they are designed and constructed according to these Standards. Table 7-1 also lists facility types that the County will not maintain. If County maintenance is anticipated for any facility not included on the list, it must be approved by the Director prior to design and construction.

Table 7-1. Facility (Permanent) Types Approved for County Maintenance

Facilities the County will Maintain	Facility the County will not Maintain
Biofiltration swales with grasses, grass-like plants, reeds, and/or sedges	Vegetation swales with shrubs or trees on bottom or side slopes
Infiltration/treatment planter boxes and rain gardens	Pervious pavement
Pre-approved proprietary stormwater treatment devices	Underground injection control (UIC) facilities subject to ODEQ regulation
	Green roofs

If a proposed SMF is classified as a UIC, it must have a DEQ issued UIC permit.

A site-specific *O&M Manual* must be submitted for review and approval with the design submittal for stormwater and drainage facilities. The *Manual* must include a list of the items to be inspected, inspection schedules, self-inspection checklists, instructions for inspection documentation, and routine maintenance procedures. See Appendix E for an outline that can be used to prepare an O&M Manual.

The O&M Manual and associated agreements, covenants, and easements will be reviewed as part of the County's overall plan review and approval process. More information is provided in Appendix E.

7.3 Operation and Maintenance Inspections, Records, and Access

Section 7.3 summarizes operation and maintenance inspections, records and access requirements for the responsible party.

7.3.1 Operation and Maintenance Inspections

Annual inspections are to be conducted by the responsible party identified within the O&M Manual and inspection reports may be reviewed by the County upon request. All stormwater management facilities must undergo an annual inspection to document maintenance and repair needs and ensure compliance with the requirements of these Standards. Maintenance needs may include the following: removal of silt, litter and other debris from all catch basins, inlets and drainage pipes; grass cutting and invasive vegetation removal; and necessary replacement of water quality vegetation. Any maintenance needs identified must be addressed by the responsible party in a timely manner. The inspection and maintenance frequency may be increased as deemed necessary by the Director to ensure proper functioning of the private stormwater management facilities.

Inspections may be conducted by the Director at any time, including but not limited to, routine inspections, random inspections, inspections based on complaints or other notice of possible violations, inspections related to the County's NPDES MS4 Permit, and joint inspections with other agencies done under environmental or safety laws. Inspections may include, but are not limited to, review of maintenance and repair records; sampling discharges, surface water, groundwater, or material/water in stormwater management facilities; and facility condition evaluations.

7.3.2 Operation and Maintenance Records

Responsible parties shall keep records of all maintenance and repairs and shall retain the records for at least 3 years. These records shall be made available to the County staff during inspection of the facility and at other reasonable times upon request. The owner shall submit a copy annually of the stormwater management facility maintenance and inspection records to the County Public Works Department.

7.3.3 Operation and Maintenance Access

All Stormwater Management Facilities and storm drainage systems shall provide access to maintain, repair and/or replace the infrastructure. Access to private and publicly maintained infrastructure shall be designed and constructed.

Publicly and privately maintained stormwater facilities and structures must provide an access road designed and constructed for the intended use and purpose for accessing and maintaining the proposed SMFs. County maintained facilities should be located adjacent to the public right-of-way.

Both public and private maintenance access roads shall be designed and constructed to the minimum standard as specified below.

The following is required for publicly maintained facilities:

- Maintenance road access for County-maintained facilities shall be shown on the recorded plat and be situated in a separate tract and identified with the specific and intended use for maintenance access.

- The County may require additional protection for access roads, including fencing, signs and/or bollards to restrict public access.
- The minimum access road requirements are at least 12 feet wide with longitudinal slopes no steeper than 15 percent. Curved alignments shall be a minimum 15 feet wide. The minimum outside turning radius shall be 40 feet and the inside minimum radius shall be 25 feet to accommodate equipment.
- Maintenance access shall be constructed of a County approved all-weather drivable surface.

The following is required for privately maintained facilities:

- Facilities shall be located in a manner so that the facility can be safely and efficiently maintained.
- Egress and ingress access routes shall be clear of any obstacles and constructed of a sufficient surface to safely convey the size and weight of vehicles, and equipment necessary to maintain, repair and replace the SMF.
- The access surface shall be maintained to accommodate scheduled maintenance.

7.4 Operation and Maintenance Warranty Periods

Section 7.4 summarizes the 2-year maintenance warranty requirements for plant establishment, including details for entering into a maintenance agreement with the County.

7.4.1 2-year Maintenance Warranty (Plant Establishment)

Stormwater facilities that are constructed in accordance with a Public Works Permit, are either situated within the public right-of-way or are within a single tract of land or easement dedicated to Marion County for stormwater management purposes. These facilities must complete a 2-year warranty and establishment period before the facility is transferred from the Applicant, generally a contractor or developer, to the County or ESSD. The Applicant is responsible for maintaining all stormwater management features during the 2-year maintenance warranty period. This includes maintaining and/or replacing the vegetated components, any structural or functional repairs, and other maintenance.

The Applicant is required to check facilities regularly for the maintenance needs identified in the 2-Year Maintenance Warranty Period Plan. If the County finds deficiencies during the warranty period, it will send a deficiency list to the applicant, allowing 15 days to complete the work after receipt of the written notice. If corrective work is not completed within the time frame, the County may correct the deficiencies itself and seek reimbursement from the applicant through the bond for all costs associated with bringing the permanent stormwater facility into compliance. Any deficiencies not corrected within the time frame may result in the 2-Year Maintenance Warranty restarting from the date the deficiency was noted.

The Applicant must keep an Operation and Maintenance Stormwater BMP Inspection Form (see Appendix E) that notes all inspection dates, facility components inspected, and maintenance or repairs made. The inspection log must document deficiencies and corrective actions taken to keep structural and vegetative components functioning as designed. The County may accept work orders, invoices, or receipts as supporting detail for the log. If deficiencies are identified by County staff during the maintenance warranty period, the applicant must provide the County with the inspection log and other documentation, as requested, to document the frequency and type of maintenance conducted. Plants must be established at the end of the 2-year warranty period. It is not acceptable to replace dying or dead plants with plants right before the end of the warranty period.

Applicants applying for the County's Public Works Permit may enter into an agreement with the County for the County to maintain vegetation during the 2-year maintenance warranty period.

The agreements typically include the provision for the following:

- Irrigation
- Vegetation monitoring and replacement of dead plants
- Sediment removal
- Weeding, inlet clearing, and trash removal
- Treatments specific to the agreement for maintenance

Applicants that contract with the County to provide vegetation warranty period services are exempt from vegetation inspections, but the Applicant is still responsible during the warranty period for other permit elements such as structural components and inlets. Applicants that contract with the County to provide vegetation services do not need to submit a 2-Year Maintenance Warranty Period Plan but must still complete the 2-Year Maintenance Warranty Period Form. Contact the County Public Works Land Development Engineering & Permits department for more information.

7.4.2 Timeline of 2-year Maintenance Warranty Activities

The County will issue a Letter of Completion after the stormwater facilities are constructed and planted per the approved plan. The letter provides official notification that construction is complete, and the 2-year maintenance warranty period has begun.

7.4.3 Release of 2-year Maintenance Warranty Period

The County will issue a letter to the applicant identifying any deficiencies that must be corrected to meet the 2-year maintenance warranty requirements. If the deficiencies are not corrected, the County will take enforcement actions per the Permit that may include applicant liability for expenses incurred by the County to correct the deficiencies. Two years after the maintenance warranty period begins, if the completed stormwater facility has passed all inspections and deficiencies have been corrected as identified by County staff, the 2-year maintenance warranty period will end, and the stormwater facility will be turned over to the County for long-term maintenance.

Following the 2-year warranty period, at the County's discretion, the Applicant may be required to prepare a modified O&M Manual for public stormwater management facilities. If it is determined that the O&M Manual requires modification to maintain acceptable functionality of the facility, then modifications to the O&M Manual shall be submitted to the County for review and approval prior to the release of the warranty surety.

Section 8

Erosion Prevention and Sediment Control Measures During Construction

When land is disturbed, the erosion rate accelerates dramatically because the ground cover of an undisturbed site protects the surface soils and removal of that cover increases the site's susceptibility to erosion. A major problem associated with erosion is the movement of soil off the site and its subsequent impact on water quality. This section outlines the requirements for erosion prevention, sediment control, and construction debris management.

The Applicant for a development permit is ultimately responsible for retaining all soil on the project site and must recognize the potential for changing, or unexpected site and weather conditions. If at any time the County approved Erosion Prevention and Sediment Control (EPSC) Plan is determined to be ineffective, the County will require additional controls to be implemented until a site is stabilized. Once this occurs, the Applicant is responsible for updating the EPSC Plan and resubmitting it to the County.

8.1 Thresholds

Within the boundaries of the County's Stormwater Management Area (SWMA), any grading or soil disturbance associated with a development activity that disturbs 10,890 square feet (1/4 acre) or more, will require the developer to complete and implement an EPSC Plan and obtain an EPSC Permit from the County. In addition, no person shall cause or allow visible and measurable erosion or sediment related to construction site activity inside the SWMA to enter the storm drainage and surface water system.

8.2 NPDES Permits 1200-C and 1200–CN

In addition to obtaining an EPSC Permit from the County for sites that disturb 10,890 square feet (1/4 acre) or more, the County must also refer the Applicant to the Oregon Department of Environmental Quality (ODEQ), or the appropriate ODEQ agent, to obtain NPDES Construction Stormwater Permit (1200-C Permit) coverage for:

- Construction projects that disturb five (5.0) or more acres
- Or that disturb less than five (5.0) acres if the site is part of a common plan of development or sale disturbing five (5.0) or more acres.

The Applicant shall inquire with the County as to the status of the 1200-CN Permit at the time of application to verify current permitting requirements. At the time of writing these Standards, the 1200-CN Permit applies to sites that disturb from one (1.0) acre to less than five (5.0) acres, within the Stormwater Management Area.

This 1200-CN permit qualifies the County's local erosion control program as being equivalent to ODEQ's 1200-C program for sites between one (1.0) and five (5.0) acres in the SWMA. Therefore, an applicant for a site disturbing from one (1.0) to less than five (5.0) acres in the SWMA is automatically covered for construction activities and is not required to also apply to ODEQ for a 1200-C permit in addition to applying for a County EPSC Permit. Any disturbance of five (5.0) acres or more requires a DEQ 1200-C permit.

The planning process outlined in Section 8 is intended to assist the Applicant in meeting the requirements of the NPDES 1200-C permit. However, it is the responsibility of the Applicant to review and comply with ODEQ's regulations and permitting process, including paying any applicable fees to reviewing agencies.

8.3 Erosion Control Best Management Practices

For planning and design of EPSC Best Management Practices for private projects, refer to the 2020 Clean Water Services "*Erosion Prevention and Sediment Control Planning and Design Manual*", which is included in Appendix F. For planning and design of public projects, the most current version of the Oregon Department of Transportation's *Erosion Control Manual* may be used. In addition, the applicant should review the requirements in *MCC Chapter 15.10: Construction Erosion and Sediment Control* and *MCC Chapter 8.05 Solid Waste Management*.

Appendix F, *Erosion Prevention and Sediment Control Supporting Documents*, provides a copy of the following documents:

- Erosion Acknowledgement Form
- EPSC Plan Checklist
- EPSC Plan Template

Section 9

References

City of Gresham. Stormwater Management Manual. (2018).

City of Lake Oswego. Stormwater Management Manual. (2020).

City of Portland. Stormwater Management Manual. (2020).

City of Salem Administrative Rules.

City of Salem Municipal Code.

Clean Water Services “Erosion Prevention and Sediment Control Planning and Design Manual”. (June 2020).

Marion County. *Department of Public Works Engineering Standard*s. (April 1990).

Marion County. *Draft Interim Stormwater Quality Treatment Engineering Standards for the Stormwater Management Area*. (2012).

Marion County Municipal Code.

Marion County Zoning Code.

NOAA Atlas 2. Precipitation-Frequency Atlas of the Western United States. Volume X–Oregon.

Oregon City’s Stormwater and Grading Design Standards. (March 2020).

Water Environmental Services. Public Review Draft–Stormwater Standards. (March 2021).

Appendix A: Site Assessment Checklist

	SITE ASSESSMENT CHECKLIST[1]	
	Information Needed	**Attach supporting materials as needed**
2.2.1 Site Information		
	Applicant contact information	Applicant name: Business name: Contact address, phone number, and e-mail:
	Project location Address	Site address: Site description: Major drainage basin: Is the project site located within a sensitive area or natural resource area? ________ (Y/N)[2] Include a vicinity map of the site (including location of property in relation to adjacent properties, roads, and pedestrian/bike facilities).
	Project type	Identify types of development planned for the site such as commercial, industrial, single-family residential, multi-family residential, or other (describe):
	Size of site	Size of site: _______ (acres) Number of existing/proposed tax lots: ______ Amount of new and replaced impervious area: ______ (SF)
2.2.2 Site Assessment		
	Topography Map and Description Evaluate site and map slopes: Flat: 0-10% Moderate: 10-25% Steep: 25% and greater	• Surveyed or aerial-based mapping with 2-foot intervals for slopes 0-25% slope and 10-foot intervals for steeper. • In addition to slopes, the map shall indicate setback areas around those steep ground slopes and slide prone areas.
	Soils and Groundwater Research and map site soil hydrologic group, depth to groundwater	NRCS Hydrologic Soil Type (show on map if more than one type present): Attach seasonal groundwater depth evaluation if available or required (site has floodplain and/or wetland).
	Infiltration Assessment	If an infiltration test is performed, attach the documentation. Report the test type (Basic/Professional) performed and results. See **Appendix B** for the approved infiltration testing methods.

[1] This Site Assessment Checklist should be used by the applicants to document they have addressed the requirements in section 2.1 and 2.2 The County reviews this checklist during the development review process.

[2] Sensitive Area Maps can be found at https://www.co.marion.or.us/PW/ES/waterquality?Pages/sam.aspx

SITE ASSESSMENT CHECKLIST[1]		
	Determine soil capacity for onsite infiltration	Test type: ______________________________ (inches/hour) ___________________
	Hydrology Map site floodplains, wetlands, streams, and location of outfalls	Clearly label on map all intermittent and perennial creeks/streams/rivers and wetlands (per Oregon Department of State Lands and U.S. Army Corps of Engineers), FEMA floodplains, and existing drainage systems (pipes, ditches, outfalls). Check here if present on site: __________ Sensitive area(s) _____________________ Floodplain ___________________________
	Existing Drainage	Attach engineered scale Site Assessment Map, showing constructed drainage features on and adjacent to the site, including pipes, ditches, and outfalls should be mapped.
	Existing Vegetation and Land Cover Map trees and vegetation	Using aerial photos or survey, map all trees and vegetation. Note all existing trees 6-inch caliper and greater (DBH) on map. Delineate and identify other areas and types of existing vegetation. The local planning authority may require a formal tree survey.
	Land Use Zoning	Existing Land Use Zoning designation(s): _
	Access and Parking	Delineate proposed access points for all transportation modes, including emergency vehicle access, on map. Indicate amount and area of required parking onsite if applicable. Attach documentation as needed.
	Utilities to Site and Surrounding Area	Include a map with existing utilities including stormwater facilities, storm conveyance, sewer, water, electricity, phone/cable, gas within the property. In addition, any public storm system/facility downstream within 500' from the property boundary, as applicable.
	Downstream Storm Drainage System	Indicate the proposed point of discharge on the site plan. Prepare and attach a Downstream Analysis as required by **Section 5.** Check here to verify that adequate downstream capacity is available: ______
2.2.3 Site Development Considerations (attach engineered scale Preliminary Site Plan)		
	1. Preserve Natural Vegetation	The developed area should be situated to minimize the clearing of existing groundcover, maximize the preservation of wetlands, buffer waterway corridors (riparian areas), and maintain the natural drainage pathways for seasonal and intermittent drainage. If feasible, the preserved area should be located down slope (downhill) from the developed area, since flow control and water quality are enhanced by flow dispersion through undisturbed soils and native vegetation.
	2. Define Development Envelopes and Protected Areas	Define distinct development envelopes and protected areas.
	3. Minimize Direct Connections	Minimize direct connections of impervious areas to underground drainage systems by allowing stormwater to permeate into the soil (within the confines of ODEQ Underground Injection Control (UIC) program regulations and prevailing site and soil conditions) and/or be filtered by vegetation before being collected into catch basins (i.e., biofiltration swales).
	4. Use Drainage Facilities as a Benefit	Including creating multi-use facilities and natural drainage pathways where possible, while avoiding diversion of stormwater runoff from one watershed to another.

SITE ASSESSMENT CHECKLIST[1]		
	5. Use of Permeable Soil	Provide at least one foot of permeable soil in landscaped areas to disperse and infiltrate water, support plant growth and filter and decompose pollutants.
	6. Construction Techniques	Minimize soil compaction. Provide protection from compaction by defining vehicle pathways; using appropriate landscape plant selection and placement; and using amendments such as organic matter, coarse sand, pumice, granulated rubber, and similar soil components.
	7. Minimize Use of Impervious Surfaces	Minimize use of impervious surfaces consistent with site design.

Appendix B: Infiltration Testing Requirements

B.1 General

Infiltration rates are required in order to size infiltration stormwater management facilities. Testing shall be conducted or observed by a qualified professional. This qualified professional may be either a registered Professional Engineer (PE), Registered Geologist (RG), or Certified Engineering Geologist (CEG) licensed in the State of Oregon.

Note that a minimum factor or safety of 2 must be applied to the measured native infiltration rate to obtain the design infiltration rate (e.g., design infiltration rate may be no more than one-half the measured infiltration rate).

B.2 Infiltration Testing Report

The Infiltration Testing Report should be attached to the project's Stormwater Management Report. Include the following information in the Infiltration Testing Report[1]:

1. Project location and vicinity map
2. Statement of project understanding (proposed stormwater system)
3. Summary of subsurface conditions encountered
4. Summary of infiltration testing including location and number of tests and testing method used. Discussion of how the tests were performed (i.e., pipe type or diameter or test pit dimensions)
5. Infiltration testing results in inches per hour, recorded on a form similar to that shown in Table B-1.
6. Recommended design infiltration rate
7. Groundwater observations, including dates of observations, and an estimate of the depth to seasonal high groundwater
8. Site plan showing location and elevation of infiltration tests, including datum used for recorded elevations
9. Boring or test pit logs—Logs should include the following:
    a. An associated soil classification consistent with American Society for Testing Materials (ASTM) D2488-00, Standard Practice for Classification for Description and Identification of Soils (Visual-Manual Procedure)
    b. Any additional pertinent subsurface information, such as soil moisture conditions, depth and description of undocumented or engineered fill, soil color and mottling conditions, soil stiffness or density, and approximate depth of contact between soil types
10. Infiltration Test Data Tables (see Table B-1 for an example and Table B-2 for a blank table)
11. The stamp indicating licensure of the qualified professional who is submitting the report

[1] Note – Adapted from Portland Stormwater Management Manual (Portland 2008).

B.3 Infiltration Testing Methods

A qualified professional must exercise judgment in the selection of the infiltration test method based on the site conditions. The County reserves the right to require additional testing, if needed. The three acceptable infiltration test methods used to determine a design infiltration rate are as follows:

1. Encased Falling Head Test
2. Double-Ring Infiltrometer Test
3. Open Pit Falling Head Test

Procedural details on each of the three test methods are provided below.

General Criteria

- Testing must be conducted or observed by a qualified professional. A qualified professional may be either a Professional Engineer (PE), Registered Geologist (RG), or Certified Engineering Geologist (CEG) licensed in the State of Oregon.
- The location and depth of the test shall be performed at the proposed facility location and depth. Boring logs shall be provided as supporting information with the infiltration and depth to groundwater tests.

Depth and Location of Required Tests

- Infiltration tests shall be performed at the base elevation of the proposed facility.
- If a confining layer, or soil with a greater percentage of fines, is observed during the subsurface investigation to be within four feet of the bottom of the planned infiltration system, the testing shall be conducted within that confining layer.
- Tests must be performed in the immediate vicinity of the proposed facility. Exceptions can be made to the test location provided the qualified professional can support that the strata are consistent from the proposed facility to the test location. The test location must be representative of the predominant soils within the proposed facility footprint.
- For relatively deep stormwater facilities, a hollow stem auger with an electronic measuring tape can be used, provided there is an adequate seal between the auger and the native soil.

Minimum Number of Infiltration Tests

At least one infiltration test is required for any potential location where a public or private stormwater management facility will be sited, as determined by a Geotechnical Engineer. For projects with many small facilities, infiltration testing is required to provide a representative data set as determined by a Geotechnical Engineer. The County may require additional infiltration tests. The County may accept a recommended infiltration rate from a Geotechnical Engineer for a large facility where more than one infiltration test is required.

Encased Falling Head Test

Description: The encased falling head procedure is based on a modification of the Environmental Protection Agency's (EPA) Falling Head Percolation Test Procedure (*Onsite Wastewater Treatment and Disposal Systems Design Manual*, EPA/625/1-80-012, 1980). The most significant modification is that this test is performed with a 6-inch casing that is embedded approximately 6 inches into the native soil. The goal of this field test is to evaluate the vertical infiltration rate through a 6-inch plug of soil, without allowing any lateral infiltration. The test is not appropriate in gravelly soils or in other soils where a good seal with the casing cannot be established.

Procedure:

1. Embed a solid, 6-inch-diameter casing into the native soil at the elevation of the proposed facility bottom (see **Figure B-1**). Ensure that the embedment provides a good seal around the pipe casing so that percolation will be limited to the 6-inch plug of the material within the casing. This method can also be applied to testing within hollow stem augers, provided the driller and tester are reasonably certain that a good seal has been achieved between the soil and auger. If an adequate seal cannot be obtained, the open pit falling head procedure shall be used (see Open Pit Falling Head Test Procedure below).

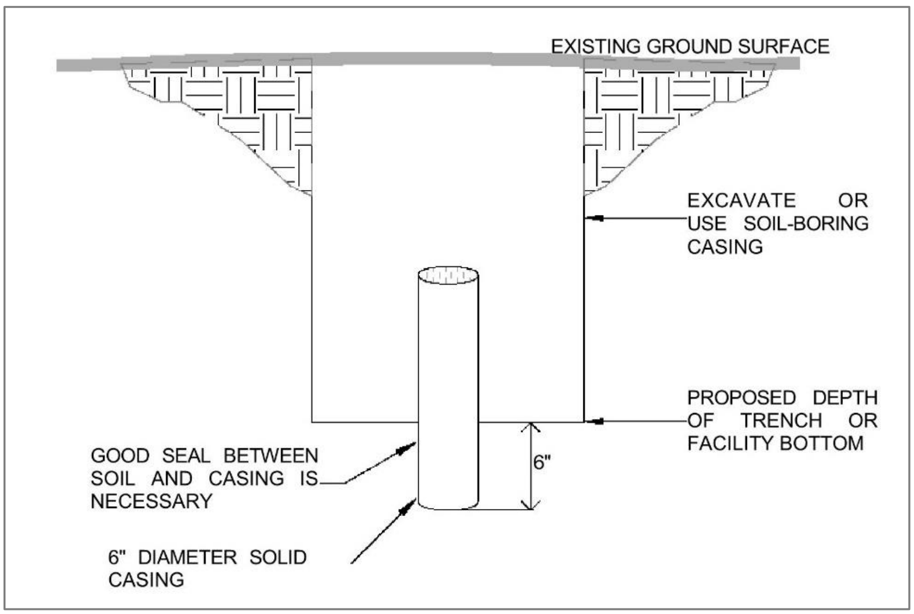


Figure B-1. Encased Falling Head Test Procedure

2. A 2-inch layer of coarse sand or fine gravel (not previously compacted) may be placed to protect the bottom from scour and sloughing.
3. Fill the pipe with clean water a minimum of 1 foot above the soil to be tested and maintain this depth for at least 4 hours (or overnight if clay soils are present) to presoak the native material. Percolation rate measurements must be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period must be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

   In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.

4. To conduct the first trial of the test, fill the pipe to approximately six inches above the soil and measure the water level to the nearest 0.01 foot (1/8 inch). The level should be measured with a tape or other device with reference to a fixed point, which should be identified in the results table. The top of the pipe is often a convenient reference point. Record the exact time.
5. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all the water has drained. The infiltration test is continued until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials must be conducted. After each trial, the water level is readjusted to the 6-inch level. Enter results into the Data Table (see Table B-2). At no time during the test is the water level allowed to rise more than 6 inches above the gravel.
6. The result of the last water level drop is used to calculate the tested infiltration rate. The final rate must be reported in inches per hour.
7. Upon completion of the testing, the casings must be immediately pulled, and the test pit must be backfilled.

Double Ring Infiltrometer Test

Description: The test is performed within two concentric casings embedded and sealed to the native soils. The outer ring maintains a volume of water to diminish the potential of lateral infiltration through the center casing. The volume of water added to the center ring to maintain a static water level is used to calculate the infiltration rate. The double-ring infiltrometer is appropriate only in soils where an adequate seal can be established. The goal of this field test is to minimize the error associated with the single-ring method because the water level in the outer ring forces vertical infiltration of water in the inner ring. The double-ring infiltrometer test is a well-recognized and documented technique for directly measuring soil infiltration rates. See Figure B-2 below.

Procedure: The double-ring infiltrometer test procedure must conform to ASTM 3385-94. This test may be difficult to perform where the tested soil strata are in a pit because careful regulation of the static volumes is necessary.

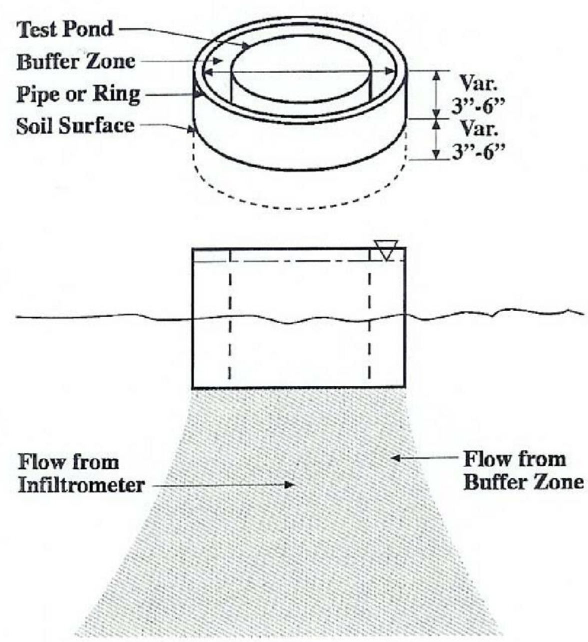


Figure B-2. Double Ring Infiltrometer Test Procedure

Open Pit Falling Head Test

Description: The Open Pit Falling Head test is applicable where site conditions prevent a good seal between the native soil and the infiltration equipment used in the other professional methods. The procedure is based on the EPA's Falling Head Percolation Test Procedure (*Onsite Wastewater Treatment and Disposal Systems Design Manual*, EPA/625/1-80-012, 1980). The test is performed in an open excavation and therefore is a test of the combination of vertical and lateral infiltration.

Procedure:

1. Excavate an approximately 2-foot by 2-foot-wide hole into the native soil to the bottom elevation of the proposed facility. The test can be conducted in a machine-excavated pit or a hand-dug pit using a shovel, posthole digger, or hand auger. If smooth auger tools or a smooth excavation bucket is used, scratch the sides and bottom of the hole with a sharp-pointed instrument, and remove the loose material from the bottom of the test hole.
2. A 2-inch layer of coarse sand or fine gravel may be placed to protect the bottom from scour and sloughing.
3. Fill the hole with clean water a minimum of 1 foot above the soil to be tested and maintain this depth of water for at least 4 hours (or overnight if clay soils are present) to presoak the native material.
4. Percolation rate measurements must be made after 15 hours and no more than 30 hours after the soaking period begins. It is important that the soil be allowed to soak for a sufficiently long period of time to allow the soil to swell if accurate results are to be obtained. Any soil that sloughed into the hole during the soaking period must be removed and the water level shall be adjusted to 6 inches above the added gravel (or 8 inches above the bottom of the hole).

   In sandy soils with little or no clay, soaking is not necessary. If after filling the hole twice with 12 inches of water, the water seeps completely away in less than 10 minutes, the test can proceed immediately.
5. The measurements should be made with reference to a fixed point. A lath placed in the test pit prior to filling or a sturdy beam across the top of the pit are convenient reference points. The tester and excavator should conduct all testing in accordance with OSHA regulations.
6. Measure the water level to the nearest 0.01 foot (1/8 inch) at 10-minute intervals for a total period of 1 hour (or 20-minute intervals for 2 hours in slower soils) or until all the water has drained. At no time during the test is the water level allowed to rise more than 6 inches above the gravel.
7. Successive trials must be run until the measured infiltration rate between two successive trials does not vary by more than 5 percent. At least three trials must be conducted. After each trial, the water level is readjusted to the 12-inch level. Enter results into the data table (See **Table B-2**).
8. The results of the last water level drop are used to calculate the tested infiltration rate. The final rate must be reported in inches per hour. See the calculation following **Table B-1.**
9. For very rapidly draining soils, it may not be possible to maintain a water head above the bottom of the test pit. If the infiltration rate meets or exceeds the flow of water into the test pit, conduct the test in the following manner:
   a. Approximate the area over which the water is infiltrating.
   b. Using a water meter, bucket, or other device, measure the rate of water discharging into the test pit.
   c. Calculate the infiltration rate by dividing the rate of discharge (cubic inches per hour) by the area over which it is infiltrating (square inches).
10. Upon completion of the testing, the excavation must be backfilled.

Table B-1. Infiltration Test Data Table Example					
Location: Lot 105, Low Point Heights Subdivision		**Date:** 6/28/2010		**Test Hole Number:** 3	
Depth to bottom of hole: 57 inches		**Diameter of hole:** 0.5 feet		**Test Method:** Encased Falling Head	
Tester's Name: C.J. Tester		**Tester's Company:** Tester Company		**Tester's Contact Number**: 555-1212	
Fixed Reference Point: Top of Pipe			**Vertical Datum:** NAVD 88		
Depth, feet			Soil Texture		
0-0.5			Black Top Soil		
0.5-1.0			Brown SM		
1.0-2.2			Brown ML		
2.2-5.1			Brown CL		
Time	Time interval, minutes	Measurement, feet below ground surface	Drop in water level, feet	Infiltration rate, inches per hour	Remarks
9:00	0	3.75	-	-	Filled with 6"
9:20	20	3.83	0.08	-	-
9:40	20	3.91	0.08	2.88	-
10:00	20	3.98	0.07	2.52	-
10:20	20	4.04	0.06	2.16	-
10:40	20	4.11	0.07	2.52	-
11:00	20	4.17	0.06	2.16	-
11:20	20	4.23	0.06	2.16	Adjusted to 6" level for Trial #2

Calculation is performed for each water level drop. The design infiltration rate of two successive trials must have a difference of five percent or less.

= (Drop in water level/Time interval) x conversion

= 0.055 feet/20 minutes x (12 inches/foot) x (60 minutes/hour)

= 1.98 inches per hour

Table B-2. Infiltration Test Data Table		
Location:	**Date:**	**Test Hole Number:**
Depth to bottom of hole:	**Diameter of hole:**	**Test Method:**
Tester's Name:	**Tester's Company:**	**Tester's Contact Number:**

Fixed Reference Point:	**Vertical Datum:**
Depth, feet	Soil Texture

Time	Time interval, minutes	Measurement, feet below ground surface	Drop in water level, feet	Infiltration rate, inches per hour	Remarks

Appendix C: Implementing Green Infrastructure to the Maximum Extent Feasible

C.1 Purpose

The purpose of this appendix is to establish criteria for determining whether an applicant for a development project is meeting the requirements contained in these standards to implement Green Infrastructure (GI) to the Maximum Extent Feasible (MEF).

C.2 Applicability

This appendix is applicable to projects requiring stormwater retention and/or treatment and is to be used to support approval criteria for Site Plan Review, land divisions, and other land use application and decision processes where conformance to stormwater requirements must be demonstrated as a condition of approval.

C.3 Background

These standards require projects exceeding specified thresholds to use GI to the MEF to mitigate the impacts of stormwater runoff from new and replaced impervious surfaces. In summary:

- GI is defined as a specific type of stormwater control using vegetation, soils, and natural processes to manage stormwater. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems designed to mimic nature by reducing and/or storing stormwater through infiltration, evaporation, and/or transpiration. At the scale of a county, green stormwater infrastructure refers to the patchwork of natural areas that provide flood protection and natural processes that remove pollutants from stormwater. Projects requiring stormwater retention are required to use GI to the MEF to meet flow control and treatment performance standards.
- Projects requiring stormwater retention must meet the performance standards for retention and/or treatment as specified in these standards, regardless of the degree to which GI is used.
- Implementing GI to the MEF means that flow control and treatment requirements are to be met using these facilities unless doing so is not possible because of site limitations, considerations in engineering design, or considerations of financial costs and environmental impacts.

Because of the unique characteristics of each project site, there will be cases in which not all stormwater runoff impacts can be mitigated using exclusively GI. In such cases, compliance with this appendix is required.

During land use application and decision processes, conformance with the MEF requirement can be demonstrated by one of two means:

1. Runoff from the new and replaced impervious surfaces flows into one or more locations that have been set aside for installation of GI and the locations have a total area of at least ten percent of the total new plus replaced impervious surface area; or
2. Factors limiting implementation (see Section C.5 of this appendix) are documented and approved by the Director.

C.4 Submittal

The submittal requirement to demonstrate compliance with the non-discretionary approach is a site plan showing the following:

- Boundary of the drainage area or, if present, drainage boundaries of subareas;
- Total square footage of all new and replaced impervious surface for each area or subarea;
- The direction of runoff flow for each area or subarea;
- The location and square footage of each area to contain GI.

C.5 Factors Limiting Implementation of GI

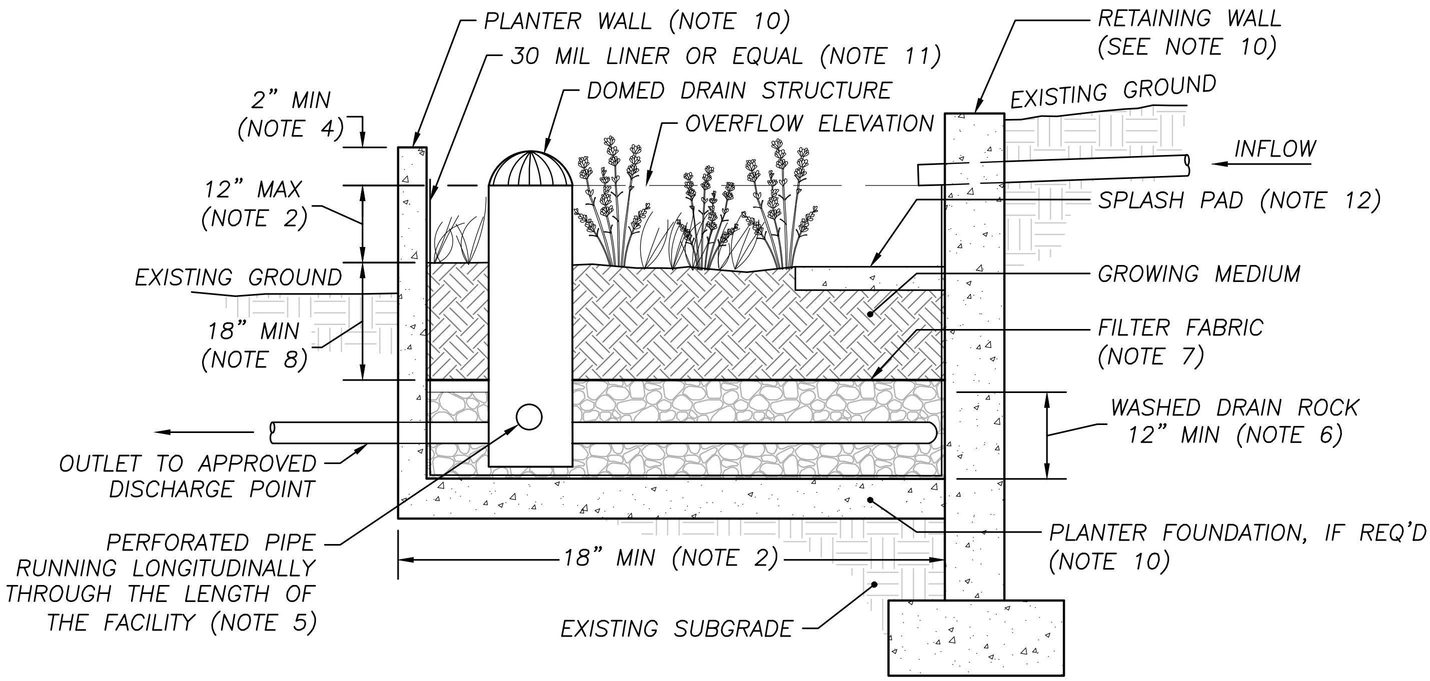
The following factors may limit implementation of GI:

- Surface slopes cannot be graded to meet the design criteria required for GI.
- The minimum dimensions of the facility cannot be met due to mandatory setbacks as set in the Stormwater Standards.
- Downspout configuration cannot be modified to convey roof runoff to the facility.
- Minimum vertical or horizontal clearance from utilities cannot be achieved as required by the utility owner, or as prescribed in the Marion County Code or administrative rules.
- The presence of sensitive areas, including wetlands, riparian corridors, and receiving waters, precludes using GI.
- Implementing GI will restrict pedestrian, bicycle, or vehicular access. This does not apply to below ground GI facilities.

C.6 Approval Process

The Director may require an applicant to provide an engineering report, signed, and stamped by a licensed Professional Engineer.

Appendix D: Typical Stormwater Facility Details



GENERAL NOTES

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO AND DURING.
2. DIMENSIONS:
   - WIDTH: 18" MINIMUM
   - DEPTH OF PLANTER (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   - SLOPE OF PLANTER: 0.5% OR LESS
3. SETBACKS:
   - PLANTERS MUST BE MINIMUM OF 5 FEET FROM PROPERTY LINE.
4. OVERFLOW:
   - INLET ELEVATION MUST ALLOW FOR 2" OF FREEBOARD, MINIMUM.
   - PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
   - SIZE OVERFLOW FOR THE 50-YEAR DESIGN STORM. IDENTIFY OVERFLOW ROUTE IN THE STORMWATER MANAGEMENT PLAN.
5. PIPING:
   - PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40, 6" MINIMUM DIAMETER. PVC NOT ALLOWED ABOVE GROUND.
6. DRAIN ROCK:
   - SIZE FOR FLOW-THROUGH PLANTER: 1 1/2" – 3/4" WASHED
   - DEPTH: 12" MINIMUM
7. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM SHALL BE WITH FILTER FABRIC.
8. GROWING MEDIUM:
   - DEPTH: 18" MINIMUM
   - FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX H.
10. PLANTER FOUNDATION AND WALLS:
    - MATERIALS SHALL BE 4" REINFORCED CONCRETE, OR OTHER DURABLE MATERIAL.
    - CONCRETE WALLS SHALL BE INCLUDED ON FOUNDATION PLANS.
    - INSTALL INVERTED CURB AS NEEDED BETWEEN PLANTER AND ROAD SUBGRADE.
    - WALL HEIGHTS GREATER THAN 24" ABOVE GRADE REQUIRE HANDRAIL.
11. WATERPROOF LINER (IF REQUIRED):
    - LINER SHALL BE 30 MIL PVC OR EQUIVALENT, FOR FLOW THROUGH FACILITIES.
    - A WATERPROOF LINER IS NOT REQUIRED IF THE FOUNDATION OR WALL MATERIAL IS WATERPROOF REINFORCED CONCRETE OR APPROVED EQUAL.
12. INSTALL SPLASH PAD TO TRANSITION FROM INLET TO GROWING MEDIUM. SEE DETAIL 007

REVISIONS

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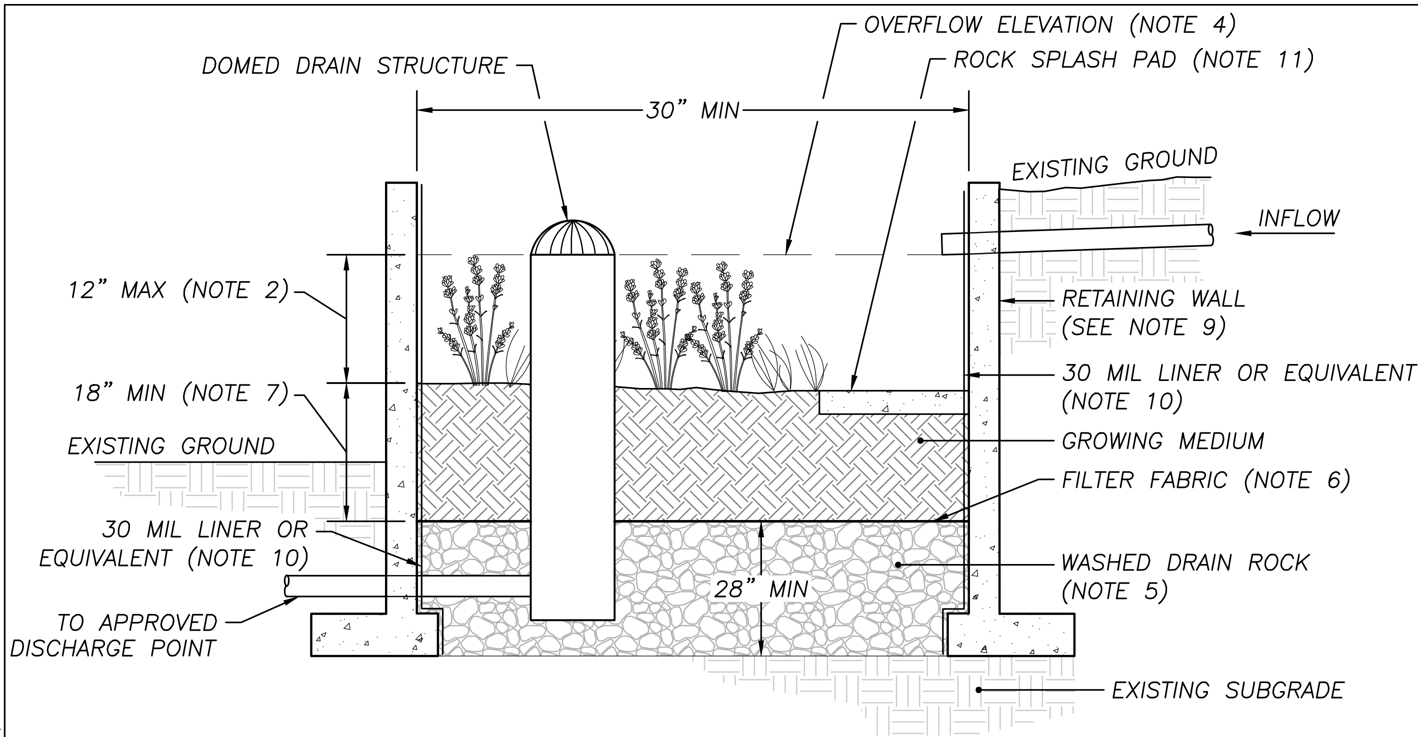

GENERAL NOTES

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   - WIDTH: 30" MINIMUM
   - DEPTH OF PLANTER (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   - SLOPE OF PLANTER: 0.5% OR LESS
3. SETBACKS:
   - PLANTERS MUST BE MINIMUM OF 5 FEET FROM PROPERTY LINE.
4. OVERFLOW:
   - OVERFLOW ELEVATION MUST ALLOW FOR 12" OF FREEBOARD, MINIMUM.
   - SIZE OVERFLOW FOR THE 50-YEAR DESIGN STORM. IDENTIFY OVERFLOW ROUTE IN THE STORMWATER MANAGEMENT PLAN.
5. DRAIN ROCK:
   - SIZE: 1 1/2" – 3/4" WASHED
   - DEPTH: 28" MINIMUM
6. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM SHALL BE WITH FILTER FABRIC.
7. GROWING MEDIUM:
   - DEPTH: 18" MINIMUM
8. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX H.
9. PLANTER WALLS:
   - MATERIALS SHALL BE CONCRETE OR OTHER DURABLE MATERIAL.
   - CONCRETE WALLS SHALL BE INCLUDED ON FOUNDATION PLANS.
   - INSTALL INVERTED CURB AS NEEDED BETWEEN PLANTERS AND ROAD SUBGRADE.
   - WALL HEIGHTS GREATER THAN 24" ABOVE GRADE REQUIRE HANDRAIL.
10. WATERPROOF LINER:
    - LINER SHALL BE 30 MIL PVC OR EQUIVALENT.
    - A WATERPROOF LINER IS NOT REQUIRED IF THE WALL MATERIAL IS WATERPROOF REINFORCED CONCRETE OR APPROVED EQUAL.
11. INSTALL SPLASH PAD TO TRANSITION FROM INLET TO GROWING MEDIUM. SEE DETAIL 007

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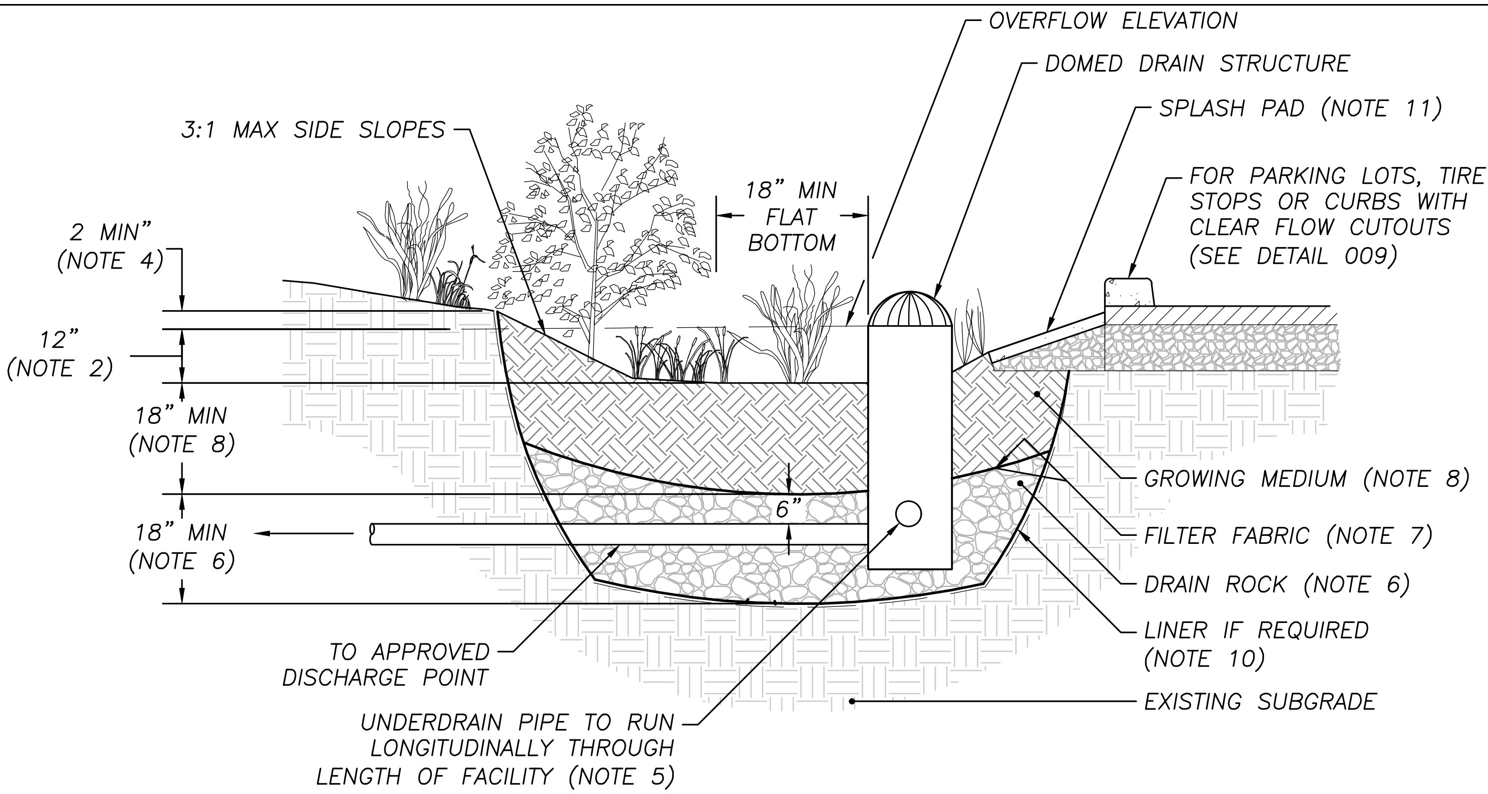

GENERAL NOTES

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, AND DURING CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED RAIN GARDENS ARE PREFERRED TO MAXIMIZE ONSITE INFILTRATION.
2. DIMENSIONS:
   - DEPTH OF BASIN (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   - FLAT BOTTOM WIDTH: 18" MINIMUM
   - SIDE SLOPES OF BASIN: 3:1 MAXIMUM
   - SLOPE OF RAIN GARDEN: 0.5% OR LESS
3. SETBACKS:
   - FILTRATION RAIN GARDEN MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. OVERFLOW:
   - OVERFLOW REQUIRED. INLET ELEVATION MUST ALLOW FOR 2" OF FREEBOARD, MINIMUM.
   - PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
   - SIZE OVERFLOW FOR THE 50-YEAR DESIGN STORM. IDENTIFY OVERFLOW ROUTE IN THE STORMWATER MANAGEMENT PLAN.
5. PIPING:
   - PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40. MINIMUM DIAMETER IS 6".
6. DRAIN ROCK:
   - SIZE: 1 1/2" to 3/4"-0 WASHED
   - DEPTH: 18" MINIMUM
7. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM SHALL BE WITH FILTER FABRIC.
8. GROWING MEDIUM:
   - DEPTH: 18" MINIMUM
   - FACILITY SURFACE AREA MAY BE REDUCED BY 20% WHEN GROWING MEDIA DEPTH IS INCREASED TO 30" OR MORE.
9. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX H.
10. WATERPROOF LINER (IF REQUIRED): SHALL BE 30 MIL PVC OR EQUIVALENT.
11. INSTALL SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM. SEE DETAIL 007.

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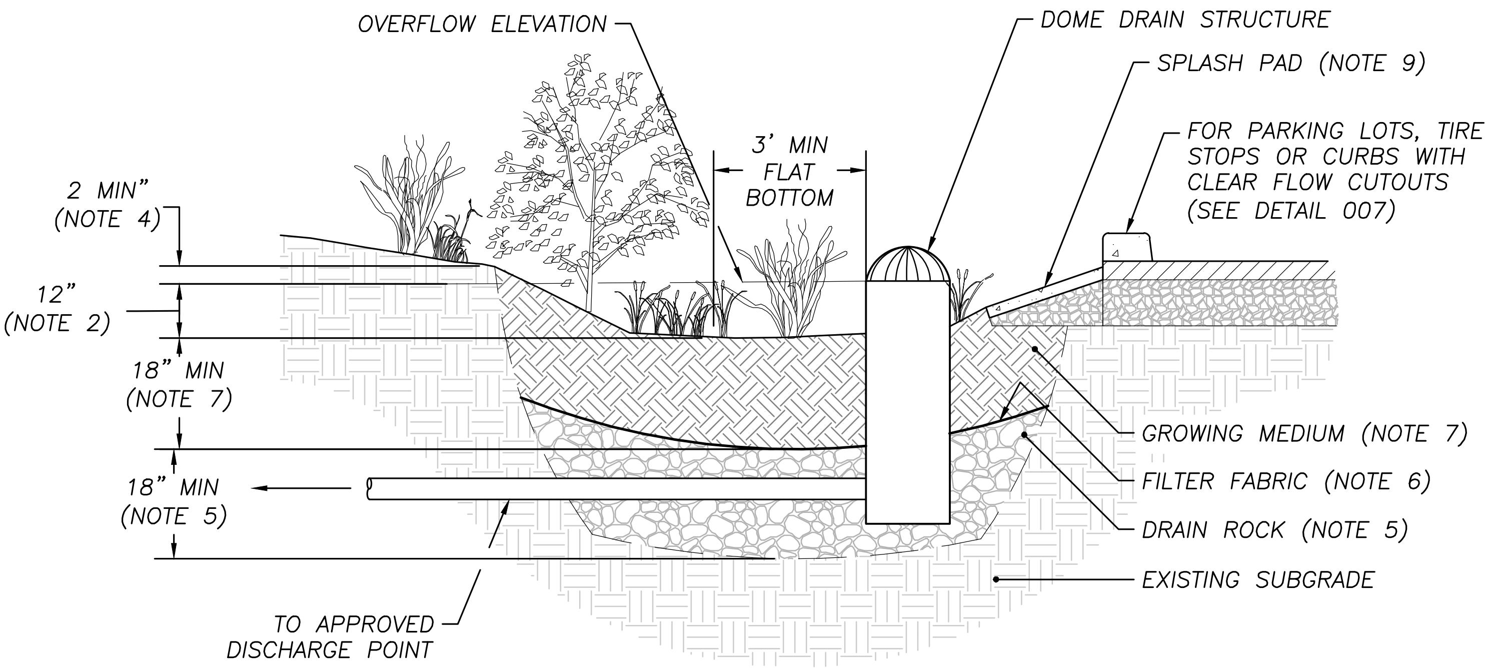

GENERAL NOTES

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   - DEPTH OF BASIN (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 12"
   - FLAT BOTTOM WIDTH: 3' MINIMUM
   - SIDE SLOPES OF BASIN: 3:1 MAXIMUM
   - SLOPE OF RAIN GARDEN: 0.5% OR LESS
3. SETBACKS:
   - INFILTRATION RAIN GARDEN MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES.
4. OVERFLOW:
   - SIZE OVERFLOW FOR THE 50–YEAR DESIGN STORM. IDENTIFY OVERFLOW ROUTE IN THE STORMWATER MANAGEMENT PLAN.
5. DRAIN ROCK:
   - SIZE: 1 1/2" TO 3/4"– WASHED
   - DEPTH: 18"
6. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM SHALL BE WITH FILTER FABRIC.
7. GROWING MEDIUM:
   - DEPTH: 18" MINIMUM
8. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX H.
9. INSTALL SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM. SEE DETAIL 007

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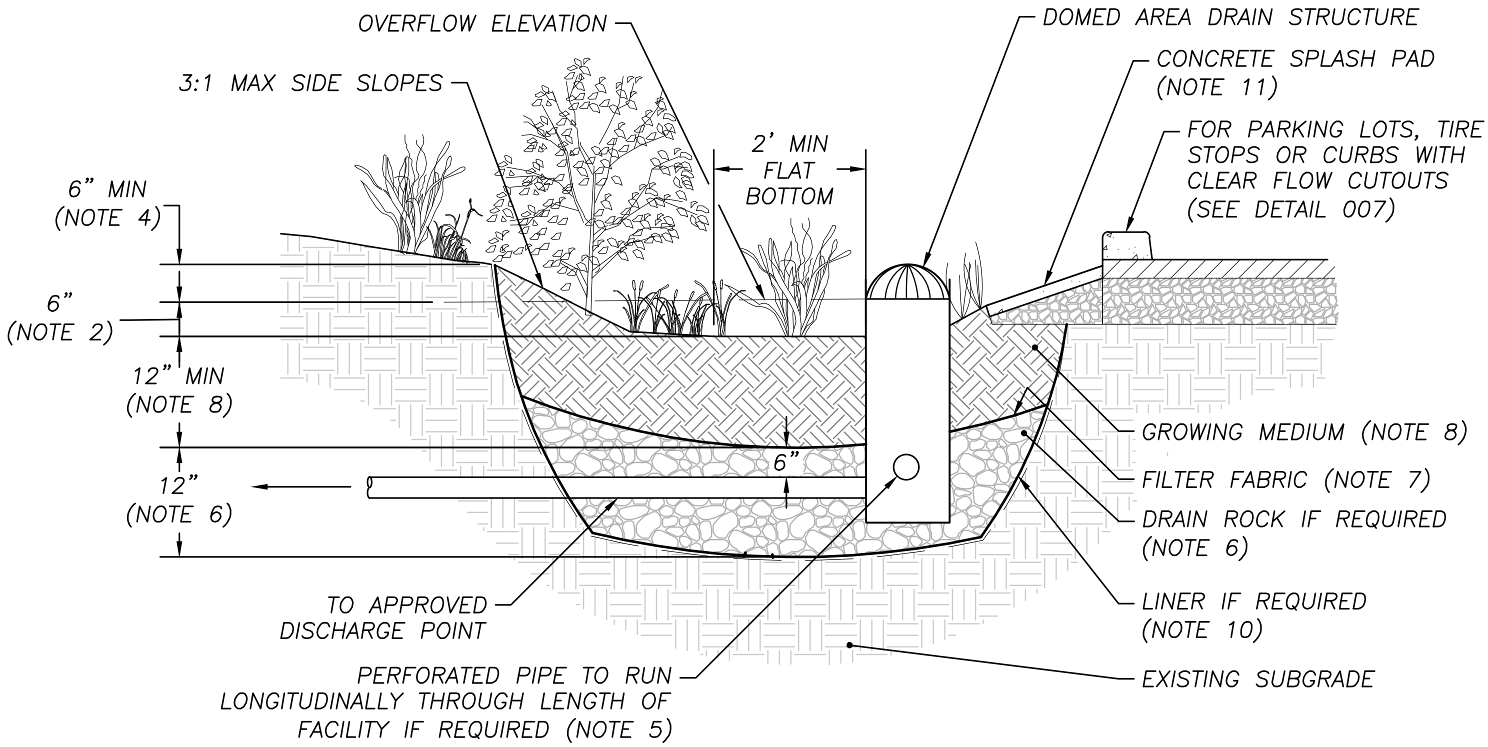

GENERAL NOTES

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, AND DURING CONSTRUCTION. UNLESS REQUIRED BY SITE CONDITIONS, UNLINED SWALES ARE PREFERRED TO ALLOW MAXIMUM INFILTRATION.
2. DIMENSIONS:
   - DEPTH OF SWALE (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 6"
   - LONGITUDINAL SLOPE OF SWALE: NO LESS THAN 0.3% AND NO MORE THAN 6.0%. INSTALL CHECK DAM IF OVER 4.0%. SEE NOTE 12.
   - FLAT BOTTOM WIDTH: 2' MINIMUM
   - SIDE SLOPES OF SWALE: 3:1 MAXIMUM
3. SETBACKS:
   - FILTRATION SWALES MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES UNLESS APPROVED BY BUILDING OFFICIAL.
4. OVERFLOW:
   - INLET ELEVATION MUST ALLOW FOR 6" OF FREEBOARD, MINIMUM.
   - PROTECT FROM DEBRIS AND SEDIMENT WITH STRAINER OR GRATE.
   - SIZE OVERFLOW FOR THE 50-YEAR DESIGN STORM. IDENTIFY OVERFLOW ROUTE IN THE STORMWATER MANAGEMENT PLAN.
5. PIPING:
   - PERFORATED UNDERDRAIN PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH.40. MINIMUM DIAMETER IS 6". PVC NOT ALLOWED ABOVE GROUND.
   - OVERFLOW PIPING: SHALL BE ABS SCH. 40, DUCTILE IRON, OR PVC SCH. 40 AND SHALL NOT BE PERFORATED. MINIMUM DIAMETER IS 6". PVC NOT ALLOWED ABOVE GROUND.
6. DRAIN ROCK (IF REQUIRED):
   - SIZE: 1 1/2" – 3/4" WASHED
   - DEPTH: 12"
7. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM SHALL BE WITH FILTER FABRIC.
8. GROWING MEDIUM:
   - 12" MINIMUM
9. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX H.
10. WATERPROOF LINER (IF REQUIRED): SHALL BE 30 MIL PVC OR EQUIVALENT.
11. INSTALL SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM. SEE DETAIL 007
12. CHECK DAMS: SHALL BE REQUIRED FOR OVER 4% SLOPE, SHALL BE SPACED AT A MAXIMUM 2-FOOT ELEVATION INTERVALS. MAINTAIN 4 – 10 INCH DEEP ROCK CHECK DAMS AT DESIGN INTERVALS. INTERMEDIATE FLOW SPREADERS SHALL BE INSTALLED AT A MINIMUM 50-FT INTERVALS.

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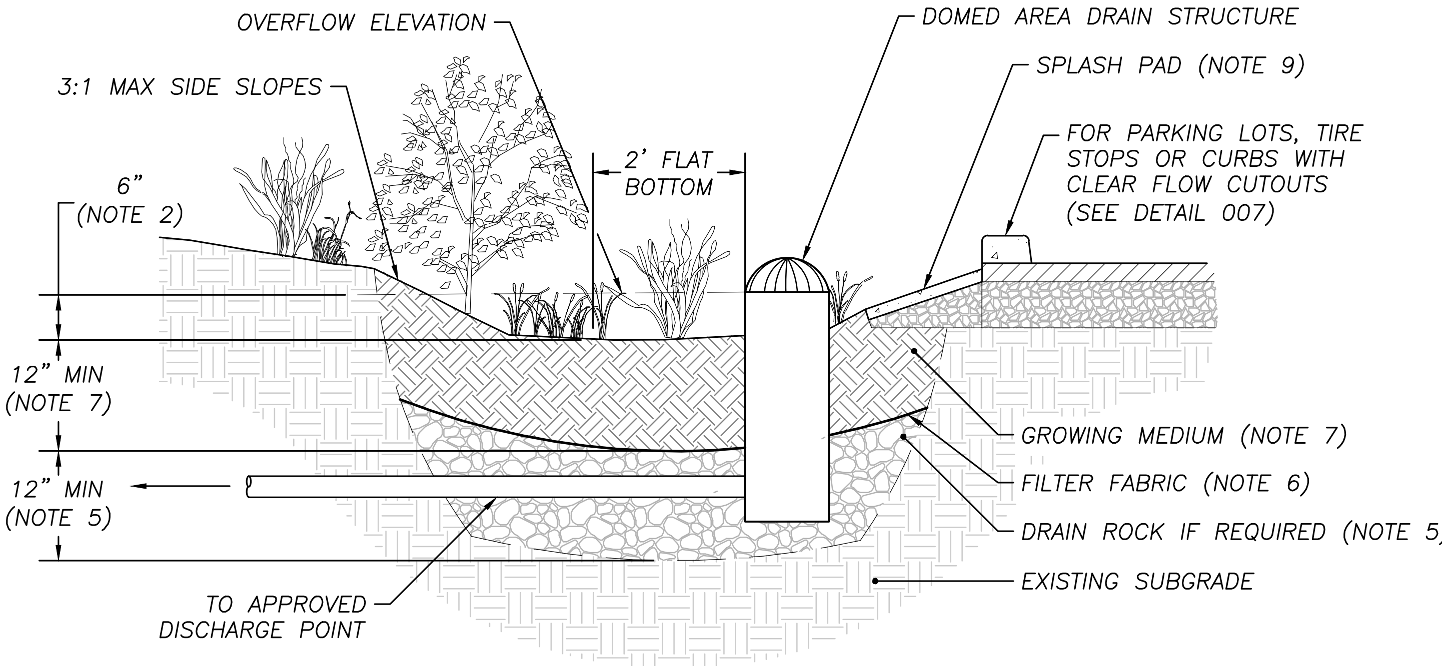

GENERAL NOTES

1. PROVIDE PROTECTION FROM ALL VEHICLE TRAFFIC, EQUIPMENT STAGING, AND FOOT TRAFFIC IN PROPOSED INFILTRATION AREAS PRIOR TO, DURING AND AFTER CONSTRUCTION.
2. DIMENSIONS:
   - DEPTH OF SWALE (FROM TOP OF GROWING MEDIUM TO OVERFLOW ELEVATION): 6"
   - LONGITUDINAL SLOPE OF SWALE: 0.5% TO 6.0%
   - FLAT BOTTOM WIDTH: 2'
   - SIDE SLOPES OF SWALE: 3:1 MAXIMUM
3. SETBACKS:
   - INFILTRATION VEGETATED SWALES MUST BE 10' FROM FOUNDATIONS AND 5' FROM PROPERTY LINES.
4. OVERFLOW:
   - SIZE OVERFLOW FOR THE 50-YEAR DESIGN STORM. IDENTIFY OVERFLOW ROUTE IN THE STORMWATER MANAGEMENT PLAN.
5. DRAIN ROCK (IF REQUIRED):
   - SIZE: 1 1/2" – 3/4"– WASHED
   - DEPTH: 12"
6. SEPARATION BETWEEN DRAIN ROCK AND GROWING MEDIUM SHALL BE WITH FILTER FABRIC.
7. GROWING MEDIUM:
   - 12" MINIMUM
8. VEGETATION: FOLLOW LANDSCAPE PLANS OR REFER TO PLANTING REQUIREMENTS IN APPENDIX H.
9. SPLASH PAD TO TRANSITION FROM INLETS TO GROWING MEDIUM. SEE DETAIL 007
10. CHECK DAMS: REQUIRED FOR OVER 4% SLOPE, SHALL BE SPACED AT A MAXIMUM 2-FOOT ELEVATION INTERVALS. MAINTAIN 4 – 10 INCH DEEP ROCK CHECK DAMS AT DESIGN INTERVALS. INTERMEDIATE FLOW SPREADERS SHALL BE INSTALLED AT A MINIMUM 50-FOOT INTERVALS.

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INFILTRATION BIOFILTRATION SWALE

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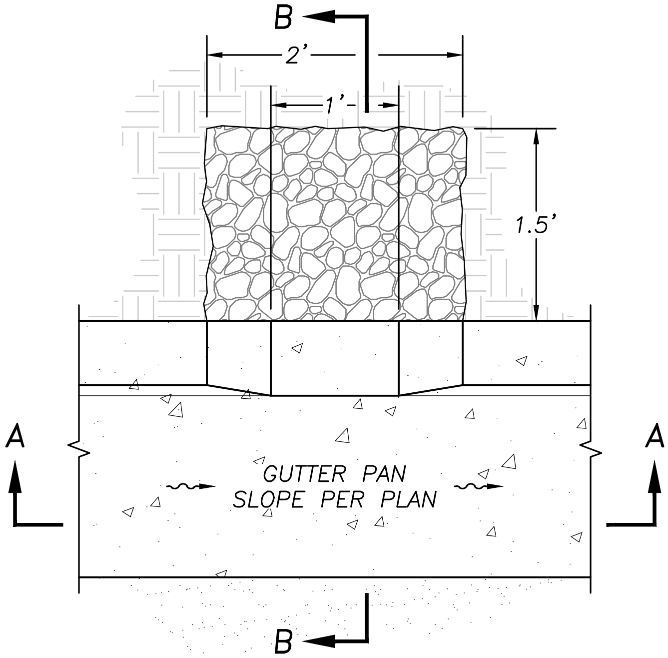
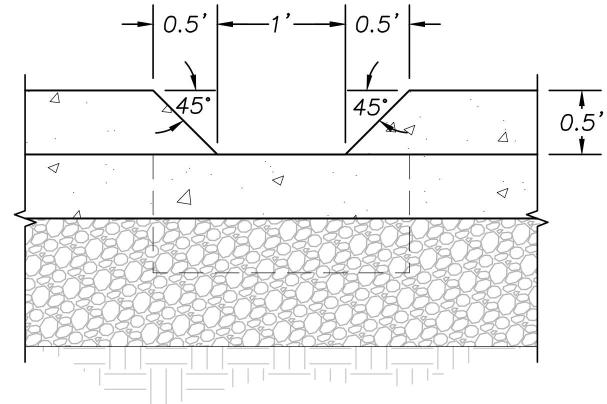
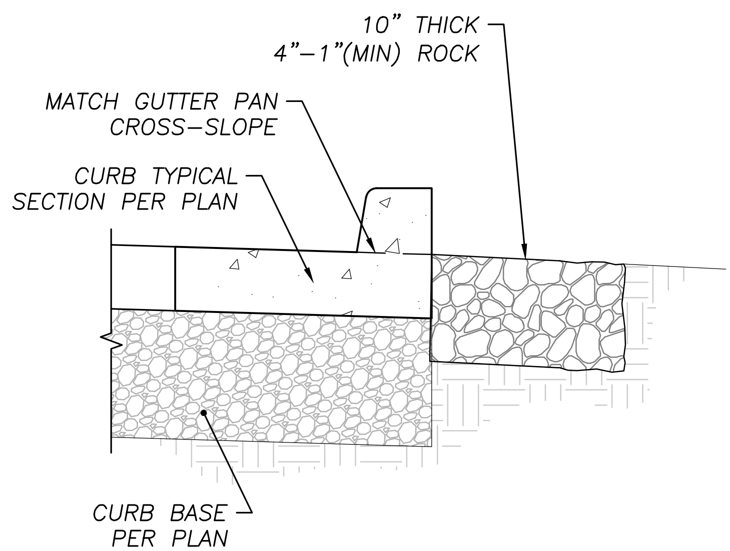


PLAN VIEW



SECTION A–A



SECTION B–B

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REVISIONS

DATE:	DESCRIPTION OF CHANGES:	BY:
	NONE	

MARION COUNTY DEPARTMENT OF PUBLIC WORKS

Marion County

CURB CUT OPENING

CREATION DATE:	REVISION DATE:	SCALE:	SHEET:
00/00/0000	00/00/0000	N.T.S	007

Appendix E: Maintenance Information

Appendix E
Maintenance Information

Table of Contents

Appendix E-1 Operations and Maintenance (O&M) Manual Outline

1. Project Description
   a. Project Location Address
   b. Project Description
   c. Size of Project Site
2. Description of Site and Stormwater Management Facilities
   a. Summary of overall site stormwater management
   b. Table identifying each stormwater facility, its size, the stormwater source to each facility, square footage of impervious surface treated, and discharge point
   c. Site map or figure showing specific location of each stormwater facility
   d. Identification of who will assume responsibility for ongoing operations and maintenance
   e. Design Specifications of Stormwater Facility(ies)
   f. Describe O&M Equipment and Accessibility
3. Schedule
   a. When and how often each facility will be inspected
   b. Specific intervals between particular operations and maintenance tasks
   c. Definition of what size storm require additional inspections
   d. Irrigation schedule (if applicable)
4. Procedures
   a. Specific procedures for each facility type
   b. Likely deficiencies and corresponding corrective actions
   c. Course of action for unexpected deficiencies
   d. If vegetation is part of a facility, describe the vegetation management procedures to be employed to ensure that adequate vegetation cover is preserved
5. Inspection and Maintenance Logs*
   a. Example and instructions for maintaining required logs

* *Required for facilities serving commercial facilities, but not required for facilities serving only one single family residence.*

Appendix E-2 Facility-specific Maintenance Activities

Biofiltration Swales

1. **Description**: Swales are planted or grassed open channels that trap pollutants by filtering and slowing flows, allowing particles to settle out. The swale should drain within 48 hours of a storm event.
2. **Schedule**: All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each 2-year storm event. Other than for facilities serving only one single family residence, the facility owner must keep a log, recording all inspection dates, observations, and maintenance activities.
3. **Procedures**:
   a. Required inspection and maintenance:
      - **Swale Inlet** (such as curb cuts or pipes) shall maintain a non-turbulent flow of water entering the swale.
        - Source of erosion shall be identified and controlled when native soil is exposed, or erosion channels are forming.
        - Sediment accumulation shall be hand-removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4" thick.
        - Inlet shall be cleared when capacity is reduced by 50%. Sources of sediment and debris shall be identified and corrected.
        - Rock splash pads shall be replenished with in kind material to prevent erosion.
      - **Side Slopes** shall be maintained to prevent erosion that introduces sediment into the swale.
        - Slopes shall be stabilized and planted using appropriate erosion control measures when any native soil is exposed or erosion channels are forming.
      - **Swale Media** shall allow stormwater to percolate uniformly through the landscape swale. If the swale does not drain within 48 hours, it shall be tilled and replanted according to design specifications.
        - Annual or semi-annual tilling shall be implemented if compaction or clogging continues. Mechanical tilling is preferred, but hand tilling is allowed.
        - Debris in quantities that inhibit operation shall be removed routinely (e.g., no less than twice a year), or upon discovery.
      - **Swale Outlet** shall maintain sheet flow of water exiting swale unless a collection drain is used. Source of erosion damage shall be identified and controlled when native soil is exposed or erosion channels are forming.
        - Outlets such as drains and overland flow paths shall be cleared when 25% of the conveyance capacity is plugged.
        - Sources of sediment and debris shall be identified and corrected.

- **Vegetation** shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion. Mulch shall be replenished as needed to ensure survival of vegetation. Establish and maintain 70 percent or greater vegetative cover.
  - Vegetation, large shrubs or trees that interfere with landscape swale operation shall be pruned or permanently removed.
  - Fallen leaves and debris from deciduous plant foliage shall be removed frequently (every two to four weeks in the Fall/Winter).
  - Grassy swales shall be mowed to keep grass 4” to 9” in height. Clippings shall be removed to remove pollutants absorbed in grasses.
  - Prohibited (e.g. Nuisance and invasive) vegetation shall be removed when discovered. Care should be taken to leave the mulch and remove vegetation. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed.
  - Dead vegetation and woody material shall be removed when swale function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed.
- **Check Dams** shall control and distribute flow.
  - Causes for altered water flow shall be identified, and obstructions cleared upon discovery.
  - Causes for channelization shall be identified and repaired.

b. Other Required Actions:

- **Debris and Litter** shall be removed to ensure stormwater conveyance and to prevent clogging of inlet drains and interference with plant growth.
- **Spill Prevention** measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- **Training and/or written guidance information** for operating and maintaining swales shall be provided to all property owners and tenants. A copy of the O&M Manual shall be provided to all property owners and tenants.
- **Access** to the swale shall be provide access to maintain, repair and/or replace the infrastructure. Egress and ingress routes shall be maintained to design standards. Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- **Insects & Rodents** shall not be harbored in the swale. Pest control measures shall be taken when insects/rodents are found to be present.

END OF MAINTENANCE ACTIVITIES FOR
BIOFILTRATION SWALES

Planter Boxes (Infiltration and Treatment Facilities)

1. **Description**: Planters are designed to allow runoff to filter through layers of topsoil (thus capturing pollutants) and then either infiltrate into the native soils (infiltration planter) or be collected in a pipe to be discharged off-site (flow-through planter). The flow-through planter is designed with an impervious bottom or is placed on an impervious surface.
2. **Schedule**: All facility components and vegetation shall be inspected for proper operations and structural stability. These inspections shall occur, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. Other than for a facility serving only one single family residence, the facility owner must keep a log, recording all inspection dates, observations, and maintenance activities.
3. **Procedures**:
   a. Required inspection and maintenance:
      - **Downspout** from rooftop or sheet flow from paving allows unimpeded stormwater flow to the planter.
        - Debris shall be removed routinely (e.g., no less than every 6 months) and upon discovery.
        - Damaged pipe shall be repaired upon discovery.
        - Ensure no barriers are at the downspouts (i.e. wheel stops).
      - **Splash Blocks** prevent splashing against adjacent structures and convey water without disrupting media.
        - Major deficiencies in structure such as cracking, rotting, and failure shall be repaired. Hairline fractures are appropriate.
      - **Planter Reservoir** receives and retains storm water prior to infiltration. Water should drain from reservoir within 3-4 hours of storm event.
        - Sources of clogging shall be identified and corrected.
        - If surface ponding occurs for extended periods, add organic compost and sand and re-till until infiltration performance is enhanced. If this proves ineffective, topsoil may need to be replaced altogether.
      - **Filter Media** consisting of engineered media (i.e. sand, gravel, and topsoil) shall allow stormwater to percolate uniformly through the planter.
        - The planter shall be excavated and cleaned, and gravel or soil shall be replaced to correct low infiltration rates (i.e. water doesn't drain in 3 to 4 hours).
        - Holes greater than 6-inches that are not consistent with the design and allow water to flow directly through the planter to the soil below the facility shall be plugged.
        - Sediment accumulation shall be hand removed with minimum damage to vegetation using proper erosion control measures. Sediment shall be removed if it is more than 4 inches thick or so thick as to damage or kill vegetation.
        - Litter and debris shall be removed routinely (e.g., no less than quarterly) and upon discovery.
        - Planter shall contain mulch, filter media and vegetation.
        - Structural deficiencies in the planter including rot, cracks, and failure shall be repaired.

- **Overflow Pipe** safely conveys flow exceeding reservoir capacity to an approved stormwater receiving system.
  - Overflow pipe shall be cleared of sediment and debris when 50% of the conveyance capacity is plugged.
  - Damaged pipe shall be repaired or replaced upon discovery.
- **Vegetation** shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.
  - Mulch shall be replenished at least annually.
  - Vegetation, large shrubs or trees that limit access or interfere with planter operation shall be pruned or removed.
  - Fallen leaves and debris from any tree or plant foliage shall be raked and removed. Care should be taken to leave the mulch as leaves and debris are removed.
  - Prohibited (e.g. Nuisance or invasive) vegetation shall be removed when discovered. Care should be taken to leave the mulch and remove vegetation. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed.
  - Dead vegetation shall be removed.
  - Vegetation shall be replaced to provide at least 90% coverage or when planter function is impaired. Vegetation shall be replaced within a specific timeframe, either 3 months, or immediately if required to maintain cover density and control erosion where soils are exposed (which ever comes first).

b. Other Required Actions:

- **Debris and Litter** shall be removed to ensure stormwater infiltration and to prevent clogging of overflow drains and interference with plant growth.
- **Spill Prevention** measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- **Training and/or written guidance information** for operating and maintaining stormwater planters shall be provided to all property owners and tenants. A copy of the O&M Manual shall be provided to all property owners and tenants.
- **Access** to the stormwater planter shall be safe and efficient. Egress and ingress routes shall be maintained to design standards in Section 7.3 of the Stormwater Standards Roadways shall be maintained to accommodate size and weight of vehicles, if applicable.
  - Obstacles preventing maintenance personnel and/or equipment access to the stormwater planter shall be removed.
  - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
- **Insects & Rodents** shall not be harbored in the stormwater planter. Pest control measures shall be taken when insects/rodents are found to be present.

END OF MAINTENANCE ACTIVITIES FOR PLANTERS

Rain Gardens (Infiltration and Treatment Facilities)

1. **Description**: A rain garden is a vegetated depression created by excavation, berms, or small dams to provide for short-term ponding of surface water until it percolates into the soil. The basin shall infiltrate stormwater within 24 hours.
2. **Schedule**: All facility components and vegetation shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. Other than for facilities serving only one single family residence, the facility owner must keep a log, recording all inspection dates, observations, and maintenance activities.
3. **Procedures:**
   a. Required inspection and maintenance:
      - **Basin Inlet** shall assure unrestricted stormwater flow to the vegetated basin.
        - Sources of erosion shall be identified and controlled when native soil is exposed or erosion channels are present.
        - Inlet shall be cleared when conveyance capacity is plugged.
        - Rock splash pads shall be replenished to prevent erosion.
      - **Embankment, Dikes, Berms & Side Slopes** retain water in the rain garden.
        - Structural deficiencies shall be corrected upon discovery.
        - Slopes shall be stabilized using appropriate erosion control measures when soil is exposed/ flow channels are forming.
        - Sources of erosion damage shall be identified and controlled.
      - **Overflow or Emergency Spillway** conveys flow exceeding reservoir capacity to an approved stormwater receiving system.
        - Overflow shall be cleared when 25% of the conveyance capacity is plugged.
        - Sources of erosion damage shall be identified and controlled when soil is exposed.
        - Rocks or other armament shall be replaced when only one layer of rock exists.
      - **Filter Media** shall allow stormwater to percolate uniformly through the rain garden.
        - If water remains 36 to 48 hours after storm, sources of possible clogging shall be identified and corrected.
        - Basin shall be raked and, if necessary, soil shall be excavated, and cleaned or replaced.
      - **Sediment and Debris Management** shall prevent loss of rain garden volume caused by sedimentation.
        - Sediment and debris exceeding 4” in depth shall be removed every 2-5 years or sooner if performance is affected.
      - **Vegetation** shall be healthy and dense enough to provide filtering while protecting underlying soils from erosion.
        - Mulch shall be replenished as needed to ensure healthy plant growth.
        - Vegetation, large shrubs or trees that limit access or interfere with basin operation shall be pruned or removed.

  - Grass shall be mowed to 4”-9” high and grass clippings shall be removed no less than 2 times per year.
  - Fallen leaves and debris from deciduous plant foliage shall be raked and removed.
  - Prohibited (e.g. Nuisance or invasive vegetation) shall be removed when discovered. Care should be taken to leave the mulch and remove vegetation. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed.
  - Dead vegetation shall be removed when rain garden function is impaired. Vegetation shall be replaced within 3 months, or immediately if required to control erosion.
  - Irrigation schedules should be adjusted during the growing season to provide the minimum water necessary to maintain plant health and to maintain the available pore space for infiltration.

b. Other Required Actions:
   - **Debris and Litter** shall be removed to ensure stormwater infiltration and to prevent clogging of overflow drains and interference with plant growth.
     - Restricted sources of sediment and debris, such as discarded lawn clippings, shall be identified and prevented.
   - **Spill Prevention** measures shall be exercised when handling substances that contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
   - **Training and/or written guidance information** for operating and maintaining rain gardens shall be provided to all property owners and tenants. A copy of the O&M Manual shall be provided to all property owners and tenants.
   - **Access** to the rain garden shall be safe and efficient. Egress and ingress routes shall be maintained to design standards in Section 7.3 of the Stormwater Standards.
     - Obstacles preventing maintenance personnel and/or equipment access to the rain garden shall be removed.
     - Gravel or ground cover shall be added if erosion occurs, e.g., due to vehicular or pedestrian traffic.
   - **Insects & Rodents** shall not be harbored in the rain garden. Pest control measures shall be taken when insects/rodents are found to be present.

END OF MAINTENANCE ACTIVITIES FOR RAIN GARDENS

Pervious Pavement

1. **Description**: Pervious pavement is a permeable pavement surface with an underlying stone reservoir that temporarily stores surface runoff before infiltrating into the subsoil or being collected in underlying drainpipes and being discharged off-site. Pervious pavement accepts only precipitation, not stormwater runoff directed to it from other sources.
2. **Schedule**: All facility components, vegetation, and source controls shall be inspected for proper operations and structural stability, at a minimum, quarterly for the first 2 years from the date of installation, 2 times per year thereafter, and within 48 hours after each major storm event. Other than for facilities serving only one, single-family residence, the facility owner must keep a log, recording all inspection dates, observations, and maintenance activities.
3. **Procedures**
   a. Required inspection and maintenance:
      - **Surface**: The surface shall be kept clean and free of leaves, debris, and sediment. The surface shall not be overlaid with an impermeable paving surface.
        - Regular sweeping shall be implemented for porous asphalt or concrete systems.
      - **Overflows** are used in the event that the facility's infiltration capacity is exceeded.
        - Overflow devices shall be inspected for obstructions or debris, which shall be removed upon discovery.
        - Overflow or emergency spillways shall be capable of transporting high flows of stormwater to an approved stormwater receiving system.
        - Sources of erosion damage shall be identified and controlled when native soil is exposed near the overflow structure.
      - **Vegetation** (where applicable)
        - Vegetation and large shrubs/trees that limit access or interfere with porous pavement operation shall be pruned.
        - Fallen leaves and debris from deciduous plant foliage shall be raked and removed.

   b. Other Required Actions:
      - **Source Control** measures prevent pollutants from mixing with stormwater. Typical non-structural control measures include raking and removing leaves, street sweeping, vacuum sweeping, limited and controlled application of pesticides and fertilizers, and other good house keeping practices.
      - **Spill Prevention** measures shall be exercised when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
      - **Training and/or written guidance information** for operating and maintaining pervious pavement shall be provided to all property owners and tenants. A copy of the O&M Manual shall be provided to all property owners and tenants.
      - **Access** to the pervious pavement shall be safe and efficient. Egress and ingress routes shall be maintained to design standards in Section 7.3 of the Stormwater Standards. Obstacles preventing maintenance personnel and/or equipment access to the porous pavement shall be removed.

- **Debris and Litter** shall be removed to prevent clogging.
- **Signage** may serve to educate people about the importance or function of the site's stormwater protection measures. It may also discourage behaviors that adversely affect stormwater protection measures. For example, if debris is a problem, a sign reminding people not to litter may partially solve the problem. Broken or defaced signs shall be replaced or repaired.

END OF MAINTENANCE ACTIVITIES FOR PERVIOUS PAVEMENT

Green Roofs

1. **Description**: Vegetated roofs are roof systems that retain and filter stormwater and provide aesthetic and energy conservation benefits.
2. **Schedule**: All elements shall be inspected once a month from April through September. Other than a green roof on the house, shed, or garage of a single-family residence, the facility owner must keep a log, recording all inspection dates, observations, and maintenance activities.
3. **Procedures**: All facility components, including soil substrate or growth medium, vegetation, drains, irrigation systems (if applicable), membranes, and roof structure shall be inspected for proper operations, integrity of the waterproofing, and structural stability throughout the life of the roof.
   a. Required inspection and maintenance:
      - **Soil Substrate/Growing Medium** shall be inspected for evidence of erosion from wind or water.
        - If erosion channels are evident, they shall be stabilized with additional soil substrate/growth medium and covered with additional plants.
      - **Structural Components** shall be operated and maintained in accordance with manufacturer's requirements. Drain Inlets shall be kept unrestricted.
        - Inlet pipe shall be cleared when soil substrate, vegetation, debris or other materials clog the drain inlet. Sources of sediment and debris shall be identified and corrected.
        - Determine if drain inlet pipe is in good condition and correct as needed.
      - **Debris and Litter** shall be removed to prevent clogging of inlet drains and interference with plant growth.
      - **Vegetation** shall be maintained to provide 90% plant cover.
        - During the Establishment Period, plants shall be replaced once per month as needed. During the long-term period, dead plants shall generally be replaced once per year in the fall months.
        - Fallen leaves and debris from deciduous plant foliage shall be removed.
        - Prohibited (e.g. Nuisance and invasive) vegetation shall be removed when discovered. Care should be taken to leave the mulch and remove vegetation. Invasive vegetation contributing up to 25% of vegetation of all species shall be removed.
        - Dead vegetation shall be removed and replaced with new plants.
        - Weeding shall be manual with no herbicides or pesticides used. Weeds shall be removed regularly and not allowed to accumulate.
        - Fertilization is not necessary and fertilizers shall not be applied.
        - During drought conditions, mulch or shade cloth may be applied to prevent excess solar damage and water loss.
        - Mowing of grasses shall occur as needed. Clippings shall be removed.

b. Other Required Actions:

- **Irrigation** can be accomplished either through hand watering or automatic sprinkler systems. If automatic sprinklers are used, manufacturers' instructions for operations and maintenance shall be followed.
  - During the Establishment Period (1-3 years), water sufficient to assure plant establishment and not to exceed ¼ inch of water once every 3 days shall be applied.
  - During the long-term period (3+ years), water sufficient to maintain plant cover and not to exceed ¼ inch of water once every 14 days shall be applied.
- **Spill Prevention** measures from mechanical systems located on roofs shall be exercised when handling substances that can contaminate stormwater. Releases of pollutants shall be corrected as soon as identified.
- **Training and/or written guidance information** for operating and maintaining green roofs shall be provided to all property owners and tenants. A copy of the O&M Manual shall be provided to all property owners and tenants.
- **Access and Safety** to the green roof shall be safe and efficient.
  - Egress and ingress routes shall be maintained to design standards in Section 7.3 of the Stormwater Standards. Walkways shall be clear of obstructions and maintained to design standards.
- **Insects** shall not be harbored on the green roof.
- **Standing water** creating an environment for development of insect larvae shall be eliminated by manual means. Chemical sprays shall not be used.

END OF MAINTENANCE ACTIVITIES FOR GREEN ROOFS

Appendix E-3. O&M Stormwater BMP - Inspection Form

Information from Inspection

Location: ______________________ Stormwater Management Facility #: ____________

Date: ______________

Reason for Inspection: ______________________

Maintenance Needed: ☐ Yes ☐ No If yes, date of inspection: ____________

Description of BMP: ______________________

Condition Identified:

- ☐ Standing Water
- ☐ Unmaintained Vegetation
- ☐ Clogged Outlet Structure or Orifice Control
- ☐ Trash
- ☐ Excessive Sediment (1/3 of total facility depth)
- ☐ Other: ____________

Description of Issue(s): ______________________

Outfall Inspection Linked to GIS: ☐ Yes ☐ No Issue Solved?: ☐ Yes ☐ No

Inspection Pictures (attached larger photos, if needed)

thumbnail image	thumbnail image	thumbnail image
thumbnail image	thumbnail image	thumbnail image

Comments/Follow-Up Items:

Inspector Signature: ______________________ Date: ____________

Appendix E-4. Declaration of Covenants for Stormwater Facility Maintenance

Name ("Owner") as the owner of real property and improvements located in Marion County, Oregon, (hereinafter the "Property") creates this Declaration of Covenants for Stormwater Facility Maintenance (hereinafter "Declaration") affecting the real property described as follows:

Property description as in the records of Marion County, Oregon;

The express purpose of this Declaration is to cause the Owner of the Property to have knowledge of, and be subject to performing the Operation and Maintenance (O&M) of the stormwater management facilities ("Facility") located on the listed Lots.

The County's Public Works (PW) Engineering Department has approved construction plans submitted by Owner for the Facility and issued On-Site Stormwater Discharge Permit #________________________________.

An *O&M Manual* for the Facility is attached hereto as "**Exhibit A**".

To protect future owners, owners of neighboring property, and County-owned property, PW Engineering has required that Owner execute this Declaration as a condition of PW's approval of construction plans and issuance of an On-Site Stormwater Discharge Permit, and/or as a condition for obtaining permanent Certificate of Occupancies for multiple structural building permits associated with redevelopment of the subject property.

NOW THEREFORE, Owner declares that it and its heirs, successors and assigns will manage, operate, and maintain the Facility as prescribed below.

1) The Owner or its designees shall keep a copy of the *O&M Manual*, this Covenant, and the as-constructed plans of the Facility available on the premises. These shall be made available to County staff upon request.
2) The Owner or its designees shall maintain, repair or replace part or all of the Facility as necessary to ensure it functions as originally designed or as modified per written agreement with the County. Stormwater Management Facilities (see Section 3) and its features unique to it from a functionality perspective, and easements associated with the Facility shall be maintained in accordance with the *O&M Manual*:
3) The Owner or its designees shall inspect the Facility in accordance with the approved *O&M Manual* to ensure it is functioning properly. At a minimum, Owner or its designees shall inspect the Facility annually. If the Facility is not functioning properly or any of the conditions requiring corrective actions listed in the *O&M Manual* exist, Owner or its designees shall take corrective action as dictated by MCC Chapter 1.25: Enforcement unless Owner or its designees make previous arrangements with the County.
4) The Owner or its designees shall keep records of system inspections and maintenance. Records shall note inspection dates, any conditions requiring maintenance actions, and maintenance conducted. Owner or its designees shall make records available to County staff upon request.
5) Modifications of physical features within the Facility that diminish the intended function of the Facility shall not be made by Owner or its designees without prior written authorization from the County. Furthermore, stormwater management facilities may not be converted to piped systems.
6) Stormwater swales, raingardens, planters, wetlands and ponds shall not be filled-in with soil or gravel, or otherwise obliterated.
7) County staff shall make a reasonable effort to notify the Owner or its designees prior to routine inspections. Unless otherwise agreed upon between County staff and the Owner or its designees, routine inspections shall be scheduled Monday through Friday during normal business hours.

After Recording Return To:

County Personnel Title - XXX
Land Dev. - Engr. & Permits
Marion County Public Works
5155 Silverton Road NE, Salem, OR, 97305

8) Upon inspection of the Facility, County staff will notify the Owner or its designees in writing of any noted conditions or practices that are not in compliance with the approved *O&M Manual* and will specify a time frame for corrective actions. If Owner or its designees do not take corrective action within the specified time, the County may take corrective action and charge the costs to the Owner.

9) Failure to correct a defective condition within the time frame specified by the County inspector or continued non-compliance with practices and procedures specified in the *O&M Manual* may result in a violation of Marion County Code Section 15.20.

10) The Facility as well as adjacent public right-of-way under County jurisdiction, easements, and/or private property upon which they reside are subject to all nuisance provisions of County regulations or Code, including control of noxious weeds, vegetation and removal of litter and debris, except as they relate to the approved vegetation within the water quality functioning portion of the Facility.

11) Grass clippings and other vegetative debris shall not be discarded in or adjacent to the stormwater management facilities or catch basins. Vegetation matter shall be removed from the Facility and disposed of in accordance with local and State requirements.

12) This Covenant shall remain in full force and effect unless canceled or modified with the written consent of the County and the Owner or its designees.

The above covenants shall run with the land, be enforceable by the County, and shall be binding upon the property owner/owners, their heirs, successors, and assigns.

IN WITNESS WHEREOF, the Owner sets its hand and seal on this _______day of _________________, 20______.

____
(Owner)

Name: ______________________________

Title: ______________________________

Affiliation: ______________________________

Mailing Address: ______________________________

____

____

STATE OF OREGON)
)
County of Marion)

On ___________________, 20_____ personally appeared the above-named ______________________________ who acknowledged the foregoing instrument to be their true act and deed.

____
Notary Public for Oregon

My Commission expires:

APPROVED:

____
Marion County Public Works LDEP

Refer to Permit #______________

Appendix F: Erosion Prevention and Sediment Control Supporting Documents

MARION COUNTY PUBLIC WORKS
5155 Silverton Rd NE
Salem OR 97305
(503) 588-5147 Fax (503) 588-7948
http://www.co.marion.or.us

Construction Erosion and Sediment Control Ordinance
ACKNOWLEDGEMENT FORM

PROPERTY OWNER: ____

SITE ADDRESS: ____

DATE: ______________________________

PERMIT NUMBER: _______________________

Although the above site is located within the Stormwater Management Area, this site is not considered "High Risk" for erosion; therefore, a drawn plan and Construction Erosion and Sediment Control permit is not required. Marion County Code Chapter 15.10 requires that the applicant and/or responsible parties for the above permit do not cause or allow erosion or sediment to enter the public storm drainage and surface water system. Details for the erosion prevention and sediment control measures are located in the Marion County Best Management Practices List for erosion control and sediment prevention, available at Marion County Public Works.

I agree to review the Marion County Best Management Practices List for erosion control and sediment prevention and use appropriate erosion control measures to prevent erosion and sedimentation from leaving the above referenced site. I understand that failure to prevent erosion and sediment from entering the public storm drainage and surface water system could result in fines.

SIGNATURE: ____
(Property Owner or the Owner's Authorized Agent)

Name (please print): ____

Company Name: ____

Mailing Address: ____

____

Phone Number: ________________________________

G:\Engineering\LDEng&Permits\Procedures and Section Info\Erosion Control\Acknowledgement FormBMPList_Jan2011.doc

EPSC BEST MANAGEMENT PRACTICES (BMPs) LIST

EROSION PREVENTION

- Buffer Zone
- Dust Control
- Ground Cover
- Hydraulic Applications
- Matting
- Plastic Sheeting
- Preservation of Natural Vegetation
- Seeding (Temp/Perm)
- Sodding

RUNOFF CONTROL

- Check Dams
- Diversion Dikes & Swales
- Grass-Lined Swale
- Outlet Protection
- Pipe Slope Drain
- Surface Roughening

SEDIMENT CONTROL

- Bio-Filter Bags
- Construction Entrance
- Dewatering
- Filter Berm
- Inlet Protection
- Oak Mats
- Pre-Fabricated Barriers
- Sand Bags
- Sediment Basin
- Sediment Fence
- Sediment Trap
- Sidewalk Subgrade Gravel Barrier
- Tire Wash
- Straw Wattles

For more information, please refer to *Clean Water Services* "Erosion Prevention and Sediment Control Planning and Design Manual" for BMP details, which is available for viewing online at: https://www.cleanwaterservices.org/media/1464/erosion-prevention-and-sediment-control-manual.pdf

Note: *Clean Water Services* (*CWS*) is a Washington County, Oregon - based water resources management public utility. *CWS* is regionally recognized as a knowledgable authority in erosion control BMPs.

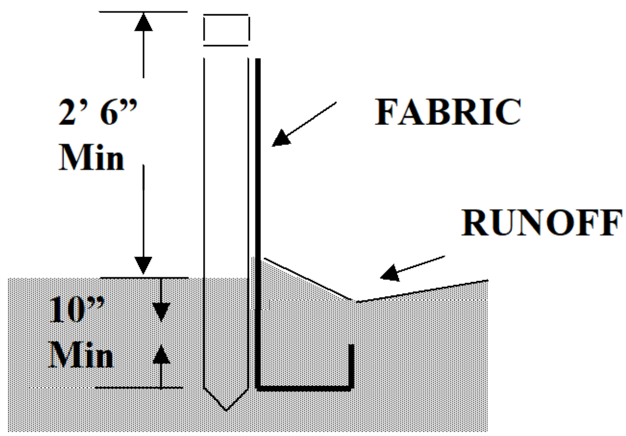
EROSION CONTROL AT YOUR CONSTRUCTION SITE

Erosion can occur when rainwater flows over a construction site. Rainwater picks up sediment, debris, and chemicals and flows into storm drains that lead into local streams.

Preventing erosion is important not only to protect wildlife and our water sources, but also to keep construction costs at a minimum. It takes time and money to replace soil and vegetation, clean clogged storm drains, and fix damage to property and natural resources.

Easy Ways to Prevent Erosion

- Minimize clearing and exposed soil
- Protect streams, wetlands, and other sensitive areas by fencing or clearly marking these areas

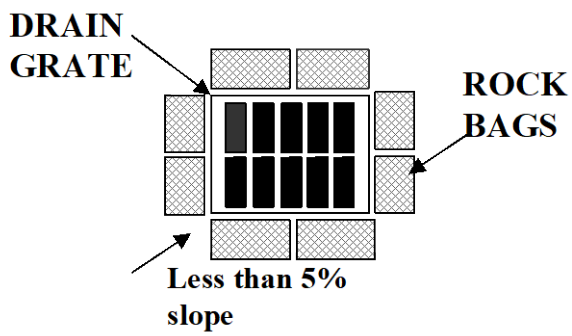


Cover Exposed Soil –

Barren soil is problematic. Cover exposed areas by reseeding and placement of mulch as soon as earth work is complete

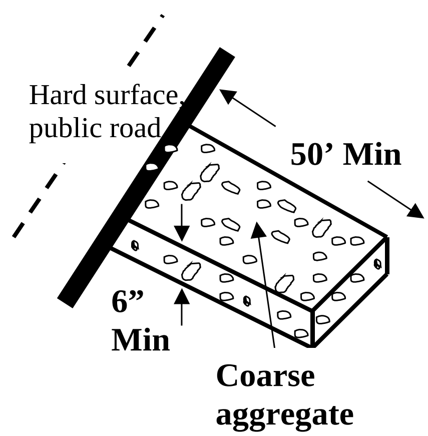
Protect Storm Drain Inlets –

- Use rock bags and inlet filter fabric
- Maintain them regularly



Build a Gravel Construction Access –

- Use the access to remove mud and dirt from tires of vehicles before they enter paved roadways
- Make sure site entrances do not become buried in soil



Department of Public Works
Environmental Services

Last Revised: 8/22/19
G:\Engineering\LDEng&Permits\Procedures and Section Info\Erosion Control\2019 EPSC App Packet\EPSC_BMPs.doc

MARION COUNTY PUBLIC WORKS
EROSION & SEDIMENTATION CONTROL (ESC)
PLAN CHECK LIST

PLAN COVER SHEET

Before Public Works Land Development Engineering & Permits (PW-LDEP) will accept an ESCP Plan for review, the following list of ESC Plan elements must be checked-off as provided for on the Plan, and then signed/dated by the Applicant or their Authorized Agent.

- ☐ Vicinity Map
- ☐ Site Map, including north arrow in correct orientation
- ☐ Project Location (Address if available), including latitude and longitude
- ☐ Property Description
- ☐ Narrative Site Descriptions including Existing Site Conditions, Developed Conditions, Nature of Construction Site Activity, Phases (i.e. clearing, rough grading, foundation, final grading, landscaping), and estimated schedule
- ☐ Define the estimated area of the permitted site and the estimated area to be disturbed, including square footage/acres
- ☐ Site Soil Characterization – Including soil classifications and soil erosive potential
- ☐ Contours on the existing conditions plan shall extend a minimum of 20' beyond all site boundaries
- ☐ Receiving water body, as applicable (named if available), wetlands, named 100-year floodplain
- ☐ Plans within urban areas shall be drawn at a scale of one-inch equals 20 or 30 feet, and for rural sites, at a scale of one-inch equals 40 or 50 feet
- ☐ Provide stationing for linear projects within the public Right-of-Way. Stationing shall run from left to right of plan and profile and typically commence at the south or west end of project and end at the north or east end of project.
- ☐ Inspection frequencies
- ☐ Standard ESC Plan notes, with permit references when applicable
- ☐ BMP Matrix for construction phases
- ☐ Names and contact information for Applicant's agents such as Architect, Engineer, Prime Contractor, and Excavator
- ☐ Name and contact information for Applicant's designated erosion control inspector
- ☐ Initialed (wet ink) Rationale Statement

MARION COUNTY PUBLIC WORKS
ESC PLAN CHECK LIST

PRE-DEVELOPMENT SHEET FOR CLEARING, DEMOLITION, AND MASS GRADING

- ☐ Existing (pre-construction) conditions site plan
- ☐ Elevations based on USGS vertical datum
- ☐ Total property boundary including surface area of development
- ☐ Perimeter of area to be disturbed
- ☐ Existing contours extending a minimum of 20' beyond all site boundaries
- ☐ Locations of receiving water body, as applicable (named if available), springs, wetlands, 100-year floodplain boundary
- ☐ Drainage flow arrows depicting estimated overland and channelized pre-development flow directions
- ☐ Locations of natural existing discharge points for overland and channelized flow to receiving stream or buffers
- ☐ Location of temporary staging area
- ☐ Locations of existing structures and indications of those to be removed
- ☐ Location for temporary stockpile areas for soil and demo debris
- ☐ Locations of septic tanks, drywells, and potable / irrigation wells
- ☐ Identify areas where vegetation is to be protected and remain undisturbed (i.e. specimen trees). Delineate this boundary with erosion and sedimentation control base measures and orange construction fencing.
- ☐ Clearly define (show and label) Sensitive Areas and Vegetated Corridors
- ☐ Location of all ESC measures including but not limited to: gravel construction entrance, perimeter control BMPs, existing inlet protection, temporary diversion channels, settling ponds, etc.
- ☐ Legend of ESC BMP elements. Element distribution can be assigned symbolically or alpha/numerically.
- ☐ Site and phase specific ESC construction notes

MARION COUNTY PUBLIC WORKS
ESC PLAN CHECK LIST

POST-DEVELOPMENT SHEET FOR UTILITY, STREET CONSTRUCTION, COMPLETION OF GRADING, AND FINAL STABILIZATION

- ☐ Developed (post-construction) conditions site plans
- ☐ Show onsite development boundary and any offsite work associated with the development. Include ESC for offsite areas.
- ☐ Finished Floor Elevation (FFE) based on USGS vertical datum
- ☐ Clearly identify areas or cuts and fills as well as show finished contours tying into existing contours
- ☐ Drainage flow arrows depicting locations of natural and altered discharge points for overland and channelized flow. Show appropriate interior sediment control BMP's downslope of all disturbed areas above streets, parking areas, and water quality facilities.
- ☐ Open / closed storm drain system and detention facilities, as applicable. Including all inlets and outlets.
- ☐ Designated areas for solid waste, hazardous waste, concrete washout, fuel storage areas, and method of control, as applicable
- ☐ Designated areas for soil stockpiles and method of control, as applicable
- ☐ Landscaping plan, including areas to be stabilized by seeding and/or sodding with watering requirements
- ☐ If seeding is specified as a BMP, specify dates in which seed is to be applied to ensure that vegetation becomes established prior to wet weather period.
- ☐ Identify areas where vegetation is to remain undisturbed. Delineate this boundary with ESC base measures and orange construction fencing.
- ☐ Relative locations of proposed features to receiving water body, as applicable (named if available), wetlands, 100-year floodplain boundary and how they will be protected from erosion
- ☐ Locations of water features (listed above) plus septic tanks, drain fields, drywells, detention ponds, potable / irrigation wells
- ☐ Show location of post development discharge points to receiving streams or buffers
- ☐ Clearly define (show and label) Sensitive Areas and Vegetated Corridors
- ☐ Include phase specific notes for dust control

- ☐ Indicate additional BMP's to be used when project boundary is within 50 feet of water of the state including but not limited to compost berms, compost blankets, compost socks, two parallel rows of sediment fence.
- ☐ Location of all ESC measures including but not limited to: inlet protection, temporary diversion channels, settling ponds, etc.
- ☐ Legend of ESC Plan BMP elements. Element distribution can be assigned symbolically or alpha/numerically.
- ☐ Site and phase specific ESC construction notes and site and phase specific ESC BMP implementation rules

MARION COUNTY PUBLIC WORKS
ESC PLAN CHECK LIST

DETAILS SHEET

- ☐ Details for all proposed BMPs and installation techniques
- ☐ General ESC Plan notes. Refer to Clean Water Services ESC planning and design manual for guidance on design criteria.
- ☐ Notes pertaining to Non-Structural BMPs, if applicable, with descriptions and method of use

Prior to submittal, check that all the following are included:

- ☐ Appropriate BMPs have been used
- ☐ One set of approvable plans
- ☐ Copy of this checklist

ESC Plan Designed by: ______________________________ Date : ______________

Checklist Completed/Verified by: _____________________ Date : ______________

Submit to:
Land Development Engineering & Permits
Marion County Public Works
5155 Silverton Road NE
Salem, OR 97305

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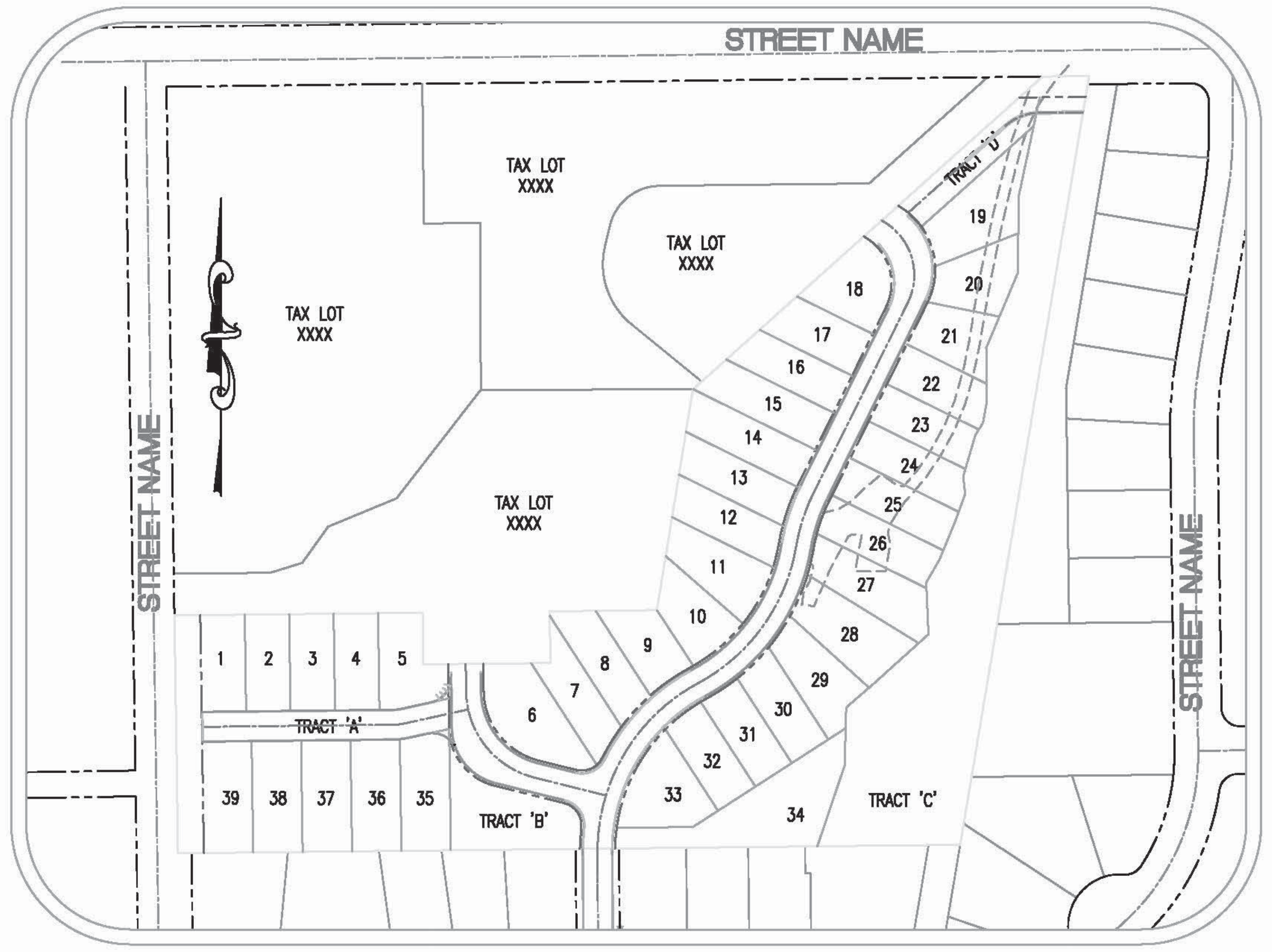
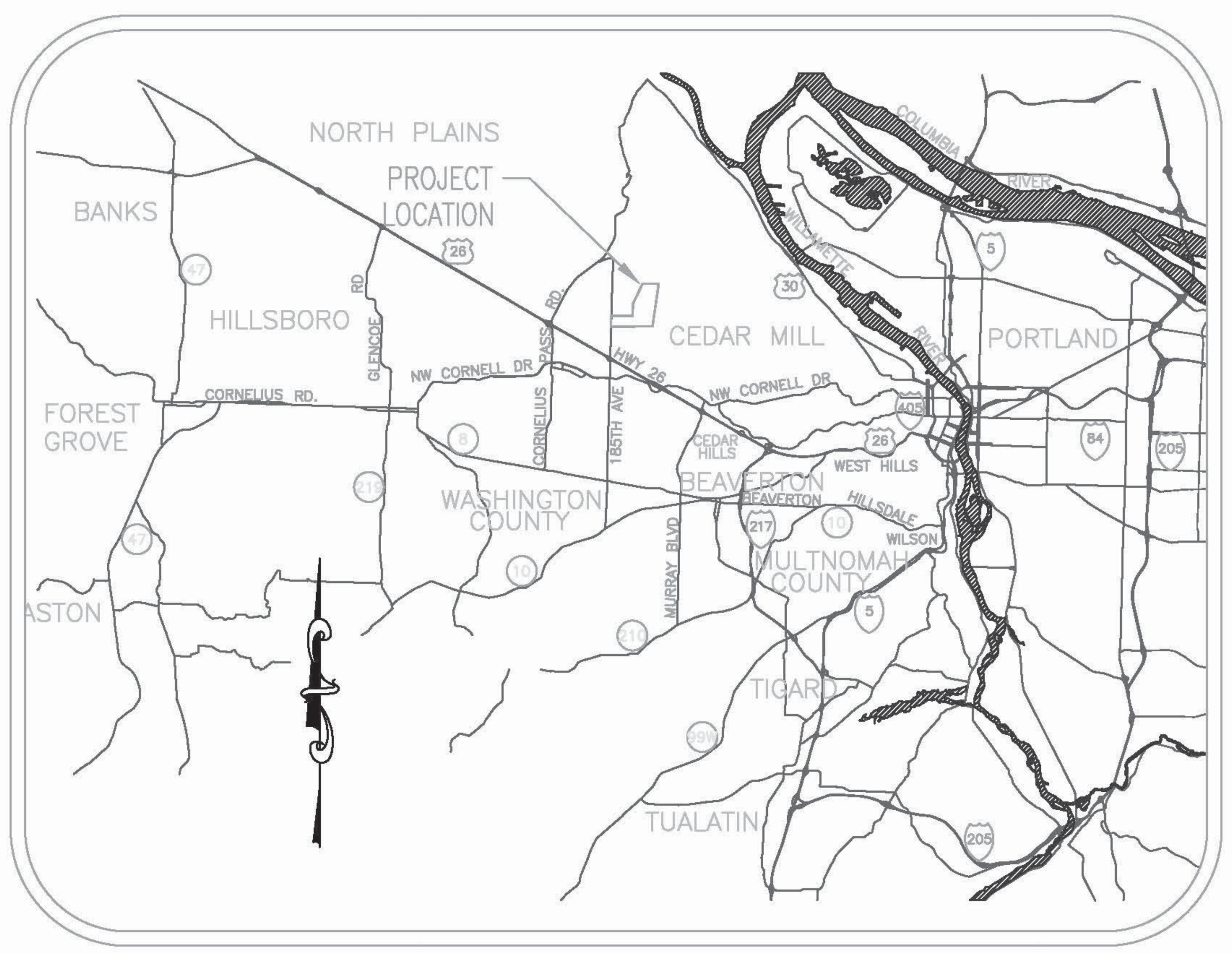
ESC PLAN FOR SITES 1 TO 5 ACRES



SITE MAP
NOT TO SCALE



VICINITY MAP
NOT TO SCALE

PROJECT LOCATION:

NEAR THE ______________________
______________________, WASHINGTON
COUNTY, OREGON
LATITUDE = XX.XXXX, LONGITUDE = XXX.XXXX

PROPERTY DESCRIPTION:

TAX LOTS ______________ (WASHINGTON COUNTY TAX MAP XX-X-XXXX) LOCATED IN THE NORTHEAST 1/4 OF SECTION 30, TOWNSHIP 1 SOUTH, RANGE 1 WEST, WILLAMETTE MERIDIAN, WASHINGTON COUNTY, OREGON

ATTENTION EXCAVATORS:

OREGON LAW REQUIRES YOU TO FOLLOW RULES ADOPTED BY THE OREGON UTILITY NOTIFICATION CENTER. THOSE RULES ARE SET FORTH IN OAR 952-001-0010 THROUGH OAR 952-001-0090. YOU MAY OBTAIN COPIES OF THESE RULES FROM THE CENTER BY CALLING 503-232-1987. IF YOU HAVE ANY QUESTIONS ABOUT THE RULES, YOU MAY CONTACT THE CENTER. YOU MUST NOTIFY THE CENTER AT LEAST TWO BUSINESS DAYS, BEFORE COMMENCING AN EXCAVATION. CALL 503-246-6699.

DEVELOPER

DEVELOPER/COMPANY:__________________
CONTACT: __________________
ADDRESS 1
ADDRESS 2
PHONE: 503-___-____
FAX: 503-___-____

PLANNING / ENGINEERING / SURVEYING FIRM

ENGINEERING & SURVEY FIRM
CONTACT: _____________
ADDRESS 1
ADDRESS 2
PHONE: 503-___-____
FAX: 503-___-____

NARRATIVE DESCRIPTIONS

EXISTING SITE CONDITIONS

* 3 HOMES, 3 OUT BUILDINGS, FORESTED AREAS, PASTURE AREAS, AND DRIVEWAYS

DEVELOPED CONDITIONS

* 39 LOT RESIDENTIAL SUBDIVISION WITH PUBLIC STREETS AND UTILITIES

NATURE OF CONSTRUCTION ACTIVITY AND ESTIMATED TIME TABLE

* CLEARING (DATES, FROM & TO:______________________)
* MASS GRADING (DATES, FROM & TO:______________________)
* UTILITY INSTALLATION (DATES, FROM & TO:______________________)
* STREET CONSTRUCTION (DATES, FROM & TO:______________________)
* FINAL STABILIZATION (DATES, FROM & TO:______________________)

TOTAL SITE AREA = 217,800 SF = 5.00 ACRES

TOTAL DISTURBED AREA = 174,240 SF = 4.00 ACRES

SITE SOIL CLASSIFICATION:

11B – CORNELIUS AND KINTON SILT LOAMS, 2 TO 7 PERCENT SLOPES
11D – CORNELIUS AND KINTON SILT LOAMS, 12 TO 20 PERCENT SLOPES
11E – CORNELIUS AND KINTON SILT LOAMS, 20 TO 30 PERCENT SLOPES
11F – CORNELIUS AND KINTON SILT LOAMS, 30 TO 60 PERCENT SLOPES
16C – DELENA SILT LOAM, 3 TO 12 PERCENT SLOPES

ON-SITE SOILS HAVE A MODERATE TO HIGH EROSION POTENTIAL. ALL FILL MATERIAL SHALL BE GENERATED ON-SITE FROM GRADING EXCAVATION AND UTILITY TRENCH SPOILS.

RECEIVING WATER BODIES:

NEAREST WATER BODY: JOHNSON CREEK

INSPECTION FREQUENCY:

SITE CONDITION	MINIMUM FREQUENCY
1. ACTIVE PERIOD	WEEKLY WHEN STORMWATER RUNOFF, INCLUDING RUNOFF FROM SNOW MELT, IS OCCURRING. AT LEAST ONCE EVERY MONTH, REGARDLESS OF WHETHER STORMWATER RUNOFF IS OCCURRING.
2. PRIOR TO THE SITE BECOMING INACTIVE OR IN ANTICIPATION OF SITE INACCESSIBILITY.	ONCE TO ENSURE THAT EROSION AND SEDIMENT CONTROL MEASURES ARE IN WORKING ORDER. ANY NECESSARY MAINTENANCE AND REPAIR MUST BE MADE PRIOR TO LEAVING THE SITE.
3. INACTIVE PERIODS GREATER THAN FOURTEEN (14) CONSECUTIVE CALENDAR DAYS.	ONCE EVERY MONTH.
4. PERIODS DURING WHICH THE SITE IS INACCESSIBLE DUE TO INCLEMENT WEATHER.	IF PRACTICAL, INSPECTIONS MUST OCCUR DAILY AT A RELEVANT AND ACCESSIBLE DISCHARGE POINT OR DOWNSTREAM LOCATION.
5. PERIODS DURING WHICH DISCHARGE IS UNLIKELY DUE TO FROZEN CONDITIONS.	MONTHLY. RESUME MONITORING IMMEDIATELY UPON MELT, OR WHEN WEATHER CONDITIONS MAKE DISCHARGES LIKELY.

* HOLD A PRE-CONSTRUCTION MEETING OF PROJECT CONSTRUCTION PERSONNEL THAT INCLUDES THE INSPECTOR TO DISCUSS EROSION AND SEDIMENT CONTROL MEASURES AND CONSTRUCTION LIMITS.
* ALL INSPECTIONS MUST BE MADE IN ACCORDANCE WITH DEQ 1200-CN PERMIT REQUIREMENTS.
* INSPECTION LOGS MUST BE KEPT IN ACCORDANCE WITH DEQ'S 1200-CN PERMIT REQUIREMENTS.
* RETAIN A COPY OF THE ESCP AND ALL REVISIONS ON SITE AND MAKE IT AVAILABLE ON REQUEST TO DEQ, AGENT, OR THE LOCAL MUNICIPALITY. DURING INACTIVE PERIODS OF GREATER THAN SEVEN (7) CONSECUTIVE CALENDAR DAYS, RETAIN THE ESCP AT THE CONSTRUCTION SITE OR AT ANOTHER LOCATION.

STANDARD EROSION AND SEDIMENT CONTROL PLAN DRAWING NOTES:

1. All permit registrants must implement the ESCP. Failure to implement any of the control measures or practices described in the ESCP is a violation of the permit.
2. The ESCP measures shown on this plan are minimum requirements for anticipated site conditions. During the construction period, upgrade these measures as needed to comply with all applicable local, state, and federal erosion and sediment control regulations.
3. Submission of all ESCP revisions is not required. Submittal of the ESCP revisions is only under specific conditions. Submit all necessary revision to DEQ or Agent.
4. Phase clearing and grading to the maximum extent practical to prevent exposed inactive areas from becoming a source of erosion.
5. Identify, mark, and protect (by fencing off or other means) critical riparian areas and vegetation including important trees and associated rooting zones, and vegetation areas to be preserved. Identify vegetative buffer zones between the site and sensitive areas (e.g., wetlands), and other areas to be preserved, especially in perimeter areas.
6. Preserve existing vegetation when practical and re-vegetate open areas. Re-vegetate open areas when practicable before and after grading or construction. Identify the type of vegetative seed mix used.
7. Erosion and sediment control measures including perimeter sediment control must be in place before vegetation is disturbed and must remain in place and be maintained, repaired, and promptly implemented following procedures established for the duration of construction, including protection for active storm drain inlets and catch basins and appropriate non-stormwater pollution controls.
8. Establish concrete truck and other concrete equipment washout areas before beginning concrete work. Direct all wash water into a pit or leak-proof container. Handle wash water as waste, concrete discharge to waters of the state is prohibited.
9. Apply temporary and/or permanent soil stabilization measures immediately on all disturbed areas as grading progresses and for all roadways including gravel roadways.
10. Establish material and waste storage areas, and other non-stormwater controls.
11. Prevent tracking of sediment onto public or private roads using BMPs such as: graveled (or paved) exits and parking areas, gravel all unpaved roads located onsite, or use an exit tire wash. These BMPs must be in place prior to land-disturbing activities.
12. When trucking saturated soils from the site, either use water-tight trucks or drain loads on site.
13. Use BMPs to prevent or minimize stormwater exposure to pollutants from spills; vehicle and equipment fueling, maintenance, and storage; other cleaning and maintenance activities; and waste handling activities. These pollutants include fuel, hydraulic fluid, and other oils from vehicles and machinery, as well as debris, leftover paints, solvents, and glues from construction operations.
14. Implement the following BMPs when applicable: written spill prevention and response procedures, employee training on spill prevention and proper disposal procedures, spill kits in all vehicles, regular maintenance schedule for vehicles and machinery, material delivery and storage controls, training and signage, and covered storage areas for waste and supplies.
15. Use water, soil-binding agent or other dust control technique as needed to avoid wind-blown soil.
16. The application rate of fertilizers used to reestablish vegetation must follow manufacturer's recommendations to minimize nutrient releases to surface waters. Exercise caution when using time-release fertilizers within any waterway riparian zone.
17. If a stormwater treatment system (for example, electro-coagulation, flocculation, filtration, etc.) for sediment or other pollutant removal is employed, submit an operation and maintenance plan (including system schematic, location of system, location of inlet, location of discharge, discharge dispersion device design, and a sampling plan and frequency) before operating the treatment system. Obtain plan approval before operating the treatment system. Operate and maintain the treatment system according to manufacturer's specifications.
18. At the end of each workday soil stockpiles must be stabilized or covered, or other BMPs must be implemented to prevent discharges to surface waters or conveyance systems leading to surface waters.
19. Construction activities must avoid or minimize excavation and creation of bare ground during wet weather October 01 – May 31.
20. Sediment fence: remove trapped sediment before it reaches one third of the above ground fence height and before fence removal.
21. Other sediment barriers (such as biobags): remove sediment before it reaches two inches depth above ground height. and before BMP removal.
22. Catch basins: clean before retention capacity has been reduced by fifty percent. Sediment basins and sediment traps: remove trapped sediments before design capacity has been reduced by fifty percent and at completion of project.
23. Within 24 hours, significant sediment that has left the construction site, must be remediated. Investigate the cause of the sediment release and implement steps to prevent a recurrence of the discharge within the same 24 hours. Any in-stream clean up of sediment shall be performed according to the Oregon Division of State Lands required timeframe.
24. The intentional washing of sediment into storm sewers or drainage ways must not occur. Vacuuming or dry sweeping and material pickup must be used to cleanup released sediments.
25. Provide permanent erosion control measures on all exposed areas. Do not remove temporary sediment control practices until permanent vegetation or other cover of exposed areas is established. However, do remove all temporary erosion control measures as exposed areas become stabilized, unless doing so conflicts with local requirements. Properly dispose of construction materials and waste, including sediment retained by temporary BMPs.
26. If vegetative seed mixes are specified, seeding must take place no later that September 1; the type and percentages of seed in the mix must be identified on the plans.
27. All pumping of sediment laden water shall be discharged over an undisturbed, preferably vegetated area, and through a sediment control BMP i.e. (filter bag).
28. All exposed soils must be covered during the wet weather period, October 01 – May 31.
29. If water of the state is within the project site or within 50 feet of the project boundary, maintain the existing natural buffer within the 50-foot zone for the duration of the permit coverage, or maintain less than the entire existing natural buffer and provide additional erosion and sediment control BMPs.

THE PERMITTEE IS REQUIRED TO MEET ALL THE CONDITIONS OF THE 1200-CN PERMIT. THIS ESCP AND GENERAL CONDITIONS HAVE BEEN DEVELOPED TO FACILITATE COMPLIANCE WITH THE 1200-CN PERMIT REQUIREMENTS. IN CASES OF DISCREPANCIES OR OMISSIONS, THE 1200-CN PERMIT REQUIREMENTS SUPERCEDE REQUIREMENTS OF THIS PLAN.

BMP MATRIX FOR CONSTRUCTION PHASES

REFER TO DEQ GUIDANCE MANUAL FOR A COMPREHENSIVE LIST OF AVAILABLE BMP'S.

	CLEARING	MASS GRADING	UTILITY INSTALLATION	STREET CONSTRUCTION	FINAL STABILIZATION	WET WEATHER (OCT. 1 - MAY 31ST)
EROSION PREVENTION						
PRESERVE NATURAL VEGETATION	**X	X	X	X	X	X
GROUND COVER					X	X
HYDRAULIC APPLICATIONS					X	
PLASTIC SHEETING						X
MATTING					X	X
DUST CONTROL	X	X	X	X	X	X
TEMPORARY/ PERMANENT SEEDING		X	X	X	X	X
BUFFER ZONE	**X	X	X	X	X	X
OTHER:						
SEDIMENT CONTROL						
SEDIMENT FENCE (PERIMETER)	**X	X	X	X	X	X
SEDIMENT FENCE (INTERIOR)			X	X	X	X
STRAW WATTLES			X	X	X	X
FILTER BERM	X	X	X	X		
INLET PROTECTION	**X	X	X	X	X	X
DEWATERING			X	X		
SEDIMENT TRAP	X	X	X	X		
NATURAL BUFFER ENCROACHMENT	*X	*X	*X	*X	*X	*X
OTHER:						
RUN OFF CONTROL				X	X	
CONSTRUCTION ENTRANCE	**X	X	X	X	X	
PIPE SLOPE DRAIN	X	X	X			
OUTLET PROTECTION	X	X	X	X	X	
SURFACE ROUGHENING					X	
CHECK DAMS	**X	X	X	X	X	
OTHER:						
POLLUTION PREVENTION						
PROPER SIGNAGE	X	X	X	X	X	X
HAZ WASTE MGMT	X	X	X	X	X	X
SPILL KIT ON-SITE	X	X	X	X	X	X
CONCRETE WASHOUT AREA	X	X	X	X	X	X
OTHER:						

* SIGNIFIES ADDITIONAL BMP'S REQUIRED FOR WORK WITHIN 50' OF WATER OF THE STATE.
** SIGNIFIES BMP THAT WILL BE INSTALLED PRIOR TO ANY GROUND DISTURBING ACTIVITY.

RATIONALE STATEMENT

A COMPREHENSIVE LIST OF AVAILABLE BEST MANAGEMENT PRACTICES (BMP) OPTIONS BASED ON DEQ's GUIDANCE MANUAL HAS BEEN REVIEWED TO COMPLETE THIS EROSION AND SEDIMENT CONTROL PLAN. SOME OF THE ABOVE LISTED BMP's WERE NOT CHOSEN BECAUSE THEY WERE DETERMINED TO NOT EFFECTIVELY MANAGE EROSION PREVENTION AND SEDIMENT CONTROL FOR THIS PROJECT BASED ON SPECIFIC SITE CONDITIONS, INCLUDING SOIL CONDITIONS TOPOGRAPHIC CONSTRAINTS, ACCESSIBILITY TO THE SITE, AND OTHER RELATED CONDITIONS, AS THE PROJECT PROGRESSES AND THERE IS A NEED TO REVISE THE ESC PLAN, AN ACTION PLAN WILL BE SUBMITTED.

____
INITIAL

PERMITTEE'S SITE INSPECTOR: JOE INSPECTOR

COMPANY/AGENCY: ______________
PHONE: ______________
FAX: ______________
E-MAIL: ______________
DESCRIPTION OF EXPERIENCE: 10 YEARS OF EXPERIENCE IN THE CONSTRUCTION INDUSTRY, OF WHICH 5 YEARS WERE SPENT INSTALLING AND MAINTAINING EROSION CONTROL MEASURES. ATTENDED AN 8 HOUR TRAINING COURSE ON THE PRINCIPLES AND PRACTICES OF EROSION CONTROL AT THE UNIVERSITY OF WASHINGTON. ATTENDED IECA CONFERENCE IN 2008 AND 2013.

SHEET INDEX

EROSION AND SEDIMENT CONTROL PLANS

DATE:

REVISIONS:
1. 1/23/07 Revised Inspection Frequency, and Notes
2. 12/01/10 Updated for 1200-C issued after 01Dec10
3. 06/02/11 Note revisions
4. 12/15/15 Updated for 1200-CN issued after 15Dec15

EROSION AND SEDIMENT CONTROL COVER SHEET

ENGINEERING FIRM

DESIGNED BY: XXX
DRAWN BY: XXX
CHECKED BY: XXX
DRAWING NO.: XXXX
SCALE: XXXX

PREPARED FOR: CLEAN WATER SERVICES
2550 SW HILLSBORO HIGHWAY
HILLSBORO, OR 97123
PHONE: 503-681-3600
FAX: 503-681-3603

PROJECT NAME

WASHINGTON COUNTY OREGON
TAX LOTS ________ WASHINGTON COUNTY TAX MAP ________

PRELIMINARY DESIGN
OREGON
EXPIRES: Month Day Year

JOB NUMBER XXXX
SHEET XXXX

LEGEND

EXISTING GROUND CONTOUR (2 FT)	
EXISTING GROUND CONTOUR (10 FT)	100
EXISTING TREE TO REMAIN	
EXISTING TREE TO BE REMOVED	
SEDIMENT BARRIER (PERIMETER)	X
SEDIMENT BARRIER (INTERIOR)	XX
ORANGE CONSTRUCTION FENCE	
SEDIMENT TRAP	
BRUSH BARRIER	
CHECK DAM	
CONSTRUCTION ENTRANCE	
DIVERSION DIKE	
DIVERSION SWALE	
DIVERSION DIKE/SWALE	
INLET PROTECTION	
SEDIMENT MAT	
TEMPORARY SLOPE DRAIN	
ROCK FILTER BERM	
TEMPORARY SLOPE STABILIZATION MEASURES	
DRAINAGE FLOW DIRECTION	

PRE-CONSTRUCTION, CLEARING, AND DEMOLITION NOTES:

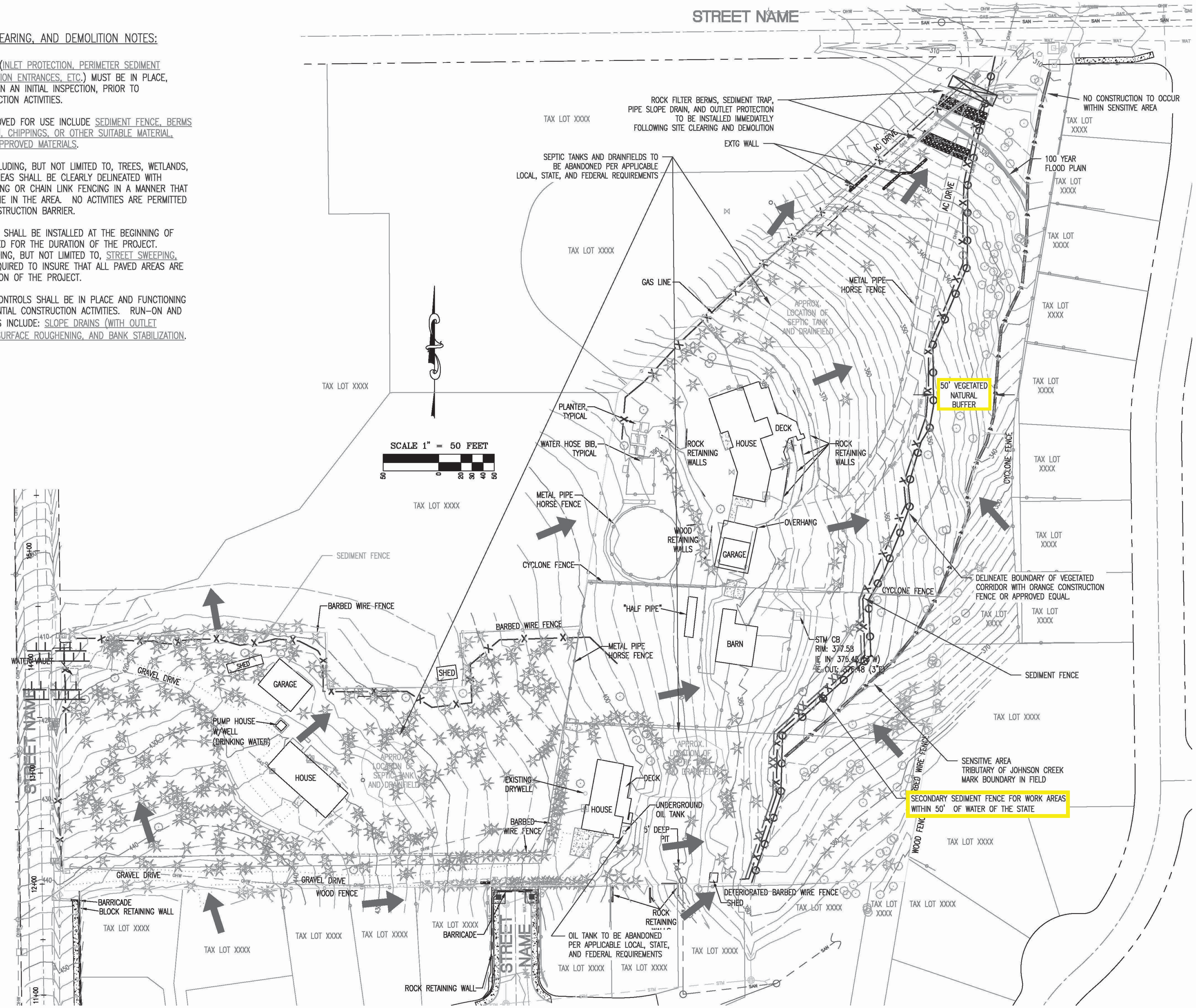
1. ALL BASE ESC MEASURES (INLET PROTECTION, PERIMETER SEDIMENT CONTROL, GRAVEL CONSTRUCTION ENTRANCES, ETC.) MUST BE IN PLACE, FUNCTIONAL, AND APPROVED IN AN INITIAL INSPECTION, PRIOR TO COMMENCEMENT OF CONSTRUCTION ACTIVITIES.

2. SEDIMENT BARRIERS APPROVED FOR USE INCLUDE SEDIMENT FENCE, BERMS CONSTRUCTED OUT OF MULCH, CHIPPINGS, OR OTHER SUITABLE MATERIAL, STRAW WATTLES, OR OTHER APPROVED MATERIALS.

3. SENSITIVE RESOURCES INCLUDING, BUT NOT LIMITED TO, TREES, WETLANDS, AND RIPARIAN PROTECTION AREAS SHALL BE CLEARLY DELINEATED WITH ORANGE CONSTRUCTION FENCING OR CHAIN LINK FENCING IN A MANNER THAT IS CLEARLY VISIBLE TO ANYONE IN THE AREA. NO ACTIVITIES ARE PERMITTED TO OCCUR BEYOND THE CONSTRUCTION BARRIER.

4. CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES INCLUDING, BUT NOT LIMITED TO, STREET SWEEPING, AND VACUUMING, MAY BE REQUIRED TO INSURE THAT ALL PAVED AREAS ARE KEPT CLEAN FOR THE DURATION OF THE PROJECT.

5. RUN-ON AND RUN-OFF CONTROLS SHALL BE IN PLACE AND FUNCTIONING PRIOR TO BEGINNING SUBSTANTIAL CONSTRUCTION ACTIVITIES. RUN-ON AND RUN-OFF CONTROL MEASURES INCLUDE: SLOPE DRAINS (WITH OUTLET PROTECTION), CHECK DAMS, SURFACE ROUGHENING, AND BANK STABILIZATION.



THESE EROSION AND SEDIMENT CONTROL PLANS ASSUME "DRY WEATHER" CONSTRUCTION. "WET WEATHER" CONSTRUCTION MEASURES NEED TO BE APPLIED BETWEEN OCTOBER 1ST AND MAY 31ST.

* NOTE: PRE-DEVELOPED RUN-OFF SHEET FLOWS EASTERLY INTO ON-SITE DRAINAGE AND NORTHERLY ONTO ADJACENT PROPERTIES.

REVISIONS:

CLEARING, DEMOLITION, MASS GRADING, EROSION AND SEDIMENT CONTROL PLAN

ENGINEERING FIRM

DESIGNED BY: | DRAWING NO.:
DRAWN BY: | SCALE:
CHECKED BY:

PREPARED FOR:

PROJECT NAME

WASHINGTON COUNTY OREGON

TAX LOTS ______ WASHINGTON COUNTY TAX MAP ______

DATE:

THIS IS A PLACE HOLDER ENGINEER XXXXXX PRELIMINARY DESIGN OREGON REMOVE FOR STAMPING

EXPIRES: Month Day Year

JOB NUMBER XXXX

SHEET XXXX

LEGEND

- FINISHED GRADE CONTOUR (2 FT) — 102
- FINISHED GRADE CONTOUR (10 FT) — 100
- SEDIMENT BARRIER (PERIMETER) — X
- SEDIMENT BARRIER (INTERIOR) — XX
- ORANGE CONSTRUCTION FENCE
- BRUSH BARRIER
- CHECK DAM
- CONSTRUCTION ENTRANCE
- DIVERSION DIKE
- DIVERSION SWALE
- DIVERSION DIKE/SWALE
- INLET PROTECTION
- SEDIMENT MAT
- TEMPORARY SLOPE DRAIN
- COMPOST BLANKET
- SEEDING & MULCHING
- CONCRETE WASH AREA
- OUTLET PROTECTION
- ROCK FILTER BERM
- TEMPORARY SLOPE STABILIZATION MEASURES
- LONG TERM SLOPE STABILIZATION MEASURES
- NEW IMPERVIOUS SURFACE
- DRAINAGE FLOW DIRECTION

THESE EROSION AND SEDIMENT CONTROL PLANS ASSUME "DRY WEATHER" CONSTRUCTION. "WET WEATHER" CONSTRUCTION MEASURES NEED TO BE APPLIED BETWEEN OCTOBER 1ST AND MAY 31ST.

GRADING, STREET AND UTILITY EROSION AND SEDIMENT CONSTRUCTION NOTES:

1. SEED USED FOR TEMPORARY OR PERMANENT SEEDING SHALL BE COMPOSED OF ONE OF THE FOLLOWING MIXTURES, UNLESS OTHERWISE AUTHORIZED:
   A. VEGETATED CORRIDOR AREAS REQUIRE NATIVE SEED MIXES. SEE RESTORATION PLAN FOR APPROPRIATE SEED MIX.
   B. DWARF GRASS MIX (MIN. 100 LB./AC.)
      1. DWARF PERENNIAL RYEGRASS (80% BY WEIGHT)
      2. CREEPING RED FESCUE (20% BY WEIGHT)
   C. STANDARD HEIGHT GRASS MIX (MIN. 100LB./AC.)
      1. ANNUAL RYEGRASS (40% BY WEIGHT)
      2. TURF-TYPE FESCUE (60% BY WEIGHT)

2. SLOPE TO RECEIVE TEMPORARY OR PERMANENT SEEDING SHALL HAVE THE SURFACE ROUGHENED BY MEANS OF TRACK-WALKING OR THE USE OF OTHER APPROVED IMPLEMENTS. SURFACE ROUGHENING IMPROVES SEED BEDDING AND REDUCES RUN-OFF VELOCITY.

3. LONG TERM SLOPE STABILIZATION MEASURES SHALL INCLUDE THE ESTABLISHMENT OF PERMANENT VEGETATIVE COVER VIA SEEDING WITH APPROVED MIX AND APPLICATION RATE.

4. TEMPORARY SLOPE STABILIZATION MEASURES SHALL INCLUDE: COVERING EXPOSED SOIL WITH PLASTIC SHEETING, STRAW MULCHING, WOOD CHIPS, OR OTHER APPROVED MEASURES.

5. STOCKPILED SOIL OR STRIPPINGS SHALL BE PLACED IN A STABLE LOCATION AND CONFIGURATION. DURING "WET WEATHER" PERIODS, STOCKPILES SHALL BE COVERED WITH PLASTIC SHEETING OR STRAW MULCH. SEDIMENT FENCE IS REQUIRED AROUND THE PERIMETER OF THE STOCKPILE.

6. EXPOSED CUT OR FILL AREAS SHALL BE STABILIZED THROUGH THE USE OF TEMPORARY SEEDING AND MULCHING, EROSION CONTROL BLANKETS OR MATS, MID-SLOPE SEDIMENT FENCES OR WATTLES, OR OTHER APPROPRIATE MEASURES. SLOPES EXCEEDING 25% MAY REQUIRE ADDITIONAL EROSION CONTROL MEASURES.

7. AREAS SUBJECT TO WIND EROSION SHALL USE APPROPRIATE DUST CONTROL MEASURES INCLUDING THE APPLICATION OF A FINE SPRAY OF WATER, PLASTIC SHEETING, STRAW MULCHING, OR OTHER APPROVED MEASURES.

8. CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES INCLUDING, BUT NOT LIMITED TO, TIRE WASHES, STREET SWEEPING, AND VACUUMING MAY BE BE REQUIRED TO INSURE THAT ALL PAVED AREAS ARE KEPT CLEAN FOR THE DURATION OF THE PROJECT.

9. ACTIVE INLETS TO STORM WATER SYSTEMS SHALL BE PROTECTED THROUGH THE USE OF APPROVED INLET PROTECTION MEASURES. ALL INLET PROTECTION MEASURES ARE TO BE REGULARLY INSPECTED AND MAINTAINED AS NEEDED.

10. SATURATED MATERIALS THAT ARE HAULED OFF-SITE MUST BE TRANSPORTED IN WATER-TIGHT TRUCKS TO ELIMINATE SPILLAGE OF SEDIMENT AND SEDIMENT-LADEN WATER.

11. AN AREA SHALL BE PROVIDED FOR THE WASHING OUT OF CONCRETE TRUCKS IN A LOCATION THAT DOES NOT PROVIDE RUN-OFF THAT CAN ENTER THE STORM WATER SYSTEM. IF THE CONCRETE WASH-OUT AREA CAN NOT BE CONSTRUCTED GREATER THAN 50' FROM ANY DISCHARGE POINT, SECONDARY MEASURES SUCH AS BERMS OR TEMPORARY SETTLING PITS MAY BE REQUIRED. THE WASH-OUT SHALL BE LOCATED WITHIN SIX FEET OF TRUCK ACCESS AND BE CLEANED WHEN IT REACHES 50% OF THE CAPACITY.

12. SWEEPINGS FROM EXPOSED AGGREGATE CONCRETE SHALL NOT BE TRANSFERRED TO THE STORM WATER SYSTEM. SWEEPINGS SHALL BE PICKED UP AND DISPOSED IN THE TRASH.

13. AVOID PAVING IN WET WEATHER WHEN PAVING CHEMICALS CAN RUN-OFF INTO THE STORM WATER SYSTEM.

14. USE BMPs SUCH AS CHECK-DAMS, BERMS, AND INLET PROTECTION TO PREVENT RUN-OFF FROM REACHING DISCHARGE POINTS.

15. COVER CATCH BASINS, MANHOLES, AND OTHER DISCHARGE POINTS WHEN APPLYING SEAL COAT, TACK COAT, ETC. TO PREVENT INTRODUCING THESE MATERIALS TO THE STORM WATER SYSTEM.

EROSION AND SEDIMENT CONTROL BMP IMPLEMENTATION:

1. ALL BASE ESC MEASURES (INLET PROTECTION, PERIMETER SEDIMENT CONTROL, GRAVEL CONSTRUCTION ENTRANCES, ETC.) MUST BE IN PLACE, FUNCTIONAL, AND APPROVED IN AN INITIAL INSPECTION, PRIOR TO COMMENCEMENT OF CONSTRUCTION ACTIVITIES.

2. "STOCK PILE AREA 1" SHALL BE MOVED TO "STOCK PILE AREA 2" FOLLOWING THE EXCAVATION CUT ACTIVITIES.

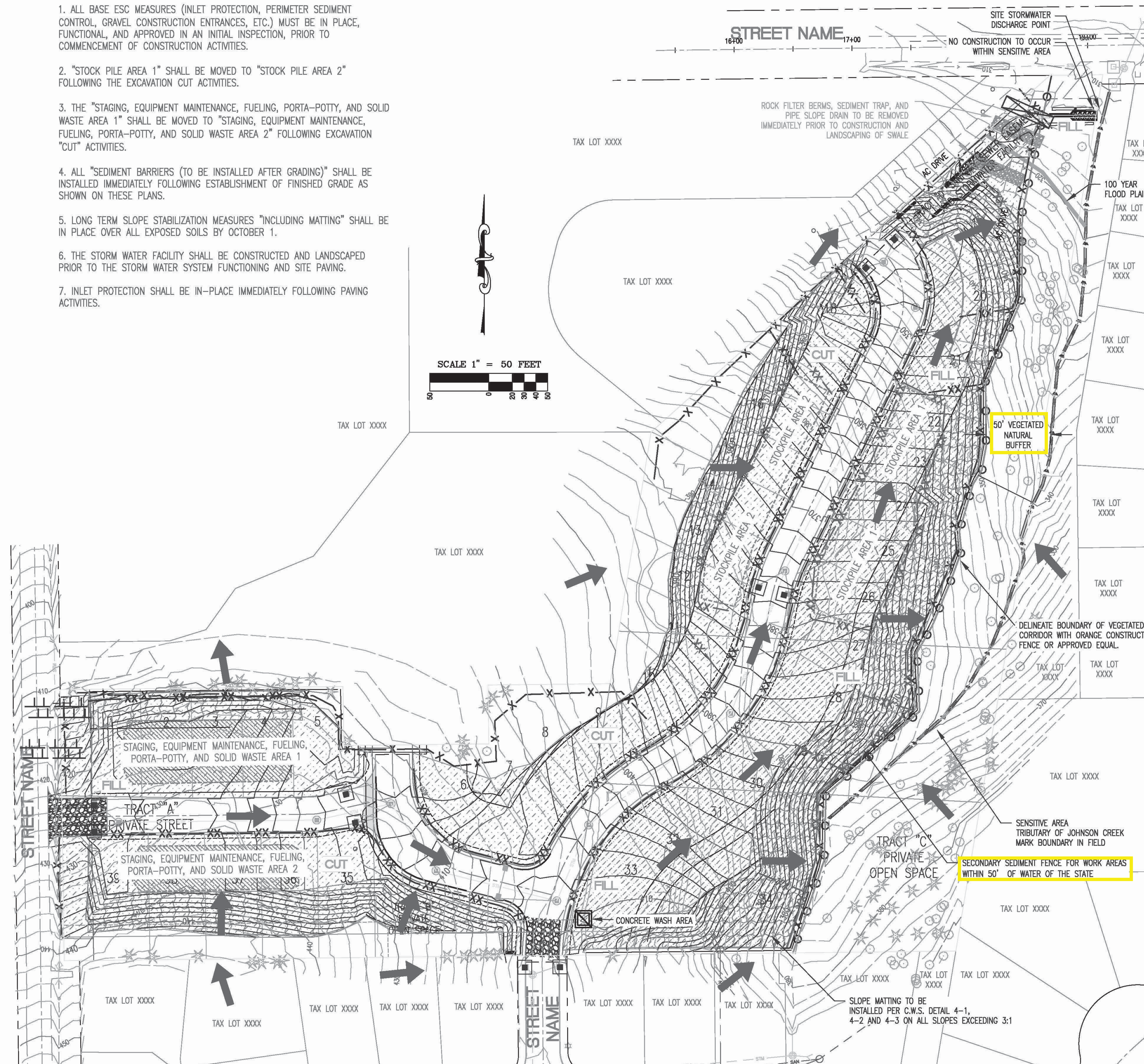
3. THE "STAGING, EQUIPMENT MAINTENANCE, FUELING, PORTA-POTTY, AND SOLID WASTE AREA 1" SHALL BE MOVED TO "STAGING, EQUIPMENT MAINTENANCE, FUELING, PORTA-POTTY, AND SOLID WASTE AREA 2" FOLLOWING EXCAVATION "CUT" ACTIVITIES.

4. ALL "SEDIMENT BARRIERS (TO BE INSTALLED AFTER GRADING)" SHALL BE INSTALLED IMMEDIATELY FOLLOWING ESTABLISHMENT OF FINISHED GRADE AS SHOWN ON THESE PLANS.

5. LONG TERM SLOPE STABILIZATION MEASURES "INCLUDING MATTING" SHALL BE IN PLACE OVER ALL EXPOSED SOILS BY OCTOBER 1.

6. THE STORM WATER FACILITY SHALL BE CONSTRUCTED AND LANDSCAPED PRIOR TO THE STORM WATER SYSTEM FUNCTIONING AND SITE PAVING.

7. INLET PROTECTION SHALL BE IN-PLACE IMMEDIATELY FOLLOWING PAVING ACTIVITIES.



REVISIONS:

UTILITY + STREET CONST.
GRADING + STABILIZATION
EROSION/SED CONTROL PLAN

ENGINEERING FIRM

DESIGNED BY:
DRAWN BY:
CHECKED BY:
DRAWING NO.:
SCALE: AS NOTED

PREPARED FOR:

PROJECT NAME

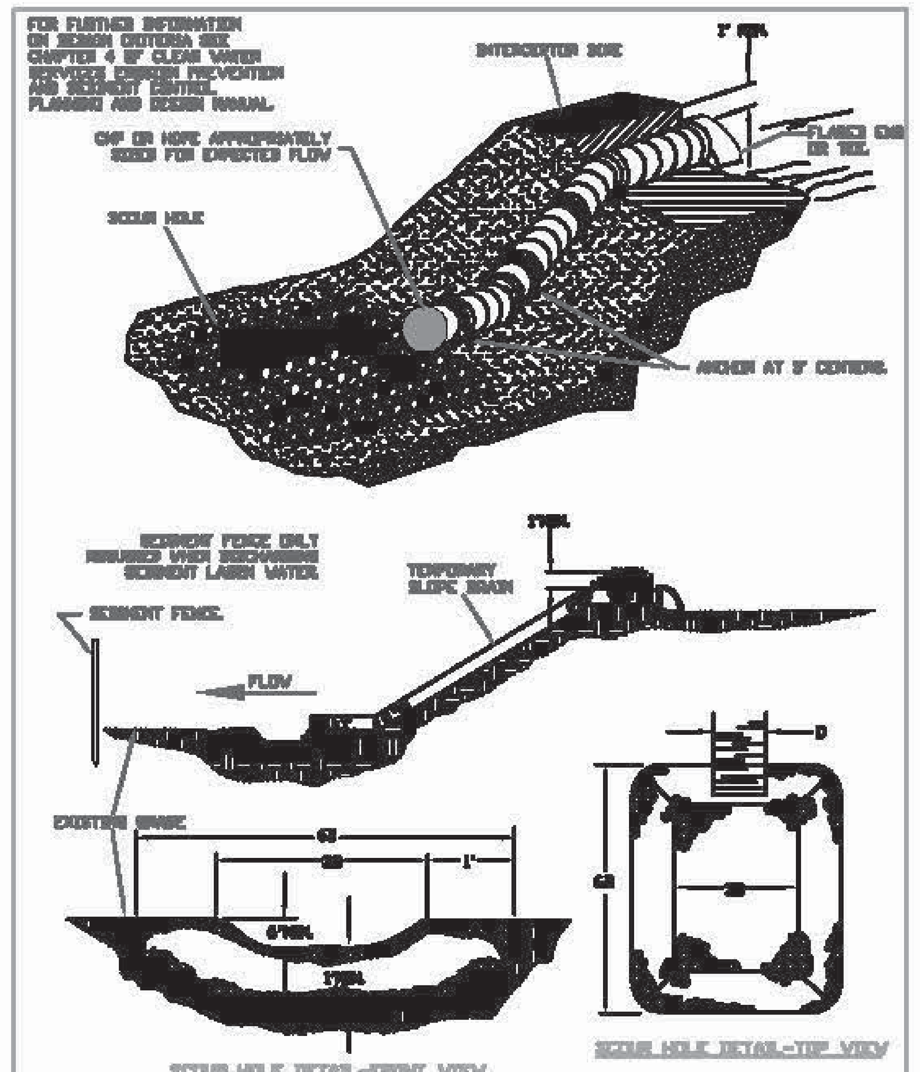
WASHINGTON COUNTY OREGON
TAX LOTS
WASHINGTON COUNTY TAX MAP

DATE:

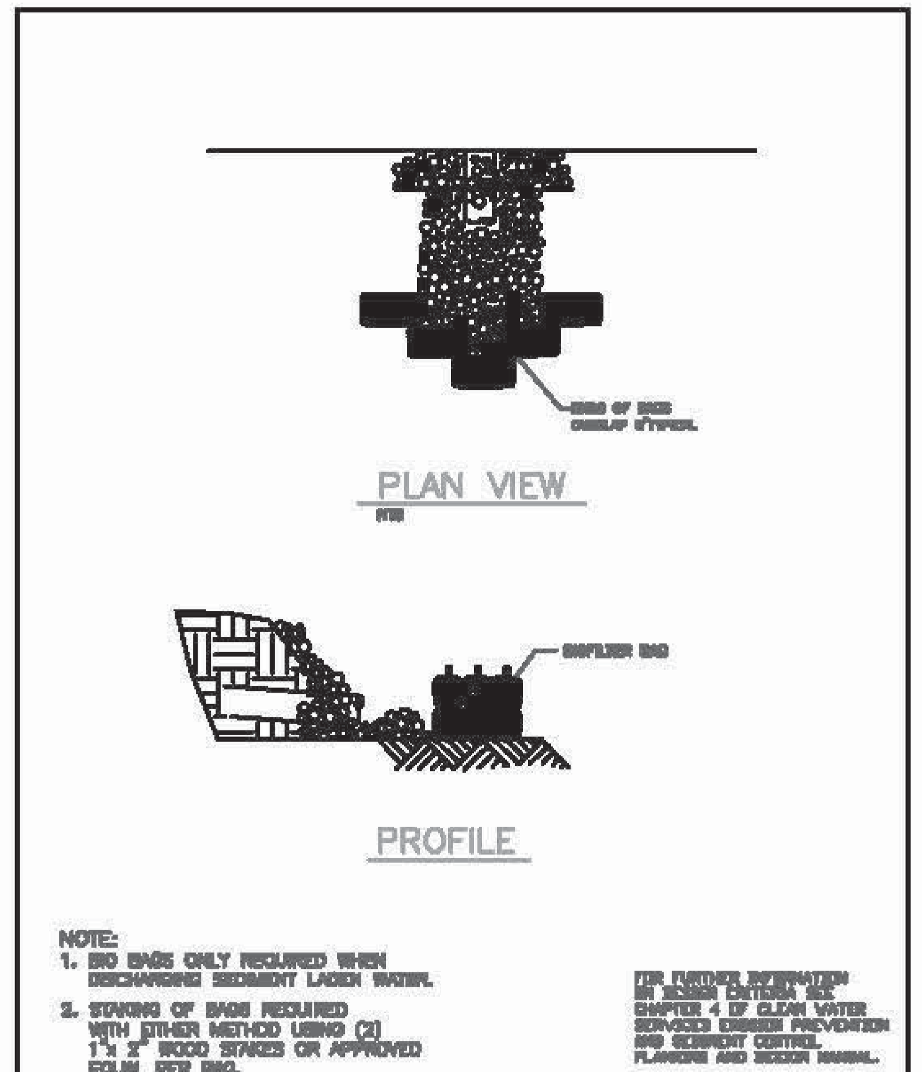
THIS IS A PLACE HOLDER
ENGINEER
XXXXXXX
PRELIMINARY DESIGN
OREGON
REMOVE FOR STAMPING
EXPIRES: Month Day Year

JOB NUMBER
XXXX

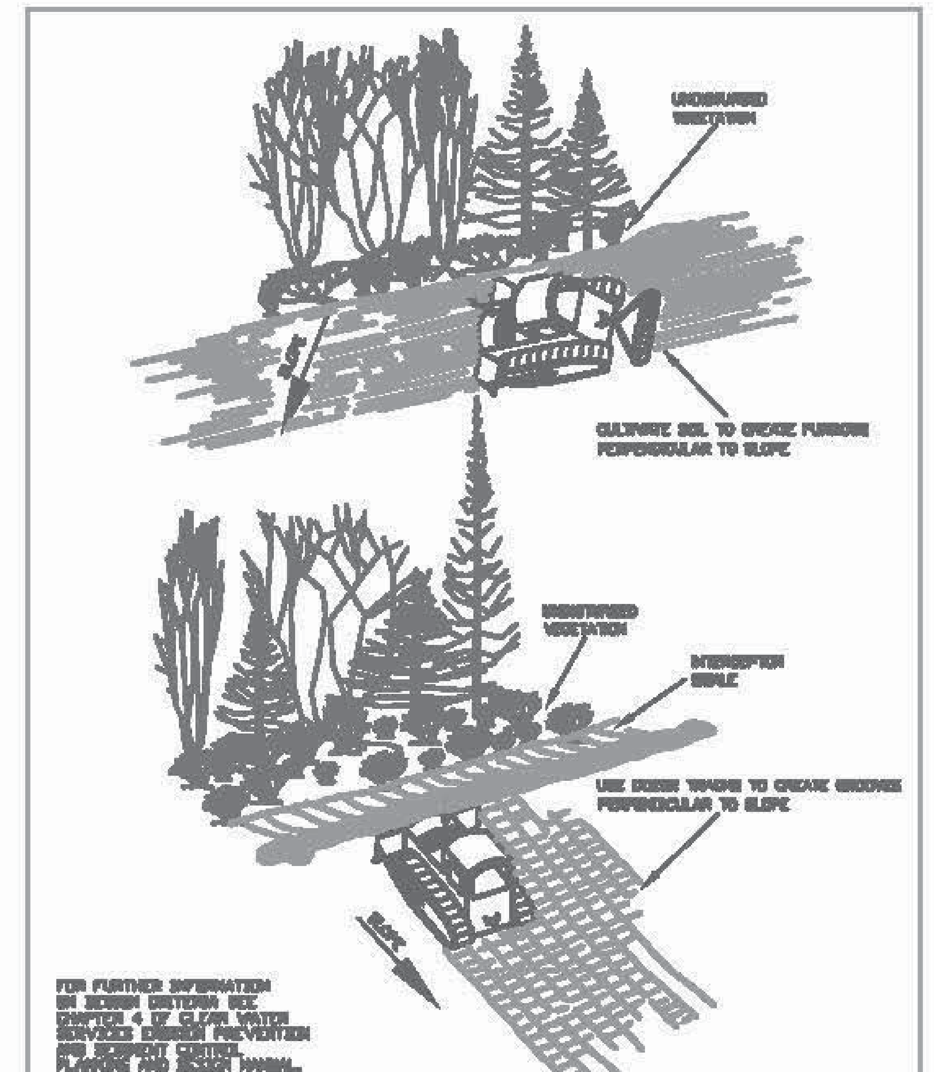
SHEET
XXX-XXX



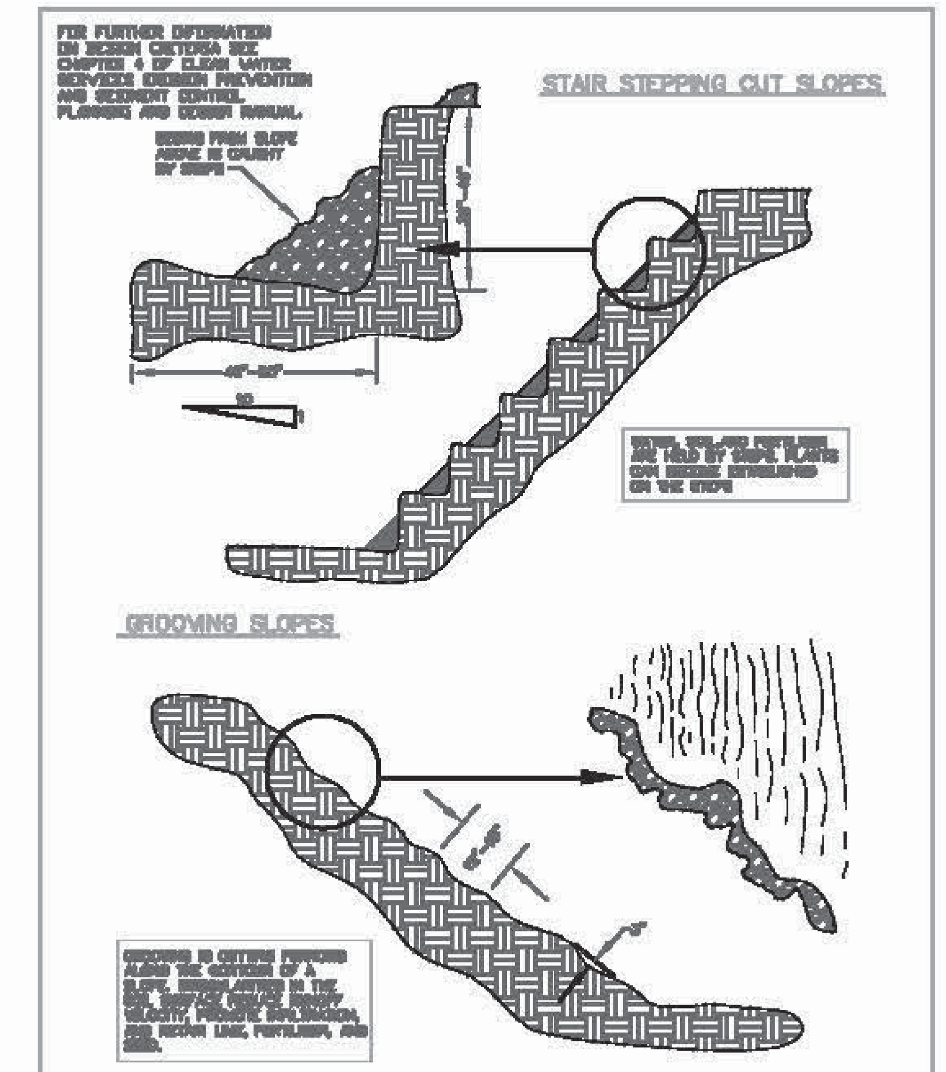
PIPE SLOPE DRAIN



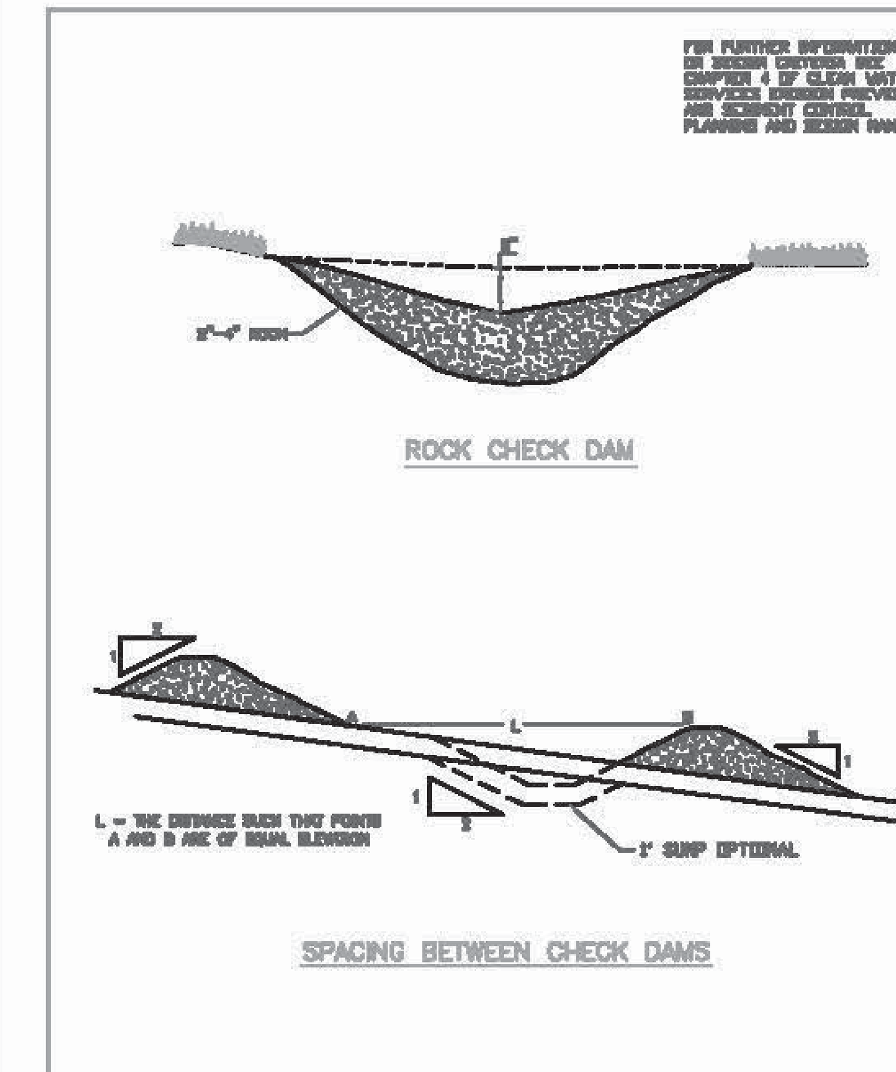
OUTLET PROTECTION
RIP RAP



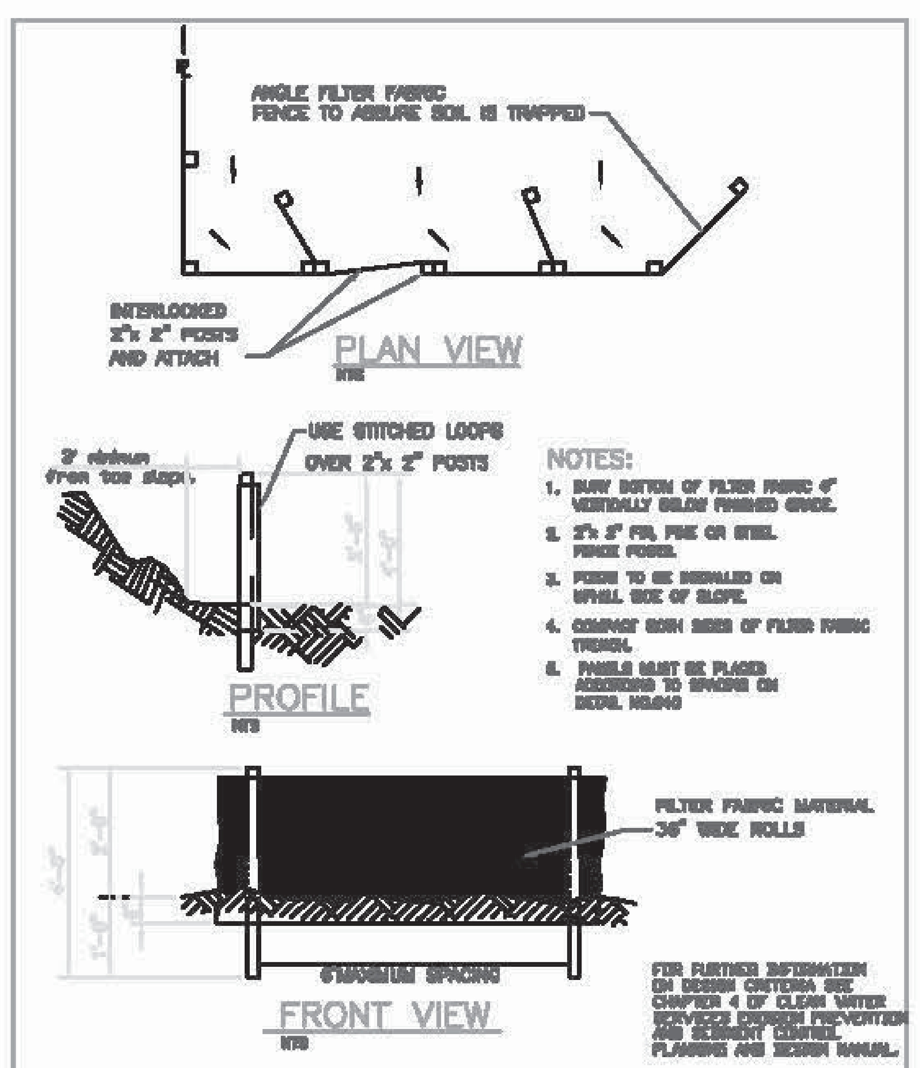
SURFACE ROUGHENING
CAT TRACKING



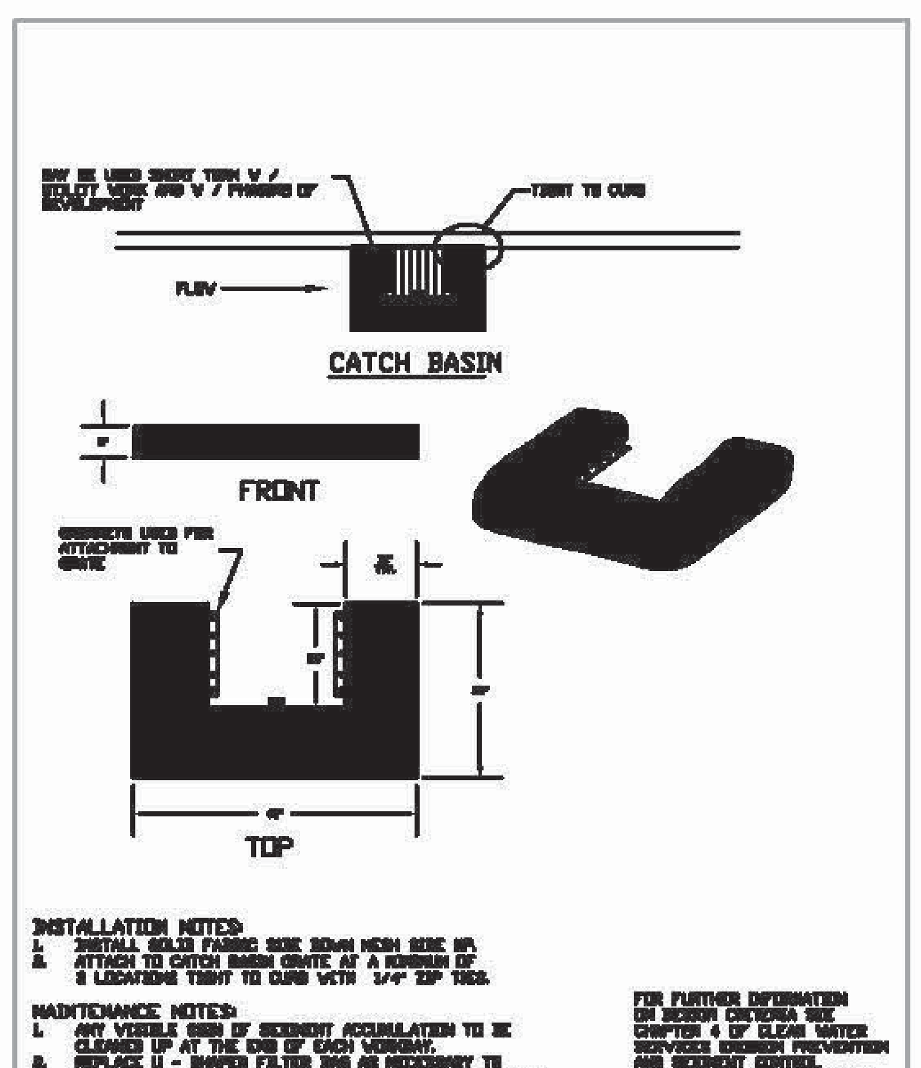
SURFACE ROUGHENING
STAIR STEPPING/GROOVING SLOPES



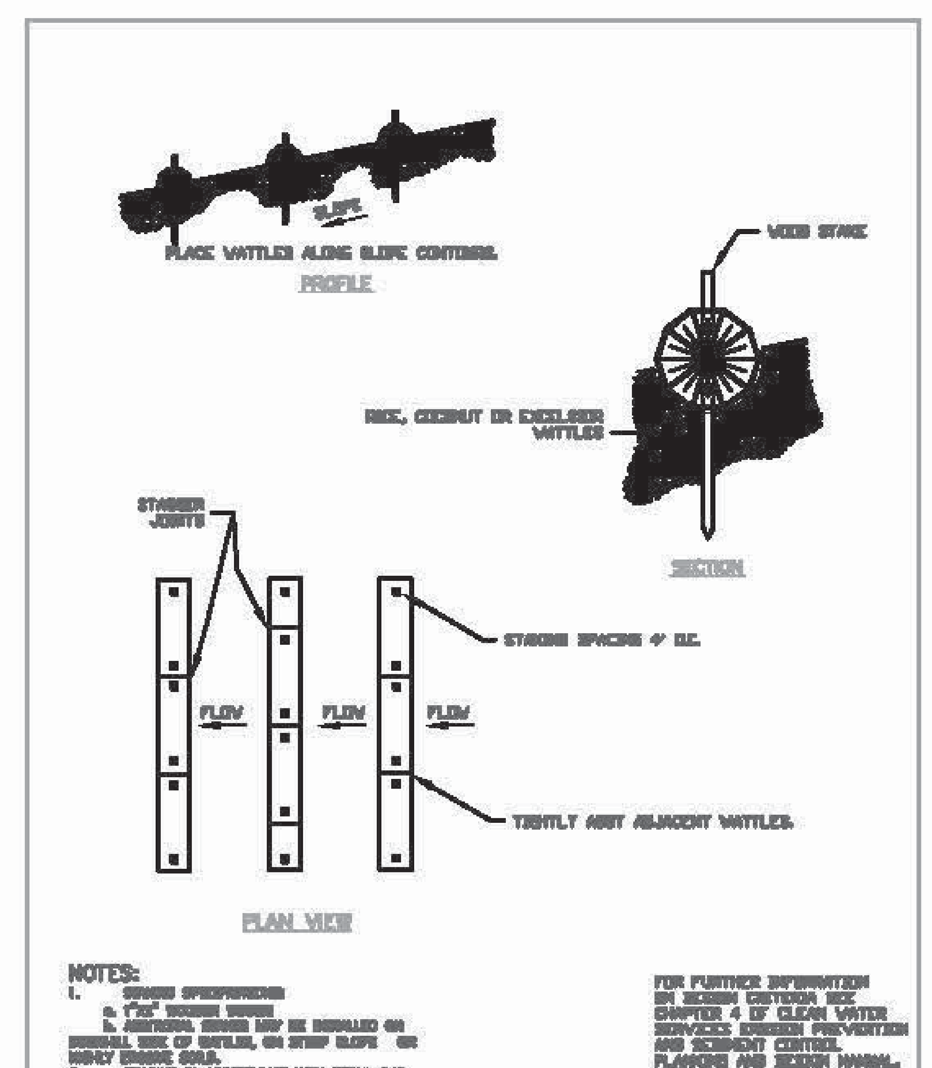
CHECK DAM
ROCK



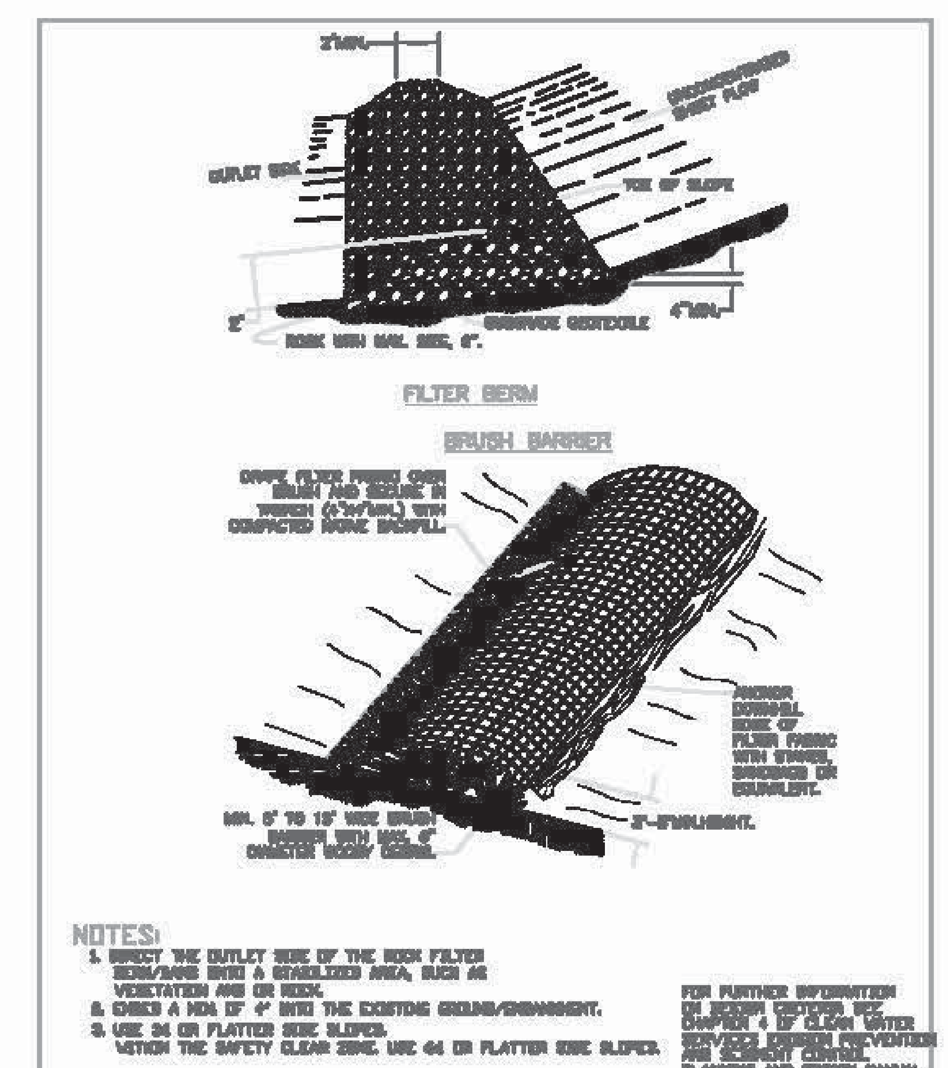
SEDIMENT FENCE



INLET PROTECTION
TYPE 6



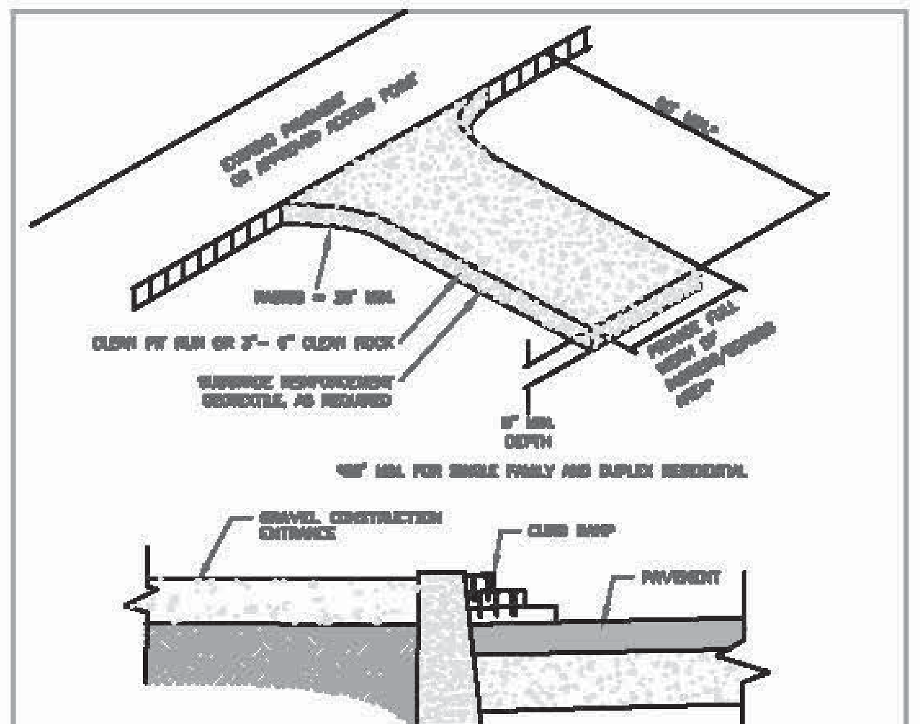
WATTLES



FILTER BERMS
ROCK/BRUSH

EXAMPLE DETAILS SHOWN REPRESENT THOSE CHOSEN FOR THIS ESC TEMPLATE. USERS NEED TO CONSULT THE DEQ GUIDANCE MANUAL OR LOCAL AGENT'S ESCP MANUAL FOR A COMPREHENSIVE LIST OF AVAILABLE DETAILS.

REVISIONS:	EROSION AND SEDIMENT CONTROL DETAILS	ENGINEERING FIRM	DESIGNED BY: / DRAWN BY: / CHECKED BY: / DRAWING NO.: / SCALE: AS NOTED / PREPARED FOR:	PROJECT NAME / WASHINGTON COUNTY / OREGON / TAX LOTS / WASHINGTON COUNTY TAX MAP	DATE: / PRELIMINARY DESIGN	JOB NUMBER XXXX / SHEET XXXX



NOTES:
1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHTS-OF-WAY. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEAN OUT OF ANY MEASURES USED TO TRAP SEDIMENT.
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT-OF-WAY.
3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.
4. WHERE RUNOFF CONTAINING SEDIMENT LADEN WATER IS LEAVING THE SITE VIA THE CONSTRUCTION ENTRANCE, OTHER MEASURES SHALL BE IMPLEMENTED TO DIVERT RUNOFF THROUGH AN APPROVED FILTERING SYSTEM.
5. DIMENSIONS

SINGLE FAMILY
20' LONG BY 20' WIDE 8" DEEP OF ¾" MINUS CLEAN ROCK.

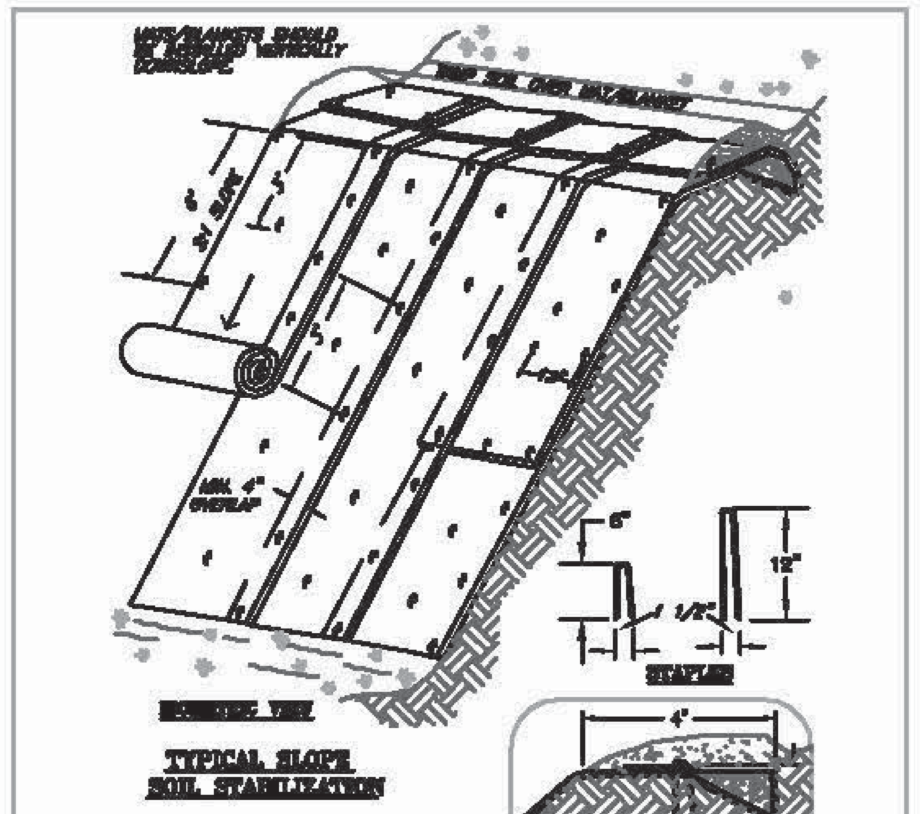
COMMERCIAL
50' LONG BY 20' WIDE 3-6" CLEAN ROCK.
GOVERNING AUTHORITY MAY REQUIRE GEOTEXTILE FABRIC TO PREVENT SUB-SOIL PUMPING.

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

CONSTRUCTION ENTRANCE

Detail Drawing 805 — REVISED 12-08

Clean Water Services



TYPICAL SLOPE SOIL STABILIZATION

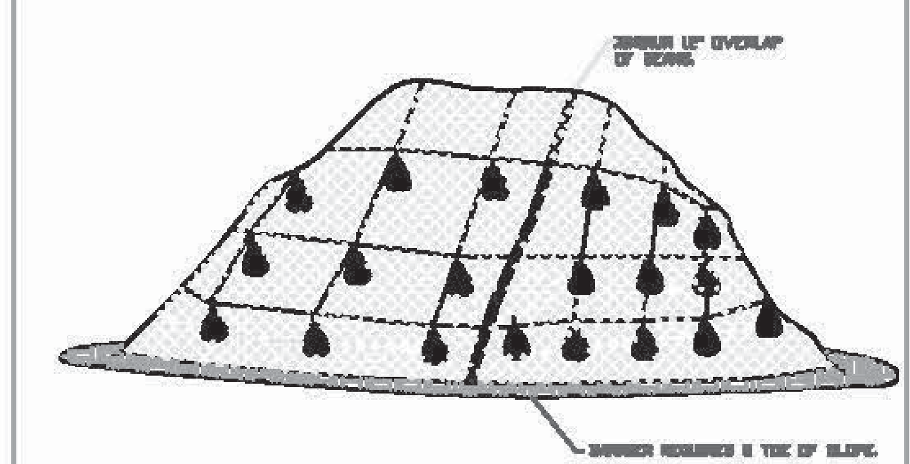
NOTES:
1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
4. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.

NOT TO SCALE

MATTING SLOPE INSTALLATION

DRAWING NO. 805 — REVISED 12-08

Clean Water Services



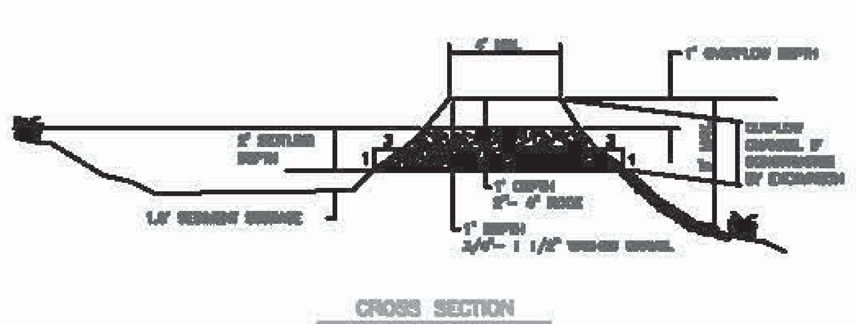
PLASTIC SHEETING

NOTES:
1. MINIMUM 12" OVERLAP OF ALL SEAMS REQUIRED.
2. BARRIER REQUIRED @ TOE OF STOCK PILE.
3. COVERING MAINTAINED TIGHTLY IN PLACE BY USING SANDBAGS OR TIRES ON ROPES WITH A MAXIMUM 10' GRID SPACING IN ALL DIRECTIONS.

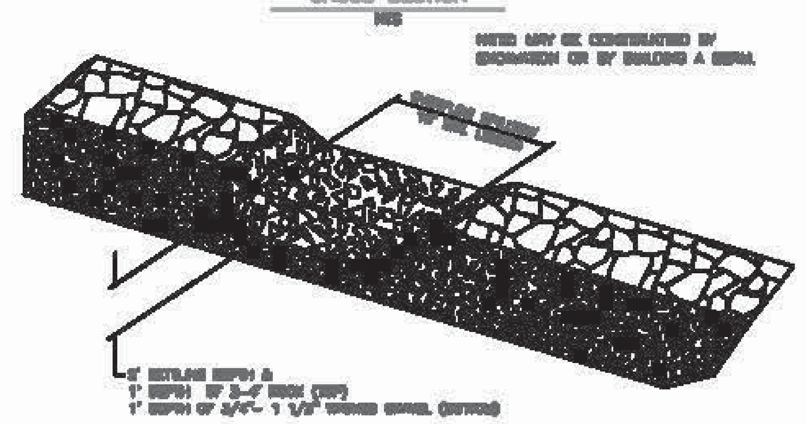
PLASTIC SHEETING

DRAWING NO. 810 — REVISED 12-08

Clean Water Services



CROSS SECTION



SEDIMENT TRAP OUTLET

NOTE:
A FILTER FABRIC FENCE OR SIMILAR FILTER MUST BE CONSTRUCTED TO FILTER RUNOFF FROM THE SEDIMENT TRAP PRIOR TO DISCHARGE FROM THE CONSTRUCTION SITE.

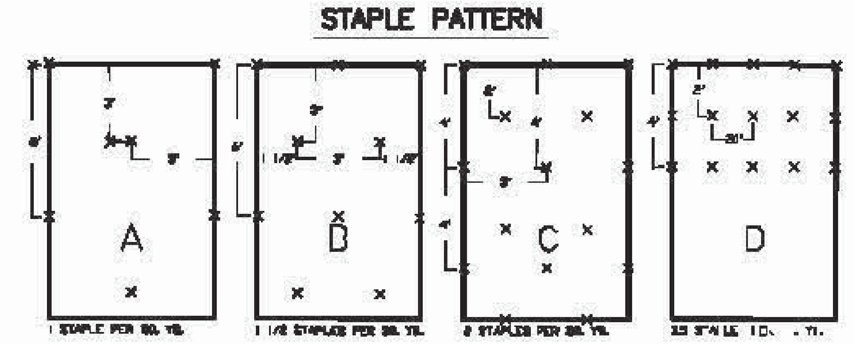
FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

SEDIMENT TRAP

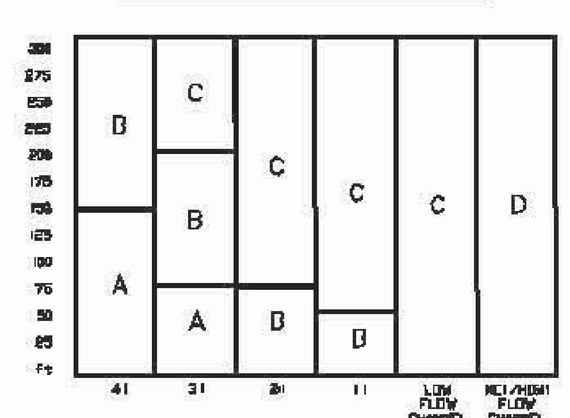
DRAWING NO. 830 — REVISED 12-08

Clean Water Services

STAPLE PATTERN



LENGTH AND SLOPE TABLE



MINIMUM STAPLE PATTERN GUIDE AND RECOMMENDATION FOR SLOPE AND CHANNEL APPLICATION.

STAPLE TABLE	Detail Drawing 4-3

Page 4-31

REVISIONS:

EROSION AND SEDIMENT CONTROL DETAILS

ENGINEERING FIRM

DESIGNED BY: DRAWN BY: CHECKED BY: DRAWING NO.: SCALE: AS NOTED

PREPARED FOR:

PROJECT NAME

WASHINGTON COUNTY — OREGON

TAX LOTS ______ WASHINGTON COUNTY TAX MAP ______

DATE:

THIS IS A PLACE HOLDER — PRELIMINARY DESIGN — OREGON — REMOVE FOR STAMPING

EXPIRES: Month Day Year

JOB NUMBER XXXX

SHEET XXXX

Clean Water Services

EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL

June 2020

EROSION PREVENTION
AND
SEDIMENT CONTROL

PLANNING AND DESIGN MANUAL

Developed in Partnership with:

City of Gladstone

City of Happy Valley

City of Lake Oswego

City of Milwaukie

City of Oregon City

City of West Linn

City of Wilsonville

Clean Water Services (CWS)
Of Washington County

Oak Lodge Water Services District

Water Environment Services (WES)
Of Clackamas County, Oregon

Revised
June 2020

DISCLAIMER

The Erosion Prevention and Sediment Control Planning and Design Manual was developed for the sole purpose of providing the most updated Erosion, Prevention, Run-off, and Sediment Controls Best Management Practices (BMPs). The contents of this manual should not be interpreted as representing the policies or recommendations of the referenced agencies or organizations.

The mention of trade names, products or companies does not constitute an endorsement.

The previous revision of this manual was December 2008. Periodic updates will be made as materials, practices, and policies change within the industry and are made available.

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Chapter 2: Erosion Processes

Chapter 3: Erosion Control Planning

Chapter 4: Erosion and Sediment Control Measures and BMPs

Chapter 5: Pollution Control Measures and BMPs

Chapter 6: Inspection and Maintenance

Appendices

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- Erosion Control Notes
- Erosion and Sediment Control Plan Symbols

Appendix B
- Erosion Control Inspection Log
- Inspector Checklist For Erosion Control

Appendix C
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- Hydraulic Application Worksheet
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PREFACE

This Erosion Prevention and Sediment Control Planning and Design Manual was developed through a partnership between Clackamas County Water Environment Services, Clean Water Services, Oak Lodge Water Service District and the cities of Gladstone, Happy Valley, Lake Oswego, Milwaukie, West Linn and Wilsonville.

The purpose of the manual is to provide a comprehensive and detailed approach towards controlling erosion on construction sites. This manual is a guidance document that focuses primarily on the prevention of sedimentation associated with water and wind generated soil erosion. The manual includes the latest information regarding erosion control Best Management Practices (BMPs) and offers details on the proper installation and maintenance of erosion and sediment control BMPs. There are numerous other resources available and readers are encouraged to refer to the reference document listed in Appendix D for additional information.

CHAPTER 1
BACKGROUND

1.1 Introduction

The US Environmental Protection Agency (EPA) has identified erosion as the single largest significant cause of impaired water quality in rivers and streams. Millions of tons of sediment are generated annually by the construction industry in the United States. The rate of erosion on a construction site varies with site conditions, climate, and soil types, but is typically 100 to 200 tons per acre and may be as high as 500 tons per acre. The major problem associated with erosion on a construction site is the movement of soil off the site and its impact on water quality. Sediment in streams is a contributing factor in the decline of Salmonid populations in our region. Sediment fills in clean gravel, which spawning fish need and the increase in turbidity can impair the feeding ability of fish and can clog gill passages. Sediment deposition in wetlands can reduce seed germination and can reduce flood storage.

Sediment laden waters leaving construction sites and entering streams, constitutes a "take" under the Endangered Species Act. This harming and harassing of protected salmon leaves the permittee prone to third party lawsuits by special interest groups, not to mention fines from, state and federal agencies and local jurisdictions.

1.2 Regulatory Background and Policies

Water pollution in the United States is regulated under the Clean Water Act (CWA) of 1972. In 1987, Congress amended the CWA to include nonpoint sources of pollution. Nonpoint source pollution occurs when runoff from land carries pollutants to receiving waters. Section 402 of the CWA provides the legal basis for the National Pollution Discharge Elimination System (NPDES) permit program, which regulates point and nonpoint discharges.

The U.S. Environmental Protection Agency (EPA) has delegated the implementation of the National Pollution Discharge Elimination System (NPDES) program to the state of Oregon. The Oregon Department of Environmental Quality (DEQ) administers the NPDES program through Oregon Revised Statute (ORS) 468B and associated Oregon Administrative Rules (OAR). ORS 468B.025 explicitly prohibits the discharge or placement of wastes into waters of the state, prohibits the discharge of waste that causes violations of water quality standards, and prohibits violations of permit conditions.

1.3 NPDES Construction Stormwater Permits

It is the local jurisdiction's goal to comply with all conditions of the NPDES permit and other Federal, State, County, and City regulations or requirements. Under existing planning and permitting requirements, the owner/permittee must assure its actions do not harm, jeopardize, threatened or endangered species. In addition, owner/permittee must implement conservation measures, or reasonable and prudent measures identified by the U.S. Fish and Wildlife Services and the National Marine Fisheries Services, to avoid and minimize potential adverse effects to such species.

In general, the Department of Environmental Quality (DEQ) issues the NPDES 1200-C permit, but through a Memo of Agreement (MOA), some local jurisdictions serve as Agents of DEQ and/or issue a joint permit for projects within their jurisdiction. The 1200-C and the 1200-CN are the construction stormwater permits that address sediment discharge in storm water runoff from construction projects. Most jurisdictions also require a local permit on projects that disturb 500 square feet or more (threshold varies by jurisdiction). In addition, erosion and sediment control measures must be installed prior to any disturbance.

The current 1200-C and 1200-CN regulations can be obtained from the DEQ web site. Below are brief descriptions of each permit:

- **NPDES 1200-C Permit:** The 1200-C permit regulates stormwater runoff to surface waters from construction activities and is required for all projects in the state affecting one or more acres. The permit provides for a public review process for those projects that disturb five acres or more of land.

- **NPDES 1200-CN Permit:** Small-lot construction sites within specific local government agencies' jurisdictions can be managed through local codes and automatically be covered under a NPDES 1200-CN Permit. Coverage under this permit is available only in specific jurisdictions referred to as 1200-CN Jurisdictions.

It is important to note that erosion and sediment control measures must be installed prior to any disturbance. In addition, the owner/permittee should be aware of, and adhere to, any limitations in the work area imposed by environmental permits such as the Division of State Lands (DSL), and U.S. Army Corps of Engineers (USACE) removal/fill permit.

1.3.1 NPDES Construction Stormwater Permit Requirements

As the administrator of the NPDES permit, DEQ or its designee has the authority to grant permits for construction activities clearing, grading, excavation, and stockpiling.

Potential pollutant sources covered by this permit include those released through construction activities performed under the authority or jurisdiction of the public agency. Until the permit expires or is modified or revoked, the permittee or the permittee's contractor is authorized to construct, install, modify, or operate erosion and sediment control measures and storm water treatment and control facilities, and to discharge storm water to public waters in conformance with all the requirements, limitations, and conditions set forth within the NPDES permit. Unless authorized by another NPDES permit, all other direct and indirect discharges to public waters are prohibited.

Measures used to comply with the 1200-C and CN permit are called Best Management Practices (BMPs). The primary NPDES mandated controls, limitations and plan requirements are as follows.

1. The permittee shall ensure that an adequate Erosion and Sediment Control Plan (ESCP) is prepared and implemented for each construction activity regulated by this permit and under the authority or jurisdiction of the permittee.
2. A copy of the ESCP, including revisions to the ESCP and visual monitoring records for each construction activity shall be retained on-site and made available to the DEQ, or its designee. During inactive periods of greater than seven consecutive calendar days, the ESCP shall be retained by the permittee. Permit registrant must retain all visual monitoring records for at least three (3) years after termination of permit coverage.
3. The ESCP shall be developed and implemented to prevent the discharge of significant amounts of sediment to surface waters. Under the NPDES 1200-C permit, the following observations are considered significant.
    a. Earth slides or mud flows that leave the construction site and are likely to discharge to surface waters.
    b. Evidence of concentrated flows of water causing erosion when such flows are not filtered or settled to remove sediment prior to leaving the construction site and are likely to discharge to surface waters. Evidence includes the presence of rills, gullies, or channels. Flow to storm water inlets or catch basins located on the site will be considered “leaving the site” if there are no sediment control structures downstream of the inlets or catch basins that are under the permittee’s control.
    c. Turbid flows of water that are not filtered or settled to remove sediment prior to leaving the construction site and are likely to discharge to surface waters. Flow to storm water inlets or catch basins located on the site will be considered “leaving the site” if there are no sediment control structures downstream of the inlets or catch basins that are under the permittee’s control.
    d. Deposits of sediment at the construction site in areas that drain to unprotected storm water inlets or catch basins that discharge to surface waters. Inlets and catch basins with failing sediment controls due to lack of maintenance or inadequate design will be considered unprotected.
    e. Deposits of sediment from the construction site on public or private streets outside of the permitted construction activity that are likely to discharge to surface waters.
    f. Deposits of sediment from the construction site on any adjacent property outside of the permitted construction activity that are likely to discharge to surface waters.
4. DEQ or its designee may require modifications to the ESCP at any time if the ESCP is ineffective at preventing the discharge of significant amounts of sediment to surface waters.
5. Significant amounts of sediment that leave the site shall be cleaned up within 24 hours and placed back on the site or disposed of properly. Any in-stream clean up shall be coordinated with the DSL.
6. Under no conditions shall sediment from the construction site be washed into storm drain sewers or drainage ways.
7. Each ESCP shall include any procedures necessary to meet local erosion and sediment control requirements or storm water management requirements.
8. Each ESCP shall also include, at a minimum, a site description, site map, required controls and practices, additional controls and practices, inspection requirements, inspection requirements for inactive or inaccessible sites, and written records.

1.3.2 Penalties for Water Pollution and Permit Condition Violations

The penalties for water pollution and permit condition violations are as follows:

- ORS 468.140 allows DEQ to impose civil penalties up to $25,000 per day for violation of a term, condition, or requirement of a permit. The federal Clean Water Act provides for civil penalties not to exceed $37,500 and administrative penalties not to exceed $16,000 per day for each violation of any condition or limitation of this permit.
- Under ORS 468.943, unlawful water pollution in the second degree, is a Class A misdemeanor and is punishable by a fine of up to $25,000, imprisonment for not more than one year, or both. Each day on which a violation occurs or continues is a separately punishable offense. The federal Clean Water Act provides for criminal penalties of not more than $50,000 per day of violation, or imprisonment of not more than 2 years, or both for second or subsequent negligent violations of this permit.
- Under ORS 468.946, unlawful water pollution in the first degree is a Class B felony and is punishable by a fine up to $250,000, imprisonment for not more than 10 years or both. The federal Clean Water Act provides for criminal penalties of $5,000 to $50,000 per day of violation, or imprisonment of not more than 3 years, or both for knowing violations of the permit. In the case of a second or subsequent conviction for knowing violation, a person is subject to criminal penalties of not more than $100,000 per day of violation, or imprisonment of not more than 6 years, or both.
- Local jurisdictions may also levy fines for permit violations and violation of local erosion program requirements.

1.4 Additional Water Quality Requirements

Additional water quality requirements that are in place or are being developed may have a significant impact on erosion prevention and sediment control requirements. The following are statewide standards that are in place and need to be considered:

- Total Maximum Daily Loads (TMDLS) – set the amount of certain pollutants a waterway can receive without violating water quality standards. A plan is then developed and put in to place to reduce the levels of these pollutants.
- Turbidity Standards – Turbidity is a measure of cloudiness in water. It can be caused by soil erosion, water discharge and runoff. High turbidity levels mean that water bodies contain a denser amount of particles. Turbidity may adversely affect a wide range of aquatic species, including endangered fish.
- Underground Injection Control (UIC) – rules for subsurface drainage systems that are designed to distribute storm and surface water below the ground surface (e.g. drywells/sumps, certain types of “French drains”, etc.). These rules are associated with the Safe Drinking Water Act and are designed to help protect aquifers from contamination.

More information is available on the DEQ website and through your local jurisdiction.

1.5 Agencies and Interest Groups

During the planning process, developers, designers should coordinate meetings with interest groups and public agencies or jurisdictions that may either have an interest in, or control of the impacts of proposed development. This process provides a means for interested parties to supply input regarding erosion and sediment controls, environmentally sensitive areas, and other regulated activities.

The development of an ESCP spans the entire planning, design, and construction stages of a project. To be successful, it is imperative that communication among the interested parties be established and maintained throughout each stage of development and in accordance with Federal, State, and local agencies requirements. Some of the principle agencies and interested parties are described in the following sections.

1.5.1 Interest Groups & Citizens

Citizen advisory committees, watershed councils, friends groups and neighborhood associations are taking a more active role with growth of their communities. Civic and environmental values have become an integral part of the land use process. This collaborating with local governments has created a more responsive method for planning urbanization and protecting the natural features that add to the livability of our watersheds.

Watershed restoration is an excellent way to enhance community volunteerism in our rapidly urbanizing areas. Local municipalities have developed an advantageous working relationship with civic-minded groups. Communities taking ownership of their local watersheds has proven advantageous to the environment.

1.5.2 Department of State Lands (DSL)

Department of State Lands (DSL) was first established in 1878 as the Office of the Clerk of the Land Board and is one of Oregon's oldest state agencies. It was renamed and elevated to Executive Agency status by the 1967 State Legislature. DSL manages the state's submerged and submersible lands under navigable rivers, lakes, estuaries, and the territorial sea to maintain fisheries, commerce, recreation, and navigation.

DSL is a regulatory agency, responsible for administration of Oregon's Section 401 Removal-Fill Law. That law, enacted in 1967, is intended to protect, conserve and allow the best use of the state's water resources. A permit is required from DSL to remove, fill or alter more than 50 cubic yards of material within the bed or banks of waters of the state.

Exceptions are in State Scenic Waterways and areas designated essential salmon habitat, where a permit is required for all in-stream activity, regardless of size.

DSL also is responsible for Oregon's wetlands program. This includes maintenance of a statewide wetland inventory, providing public information and technical assistance about wetlands to local governments and landowners, and providing wetland conservation grants to local governments conducting detailed wetland inventories.

1.5.3 United States Army Corps of Engineers (USACOE)

Army Corps of Engineers (ACOE), principal engineering component of the United States Army, dates from June 16, 1775, when the Continental Congress authorized a chief engineer and two assistants for the army. They prepared the fortifications for the Battle of Bunker Hill. The engineers were permanently organized into a corps in 1802.

The present work of the corps is divided between military and civil projects. The program currently includes construction for the army and air force and environmental restoration of areas contaminated by toxic wastes. The civil program centers on development of water resources, including navigation improvement, hydroelectric power, flood control, recreation, and conservation of fish and wildlife. When requested, the corps provides engineering expertise to other agencies, state and local governments. The work ranges from constructing wastewater treatment plants and space launch facilities to other complex engineering tasks. Engineering professionals help remove toxic wastes and help other nations with the damage caused by disasters and wars.

DSL and ACOE have developed a joint permit application process. Although the regulatory authorities of DSL and ACOE are different, their roles, when considered together, include protecting navigable waters (and the ocean), ensuring wise and beneficial water use, maintaining and enhancing water quality, protecting fish and wildlife habitat and recreation resources, and in general, protecting the public interest.

Joint permit applications, after receipt, are forwarded to the DEQ, or its designee for review to ensure that it does not endanger Oregon’s streams and wetlands and to confirm that the plans meet water quality laws and standards. Frequently, applicants are required to incorporate protective measures into their construction and operational plans, such as bank stabilization, treatment of storm water runoff, spill protection, and fish and wildlife protection.

1.5.4 United States Department of Agriculture (USDA)

The U.S. Department of Agriculture (USDA) offers landowners financial, technical, and educational assistance to implement conservation practices on privately owned land. Using this help, farmers, ranchers, and forest landowners apply practices that reduce soil erosion, improve water quality, and enhance cropland, forestland, wetlands, grazing lands, and wildlife habitat. Incentives offered by USDA promote sustainable agricultural and forestry practices, which protect and conserve valuable farm and forestland for future generations. USDA assistance also helps individuals and communities restore natural resources after floods, fires, or other natural disasters.

1.5.5 Natural Resources Conservation Service (NRCS)

The Natural Resources Conservation Service (NRCS), formerly called the Soil Conservation Service, was born of adversity, a national response to the Dust Bowl catastrophe of the mid-1930. The agency's first chief, Hugh Hammond Bennett, spoke eloquently for the land when he convinced Congress that soil erosion was a national menace, that a permanent agency was needed within the Department of Agriculture to call landowners' attention to their land stewardship opportunities and responsibilities, that a nationwide partnership of Federal agencies with local communities was needed to help farmers and ranchers conserve their land.

NRCS is the U.S. Department of Agriculture's lead conservation agency. Its partners include conservation districts, state and federal agencies, NRCS Earth Team volunteers, agriculture and environmental groups, and professional societies. The strength of NRCS is in its workforce. They are based out of county, state, regional, and national offices and specialize in soil science, soil conservation, agronomy, biology, agroecology, range conservation, forestry, engineering, geology, hydrology, cultural resources, and economics.

1.5.6 Soil & Water Conservation District (SWCD)

The first SWCD in Oregon was established in Tillamook County in 1941. Presently there are forty-five conservation districts in Oregon, providing services to private landowners and managers statewide. There is at least one conservation district in each Oregon County. Soil and Water Conservation Districts are political subdivisions of state government and are under the administrative oversight authority of the Oregon Department of Agriculture. When the first conservation districts were formed, their focus was on soil erosion control in rural areas. Once considered primarily agriculturally oriented, many conservation districts are now actively involved in urban water quality and quantity issues, such as land uses and run off from construction sites, and in assisting landowners with just a few acres.

Perhaps the most important responsibility of the Soil and Water Conservation District is to conduct research relating to the character of soil erosion, the character of floodwater and sediment damage. They also develop comprehensive plans and specifications for the conservation of soil resources and for the continued control and prevention of soil erosion.

1.5.7 United States Department of Fish and Wildlife Service (USFWS)

The U.S. Fish and Wildlife Service is the federal regulatory agency authorized to enforce the provisions of the Endangered Species Act and the Migratory Bird Act. The USFWS ensures that federal actions do not jeopardize listed species or destroy or adversely modify critical habitat. This applies to management of federal lands as well as other federal actions that may affect listed species, such as federal approval of private activities through the issuance of federal permits, licenses, or other actions.

1.5.8 Oregon Department of Fish and Wildlife (ODFW)

The Oregon Department of Fish & Wildlife is made up of predominately fish and wildlife biologists. Their main responsibility is to protect fish and wildlife as well as their habitat throughout the entire State of Oregon. Their key audiences are fishing & hunting license holders, unorganized wildlife enthusiasts, organized conservation groups, legislators and the media. ODFW has the authority to seek damages in a court of competent jurisdiction for the value of fish and wildlife injured or killed as the result of pollution or violation of the condition of any permit. The damages could include all costs for restoring the production of fish and wildlife in the affected areas.

ODFW works cooperatively with other state and federal agencies to eliminate sources of pollution or other environmental damage, to prevent natural resource losses through educational efforts and through enforcement of anti-pollution and other environmental laws, and to ensure that violations of anti-pollution and other environmental laws are pursued to the fullest extent of the law.

1.5.9 National Marine Fisheries Service (NMFS)

The National Marine Fisheries Service (NMFS) is a part of the National Oceanic and Atmospheric Administration (NOAA). NMFS administers NOAA's programs to conserve, protect and manage living marine resources. The Protected Resources Division (PRD), located in Portland, Oregon, provides program oversight, and regional policy guidance on the conservation of at-risk anadromous, estuarine, and marine fishes in the NMFS Northwest Region. The PRD staff includes biologists, natural resource specialists, and policy analysts who work in conjunction with other NMFS programs to help administer provisions of the Endangered Species Act (ESA).

NMFS is dedicated to the protection of marine resources including salmon and trout that live at least part of their lives at sea. Due to declining numbers, certain populations have been listed as endangered or threatened under the Endangered Species Act. The ESA protects these fish and the habitats they depend on as they migrate to and from the Pacific Ocean. Along with federal protection under the ESA, state laws apply additional safeguards for the fish and their habitats.

Protection of water quality sensitive areas and restoration of vegetated corridors are important because once protective regulations enacted through the ESA are issued, NMFS requires that all parties must avoid killing or harming a listed species, and avoid adverse affects to the habitat that supports listed species.

1.5.10 Oregon Department of Forestry (ODF)

The ODF manages several programs, which protect the State’s forestlands and ensure a plentiful natural resource. The Department’s largest program protects the roughly 16,000,000 acres of forestland from wild fire. The Forest Practices program assures the growing and harvesting of forest tree species and maintenance of forestland for forest purposes are the primary uses of privately owned forestlands. The program also assures that forest practices are consistent with the sound management of soil, air, water, fish, and wildlife resources. Like many of the other environmental agencies, the ODF provides technical and financial assistance. By providing this service, it helps to mitigate Oregon's future timber supply shortage while it promotes forest health. It also enhances and protects critical natural resource values such as fish and wildlife habitat, soils, air, water, recreation, and aesthetics on non-federal forestland.

1.5.11 Metro Regional Government – Stream and Floodplain Protection Plan (Title 3)

The goal of the Stream and Floodplain Protection Plan (Title 3) is to protect the region's health and public safety by reducing flood and landslide hazards, controlling soil erosion, and reducing pollution of the region's waterways.

Title 3 specifically implements the Oregon Statewide Land Use Goals 6 and 7 by protecting streams, rivers, wetlands, and floodplains by avoiding, limiting or mitigating the impact on these areas from development.

Title 3 contains performance standards to protect against flooding. The standards limit development in a manner that requires balanced cut and fill and floor elevations at least one foot above the flood hazard standard. The areas subject to these requirements have been mapped and adopted by Metro Council. The areas are the FEMA 100-year floodplain and the area of inundation for the February 1996 flood.

The purpose of these standards is to protect and allow enhancement of water quality. The water quality areas are rivers and streams with a protected vegetated corridor width depending on the slope of the stream and the number of acres drained by the stream. The performance standards require erosion and sediment control, planting of native vegetation on the stream banks when new development occurs, and prohibition of the storage and uses of hazardous material in water quality areas.

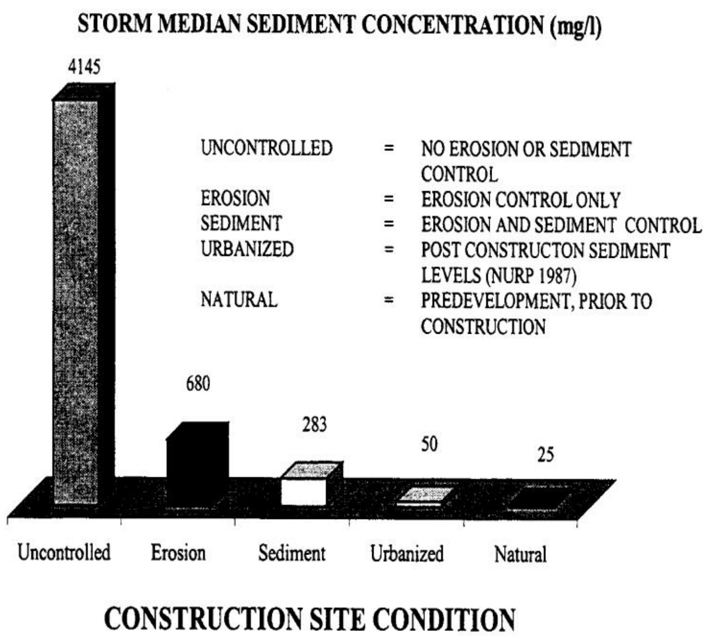
Finally, the functional plan directs Metro to establish performance standards to protect regionally significant fish and wildlife habitat areas. Those seeking to develop sites within these sensitive areas must contact their local jurisdictions to determine buffer width.

CHAPTER 2
EROSION PROCESSES

2.1 Concepts of Erosion and Sedimentation

Erosion is a natural process by which soil and rock material is loosened and transported. Erosion by the action of water, wind, and ice has produced some of the most spectacular landscapes. Natural erosion occurs primarily on a geologic timescale, but when human activities alter the landscape, the process of erosion can be greatly accelerated.

When land is disturbed at a construction site, the erosion rate accelerates dramatically. Uncontrolled construction site erosion can cause serious and costly problems, both on-site and off-site (refer to Figure 2-1). Since ground cover on an undisturbed site protects the surface, the removal of that cover increases the site's susceptibility to erosion. Disturbed land may have an erosion rate 1,000 times greater than the pre-construction rate. Even though the process of construction requires that land be left bare for periods of time, proper planning and use of erosion prevention measures can reduce the impact of accelerated erosion caused by land development.



Source: Performance of Current Sediment Control Measures at Maryland Construction Sites, Virginia Erosion and Sediment Control Handbook

Figure 2-1 Absence of surface cover increases the soil susceptibility to erosion

When combined with an understanding of basic erosion control and sedimentation processes, fundamental erosion prevention and sediment control principles will lay the groundwork for successful implementation of erosion and sediment control best management practices. Soils, topography, and drainage patterns of a specific site may influence the potential for soil erosion. Identifying potential erosion problems at the planning stage and recognizing highly erodible areas will help in selecting effective erosion control practices.

2.2 Types of Erosion

Erosion is often described as the detachment of soil particles by some force. This force may be due to rainfall, wind, or other forces. Once detachment occurs, the particles are transported. This is most often caused by water action, although wind can also be a major contributor.

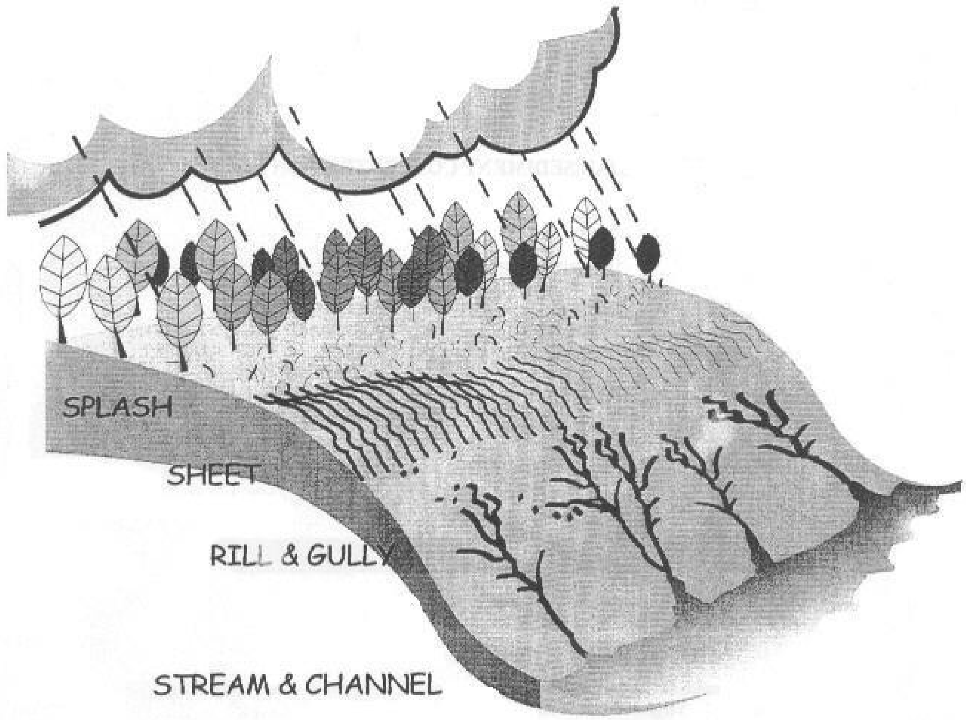


Figure 2-2 Major types of soil erosion

2.2.1 Water Erosion

Water erosion is the result of rain detaching and transporting soil, either directly by means of rain splash or indirectly by rill and gully erosion. The major types of water erosion are:

Splash **–** When vegetative cover is stripped away, the soil surface is directly exposed to raindrop impact. Splash erosion results when the force of raindrops falling on bare or sparsely vegetated soil detaches soil particles that can easily be transported by runoff. This pounding action destroys the soil structure and often a hard crust forms when the soil dries. This crust inhibits water infiltration and plant establishment, increasing runoff and future erosion.

Sheet **–** The removal of exposed surface soil can be caused by the action of unchanneled surface runoff. Shallow "sheets" of water flowing over the soil surface cause sheet flow. Sheet flow transports soil particles that have been detached by splash erosion. The shallow surface flow rarely moves as a uniform sheet for more than a few feet before concentrating in the surface irregularities.

Rill **–** As surface flow changes from sheet flow to deeper concentrated flow along the low spots of the soil surface it creates rivulets, cutting grooves called rills into the soil surface. The energy of this concentrated flow is able to both detach and transport soil particles. The rills are small but well-defined channels that are at most only a few inches deep.

Gully **–** Some gullies are formed when runoff cuts rills deeper and wider or when the flows from several rills come together and form a large channel. Gullies can enlarge in both uphill and downhill directions. If the flow of water is sufficient, large chunks of soil can fall from a gully headwall in a process called mass wasting. Once a gully is created, it is very difficult to control, and costly to repair.

Channel **–** When stream bank vegetation is disturbed or when the velocity or volume of a stream is increased, channel erosion can occur. Natural streams have adjusted over time to the quantity and velocity of runoff that normally occurs within a watershed. The vegetation and rocks lining the banks are sufficient to prevent erosion under these steady-state conditions. When a watershed is altered by removing vegetation, by increasing the amount of impervious surfaces, or by paving tributaries, stream flows are changed. Increased volume and velocity of runoff may cause expansion of gullies into well-defined channels. These changes can disturb the equilibrium of the stream and cause channel erosion to begin. Channel erosion is commonly found at stream bends, constrictions where installed structures control the stream flow, or discharge points where storm drain culverts release storm water into a stream.

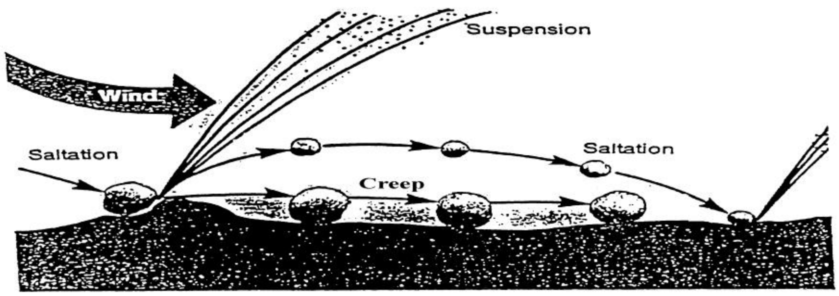
2.2.2 Wind Erosion

Wind erosion is a form of erosion occurring in flat, bare areas dry, sandy soils, or where the soils are loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing soil from one place and depositing it in another. It causes soil loss, dryness and deterioration of soil structure, nutrient and productivity losses, air pollution and sediment transport and deposition. Soil movement is initiated as a result of wind forces exerted against the surface of the ground. For each specific soil type and surface condition there is a minimum velocity required to move soil particles. This is called the threshold velocity. Once this velocity is reached, the quantity of soil moved is dependent upon particle size, the cloddiness of particles, and wind velocity itself.

Suspension **–** Suspension occurs when very fine dirt and dust particles are lifted into the wind. They can be thrown into the air through impact with other particles or by the wind itself. Once in the atmosphere, these particles can be carried very high and be transported over extremely long distances. Soil moved by suspension is the most spectacular and easiest to recognize of the three forms of movement.

Saltation **–** The major fraction of soil moved by wind is through the process of saltation. In saltation, fine soil particles, are lifted into the air by the wind and drift horizontally across the surface, increasing in velocity as they go. Soil particles moved in the process of saltation cause severe damage to the soil surface and vegetation. They travel approximately four times longer in distance than in height. When they strike the surface again, they either rebound back into the air or knock other particles into the air.

Surface Creep **–** The large particles which are too heavy to be lifted into the air are moved through a process called surface creep. In this process, the particles are rolled across the surface after coming into contact with the soil particles in saltation.



2.3 Erosion Factors

The four principal factors in soil erosion are climate, soil characteristics, topography and ground cover. These factors are interrelated in their effect on erosion potential. The variability in Oregon’s terrain, soils, and vegetation makes erosion control unique to each construction site. Understanding the factors that affect the erosion process enables us to make useful predictions about the extent and consequences of on-site erosion.

An empirical model developed for agriculture applications, the Revised Universal Soil Loss Equation (RUSLE) predicts soil loss resulting from sheet and rill erosion. It considers both the effects of erosion control practices and the factors that influence erosion, so it is useful for evaluating erosion problems and potential solutions.

2.3.1 Climate

Climate affects erosion potential both directly and indirectly. In the direct relationship, rain is the driving force of erosion. Raindrops dislodge soil particles, and runoff carries the particles away. The erosive power of rain is determined by rainfall intensity (millimeters of rain per hour) and droplet size. A highly intense rainfall of relatively short duration can produce far more erosion than a long duration storm of low intensity. In addition, storms with large raindrops are much more erosive than misty rain events with small droplets. Oregon has considerable diversity of climate. Rainfall intensity, duration, and droplet size vary according to geographic location.

2.3.2 Soil

Soil is a product of its environment. A soil’s erodibility, or the vulnerability of soil to erosion, is a result of a number of soil characteristics, which can be divided into two groups: those influencing infiltration, or the movement of water into the ground, and those affecting the resistance to detachment and transported by rainfall and runoff. Key factors that affect erodibility are soil texture, amount of organic matter, soil structure, and soil permeability.

- Soil texture refers to the sizes and proportions of the particles making up a particular soil. Sand, silt, and clay are the three major classes of soil particles. Soils high in sand content are said to be coarse-textured. Because water readily infiltrates sandy soils, the runoff, and consequently the erosion potential, is relatively low. Soils high in content of silts and clays are said to be fine-textured or heavy. Clay, because of its stickiness, binds soil particles together and makes a soil resistant to erosion. However, once heavy rain or fast flowing water erodes the fine particles, they will travel great distances before settling.

- Organic matter consists of plant and animal litter in various stages of decomposition. Organic matter improves soil structure and increases permeability, water holding capacity, and soil fertility. Organic matter in an undisturbed soil or in mulch covering a disturbed soil reduces runoff and erosion potential. Mulch on the surface also cushions the soil from erosive impact of raindrops.

- Soil structure is the arrangement of soil particles into aggregates. Soil structure affects the soil's ability to absorb water. When the soil is compacted or crusted, water tends to run off rather than infiltrate. Erosion hazard increases with increased runoff. A granular structure is the most desirable one. Loose granular soils absorb and retain water, which reduces runoff and encourages plant growth.

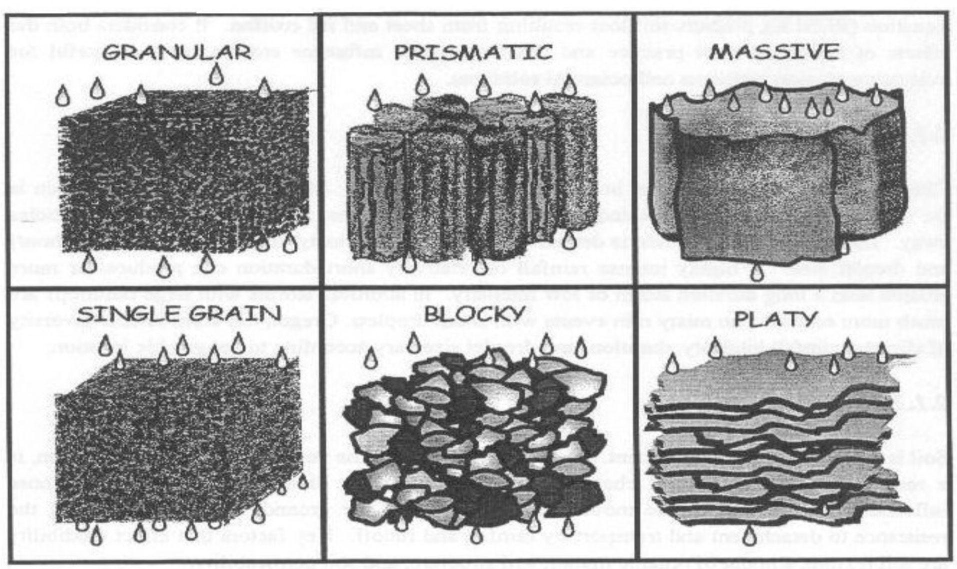


Figure 2-3 Soil Structure

- Soil permeability refers to the ability of the soil to allow air and water movement through the soil. Soil texture, structure, and organic matter all contribute to permeability. Soils that are least subject to erosion from rainfall and shallow surface runoff are those with high permeability rates, such as well-graded gravels and gravel-sand mixtures. Loose, granular soils reduce runoff by absorbing water and by providing a favorable environment for plant growth.

2.3.3 Topography

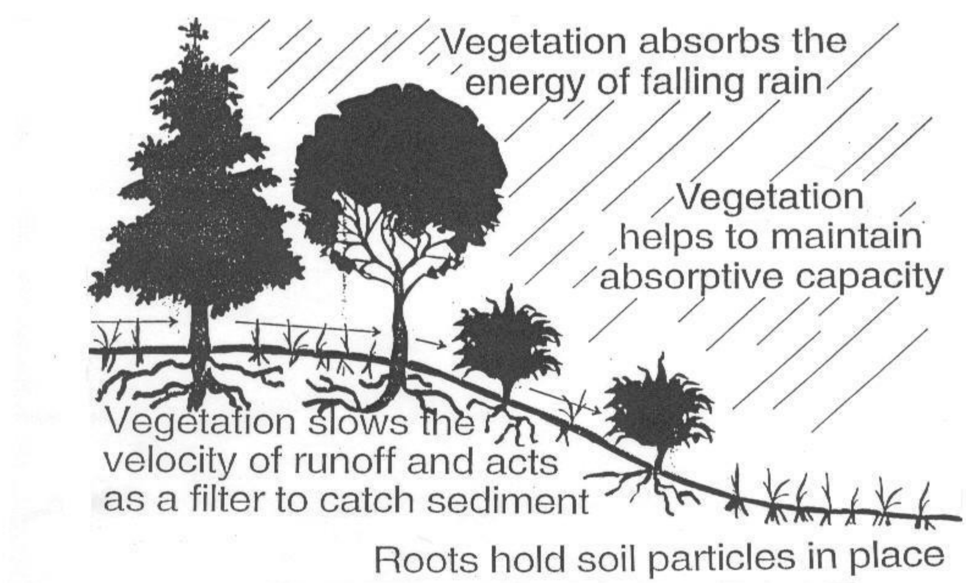
Topographic features distinctly influence erosion potential. Watershed size and shape, for example, affect runoff rates and volumes. Long, steep slopes increase runoff flow velocity. Ditches and channels can concentrate surface flow, which results in higher velocities. Slope length and slope steepness are critical factors in erosion potential, since they determine in large part the velocity of runoff. Long, continuous slopes allow runoff to build up momentum. The high velocity runoff tends to concentrate in narrow channels and produce rills and gullies.

The shape of a slope also has a major bearing on erosion potential. The base of a slope is more susceptible to erosion than the top, because runoff has more momentum and is more concentrated as it approaches the base. Slope orientation can also be a factor in determining erosion potential. In northern latitudes, exposed south-facing soils are hotter and drier, which makes vegetation difficult to establish. Northern exposures tend to be cooler and moister, receiving less sunlight, which results in slow plant growth.

2.3.4 Ground Cover

The term ground cover refers principally to vegetation, but it also includes surface treatments such as mulches, matting, wood chips, and crushed rock. Vegetation is the most effective means of stabilizing soils and controlling erosion. It shields the surface from the impact of falling rain, reduces flow velocity, and disperses flow. Vegetation provides a rough surface that slows the runoff velocity and promotes infiltration and deposition of sediment. Plants remove water from the soil and thus increase the soil's capacity to absorb water. Plant leaves and stems protect the soil surface from the impact of raindrops, and the roots help maintain the soil structure while holding the soil in place.

Benefits of Vegetation



2.4 Impacts of Erosion and Sedimentation

Erosion and sedimentation cause both environmental and economic impacts. Both are important, but often only the economic impact spurs a jurisdiction to take action. Erosion and sedimentation can cause expensive site damage and construction delays and produce environmental impacts that can be difficult to correct.

2.4.1 Environmental Impacts

Many environmental impacts from sediment pollution are cumulative and the ultimate results and costs may not be evident until years later.

- Eroded soil can contain nitrogen, phosphorus, and other nutrients. When carried into water bodies, these nutrients can trigger algal blooms that reduce water clarity, deplete oxygen, lead to fish kills, and create odors.
- Erosion of streambanks and adjacent areas can destroy streamside vegetation that provides aquatic and wildlife habitats.
- Excessive deposition of sediments in streams can smother the bottom fauna, seal stream beds, and destroy fish spawning habitat.
- Turbidity from sediment can reduce in-stream photosynthesis, which leads to reduced food supply and habitat.
- Turbidity can increase the amount of sunlight absorbed in water, raising stream temperatures.
- Suspended sediment can abrade and coat aquatic organisms.
- Erosion removes the smaller and less dense constituents of topsoil, including clays, fine silt particles and organic materials that hold nutrients that plants require for healthy establishment. The remaining subsoil is often hard, rocky, infertile, and droughty; thus making reestablishment of vegetation difficult.

2.4.2 Pollutant Sources and Impacts

Pollutants, as the term applies to our subject, are substances that can render water harmful to people, fish, or wildlife, or impair recreation or other beneficial uses. Sediments, nutrients, bacteria, oxygen-demanding materials, heavy metals, petroleum hydrocarbons, and synthetic organic chemicals are the most important classes of pollutants. Heavy metals, petroleum-hydrocarbons and synthetic organics are frequently classified as toxic pollutants, depending on their characteristics.

This section covers potential impacts on natural systems associated with pollutants from construction activities. Table 2-1 provides an overview of important pollutant categories and some of their effects on the environment.

2.4.2.1 Sediment

Sediments and other suspended solids are the most common pollutant in storm water runoff. Erosion and sediment loss from a site occur most commonly because of vegetation removal.

Soils exposed during construction, mining, logging or agriculture can contribute substantial quantities of sediment to nearby water bodies. Construction site erosion is one of the primary contributors.

Suspended particles, or turbidity, turn water cloudy, degrading aquatic habitats and can increase the cost of maintaining storm drainage facilities. Deposited sediments can affect adjacent properties and clog catch basins and storm drains, causing flooding and higher maintenance costs. When sediments enter streams and lakes, they create cloudy or turbid water conditions. This condition interferes with recreational use and enjoyment, and affects fish and other aquatic life habitats. For example, sediments can make it difficult for fish to feed and breathe, cover gravels needed by salmon and trout for spawning and rearing, and smother fish eggs and aquatic insects on which fish feed. In addition, sediments can transport many other pollutants, including nutrients, bacteria, metals and some organic pollutants.

2.4.2.2 Nutrients

Plants require nutrients such as phosphorus and nitrogen for growth, but excessive levels in receiving waters can harm water quality. Excess nutrient levels over-stimulate the growth of algae and other aquatic plants, potentially causing unpleasant tastes, odors, unsightly conditions and lowered dissolved oxygen levels form plant decay. Nutrients tend to be more of a problem in slow moving water such as lakes or sluggish streams. Sources of nutrients include organic and inorganic fertilizers, soils and decomposing vegetation.

2.4.2.3 Bacteria

The presence of disease-bearing organisms in surface waters, such as bacteria and viruses, potentially threatens public health. Fecal coliform bacteria are often used as an indicator for such pathogens, even though generally they are not pathogenic themselves. The presence of fecal coliforms, however, indicates that warm-blooded animal waste is present. The most common impacts associated with fecal coliform pollution are closed (decertified) shellfish growing areas and reduced recreational opportunity. Potential construction site sources of fecal coliforms include outhouses that are not maintained or pumped out on a regular basis. The clearing and grading process can also expose waste, deposited prior to construction, to runoff.

Bacterial decomposition of plant, animal and chemical wastes requires oxygen. When this process occurs in water, it reduces the oxygen available for fish and other aquatic organisms. If dissolved oxygen levels become too low, fish and other aquatic organisms may become stressed or die.

Construction sites can be a source of oxygen-demanding substances. For example, cleared vegetation, exposed soils, spilled chemicals, and animal or human wastes can all contribute to lower oxygen levels in water.

2.4.2.4 Heavy Metals

Many metals are toxic and are regulated by the Environmental Protection Agency (EPA). Specifically, EPA classifies eight metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver) as hazardous and regulates their disposal. Construction materials or equipment that contain such metals include paints, preservatives, metal downspouts, brake linings and tires. Other metal sources are wastes such as used automotive liquids, fuels, dust from sanding or grinding metal and painted surfaces, and wash from roadways.

Metals such as copper and zinc, which partially dissolve in water, may create toxic conditions for fish and other aquatic life. A large number of metals in construction site runoff can attach to sediments and other particles. Sediments carrying heavy metals such as mercury often settle out from water and accumulate on stream and lake bottoms where they can remain for a long time. The metals accumulate in the tissue of organisms, which are then eaten by predators near the top of food chains. High concentrations of heavy metals can sometimes be found in these predators.

2.4.2.5 Concrete and Sawcutting

Concrete/mortar washwater and sawcutting residues can be highly alkaline and contain a high amount of suspended sediments. These are harmful to people, plants, fish & wildlife if discarded improperly. In addition, when concrete wastes solidify or build up in stormwater structures and facilities, they block the drainage flow, causing localized flooding. This can result in property damage and unsafe driving conditions as well as increased maintenance costs.

2.4.2.6 Petroleum Hydrocarbons

Petroleum hydrocarbons include crude oil and any products derived from it in the refining process, such as gasoline, diesel fuel, industrial and home heating fuels, and lubricating oils. Petroleum products can be present in a number of forms on a construction site, principally as vehicle fuels, cleaning solvents, and lubricants. If released to the environment, they can harm water quality in various ways. Certain petroleum products contaminate water supplies. They are acutely toxic and kill fish and invertebrate life. Petroleum products also consume oxygen as they decay naturally and greatly reduce the aesthetic quantities of water bodies for human enjoyment. As of result of these potentially severe impacts, petroleum products require special care during storage, transfer, and usage on construction sites.

2.4.2.7 Synthetic Organics

Synthetic organics contain carbon and are any type of chemical produced through industrial or combustion processes. Synthetic organic substances include most pesticides, preservatives, solvents, and plasticizers, as well as incidental and unwanted by-products of fuel combustion. Many organics, depending on their composition and rate of degradation, are slow to degrade and remain in the environment for long periods of time. Synthetic organics can be quite toxic to fish and other aquatic life and are sometimes classified as carcinogenic (cancer causing).

Organics include common pesticides and the ingredients of many common household and industrial chemicals. Pesticides, by their very purpose, are designed to kill and can do the same in receiving waters.

Organics can be liquid or solid products, or waste materials. Liquid and solid products may enter the environment when they leak or are spilled from containers during use or transfer, are carried away by rain water and wash water, or are spilled or dumped on the ground or down the storm drain. Therefore, they also warrant a special consideration for careful inspection at construction sites.

TABLE 2-1. OVERVIEW OF POLLUTANT SOURCES, IMPACTS, AND INDICATORS

POLLUTANTS	MAJOR SOURCES	IMPACTS	INDICATORS
Sediments and other solids	Clearing/grading exposed soils	Cloudy water, smothering of fish eggs and insects, flooding	Total suspended solids, turbidity
Nutrients	Cleared vegetation exposed soils human/animal waste, fertilizer, moss killer	Algal blooms, reduced oxygen, aquatic plant growth	Different forms of phosphorus and nitrogen
Bacteria	Human/animal wastes, sewer lines, septic tanks	Shellfish contamination, human health effects	Fecal coliforms
Oxygen demanding materials	Cleared vegetation, human/animal waste, chemical reactions	Reduced oxygen in water, stress/kill salmonid fish and other aquatic life	Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), dissolved oxygen
Heavy metals	Paints, flashings, downspouts, tires, brake linings, preservatives, disturbed soils, solvents	Bioaccumulation in food chain, toxic to aquatic life, human health effects	Ar, Cd, Cu, Hg, Ni, Pb, Zn
Petroleum hydrocarbons	Oil, grease, fuels, lubricants	Decreased oxygen levels, aesthetics, human, aquatic and wildlife health effects	Oil & grease, total petroleum hydrocarbons
Concrete/Aggregates	Cement, sand, aggregates, chemical admixtures, fuels and lubricants.	Highly alkaline and toxic to fish and other aquatic organisms.	Increase pH, turbidity, Cr
Synthetic organics	Pesticides, pcb's, combustion products, solvents	Bioaccumulation in food chain, toxic to aquatic life, wildlife and humans	Variety of organics analyses

2.5 Economic Impacts

Many economic impacts are hard to quantify. How can a dollar value be assigned to loss of aquatic habitat or diminished water clarity? Other impacts may be readily quantified, for example the cost of dredging and disposing of the accumulated sediment in a silted-up reservoir or swale. The list below are some examples of the economic consequences of construction site erosion:

- Excessive sediment accumulation reduces reservoir storage capacity and more frequent sediment removal is required. The cost of building new reservoirs to replace lost reservoir capacity is high. Increasing land values and lack of available sites are making this alternative much less feasible.
- Sediment discharged into the conveyance system such as catchbasins or water quality facilities requires sediment removal and increases maintenance costs.
- Sediment deposited into waterways reduces flow capacity, interferes with navigation, and increases the risks of flooding. Regular maintenance dredging is required.
- Erosion severely diminishes the ability of the soil to support plant growth. To restore this ability is costly.
- Listing additional wildlife as endangered species increases time and fees for permitting, design, and construction in the affected watersheds. Some costs are directly assessed to specific projects while many other costs are distributed statewide by spending additional monies for habitat restoration.

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CHAPTER 3
EROSION CONTROL PLANNING

The purpose of erosion and sediment control planning is to establish erosion control measures that are intended to prevent erosion and off-site sedimentation during construction. The Erosion and Sediment Control Plan (ESCP) serves as a blueprint for the location, installation, and maintenance of practices to control erosion and prevent sediment from leaving the site during construction. The driving consideration in creating and implementing an effective ESCP is to provide erosion prevention measures rather than sediment control. Although every ESCP will have elements of both, it is often far more cost effective and practical to emphasize erosion prevention. It should be understood that plans are only a blueprint and will require modification throughout the life of the project

3.1 Erosion Prevention vs. Sediment Control

Erosion prevention - Defined as any practice that protects the soil surface and prevents the soil particles from being detached by rainfall or wind. Erosion prevention is a prevention technique that treats the soil as a valuable resource that should be kept in place. The benefit of erosion prevention is that it seeks to prevent the problem before it starts.

Erosion prevention measures are more effective than the reactive control of capturing sediment. It is often impractical to recover large amounts of sediment after it becomes dislodged and suspended in runoff. Once soil particles become dislodged, it requires greater effort and cost to contain the sediment on the site. In fact, it is generally true that erosion prevention measures are more reliable, whereas sediment control measures require continual and costly maintenance. Erosion prevention measures include temporary ground covers (mulch, temporary grasses, straw mulch and tackifier, etc.), matting, plastic sheeting, and numerous other products designed to provide mechanical or physical protection to exposed soil.

Sediment Control - Once soil erosion has occurred sediment control measures are used to trap sediment and recapture techniques will reduce the amount of sediment and associated pollutants that leave the site. Sediment leaving the site may damage neighboring properties, block drainage systems, and enter waterways. Local government budgets can be adversely impacted by the cost to remove the sediment from streets, sewers, ditches and culverts. Sediment control measures include sediment traps and basins, sediment fences, check dams, sediment barriers, catch basin filters, etc.

3.1.1 Principles of Erosion Prevention and Sediment Control

Effective erosion and sedimentation control requires first that the soil surface is protected from the erosive forces of wind, rain, and runoff, and second that eroded soil is captured on-site. Erosion control is the prevention or minimization of soil erosion. Sediment control is the trapping of suspended soil particles. Erosion control is the preferred approach. Sediment control is necessary because some erosion is unavoidable. The following principles are not complex but are effective. They should be integrated into a system of control measures and management techniques to control erosion and prevent off-site sedimentation.

Fit site construction to the terrain. Review and consider all existing conditions in the initial site selection for the project. When construction is tailored to the natural contours of the land, little grading is necessary and erosion potential is consequently reduced.

Time grading and construction to minimize soil exposure. Scheduling can be a very effective means of reducing the hazards of erosion. Stage construction activities to minimize the exposed area and the duration of exposure. In scheduling, take into account the season and the weather forecast. Time grading to coincide with a dry season or a period of lower erosion potential. Stabilize disturbed areas as quickly as possible.

Retain existing vegetation whenever feasible. Vegetation is the most effective form of erosion control. Very little erosion occurs on a soil covered with undisturbed natural vegetation. Reestablishing vegetation can be a difficult and costly process. If possible, strip only the area where construction will actually occur, street and driveway lines, and cut and fill slopes. Try to integrate existing trees and other natural vegetation into the site improvement plan.

Vegetate and mulch denuded areas. Seed and mulch denuded soils as soon as possible after grading is completed. Mulch helps seedlings to become established and protects the soil from raindrop splash until vegetation takes over. Soils may be planted with temporary or permanent vegetation. If the soil will be exposed during the winter months, protective measures other than vegetation must be used.

Divert runoff away from denuded areas. When vegetative cover is removed from land, the soil becomes highly susceptible to erosion. Runoff from areas that have been denuded should not be allowed to cross the exposed soils, particularly when the denuded areas are on slopes. Use diversion dikes or swales to divert upland runoff away from a disturbed area to a stable outlet.

Minimize length and steepness of slopes. Slope length and steepness are among the most critical factors in determining erosion potential. Increasing slope length and steepness increases the velocity of runoff, which greatly increases its erosive energy. If slope steepness is doubled while other factors are held constant, soil loss potential is increased 2-1/2 times. If both slope steepness and length are doubled, soil loss potential is nearly 4 times greater. To prevent erosive velocities from occurring on long, steep slopes, interrupt the slopes at regular intervals using barrier or trap techniques.

Keep runoff velocities low. The energy of flowing water increases as the square of the velocity, that is, as the velocity doubles, the erosive energy will quadruple and the water can theoretically move particles 64 times larger by volume. Channel velocities can be kept low by lining drainage ways with rough surfaces such as vegetation and riprap, by designing broad, shallow flow areas, and by constructing check dams at frequent intervals. Concrete channels, although efficient and easy to maintain, remove runoff quickly, often resulting in downstream channel erosion and flooding.

Prepare drainage ways and outlets to handle concentrated or increased runoff. Construction changes the characteristics of runoff. The creation of impervious surfaces, removal of plant cover, and compaction of soil by construction traffic allows less water to percolate into the soil and therefore increases the volume of runoff. Alternatively, if a project can be so designed that runoff from development areas is allowed to infiltrate into the soil on-site, no off-site channel enlargement or protection should be necessary. To prevent channel erosion from occurring, design drainage ways to withstand the peak flows without erosion, select lining materials appropriate for peak flows, and de-energize concentrated flows at outlets using energy dissipaters.

Trap sediment on site. If development substantially changes the natural drainage conditions in a watershed, merely protecting the drainage channels on a project site may not be sufficient to prevent erosion. Some erosion during construction is unavoidable. The function of a sediment barrier is to prevent sediment from leaving a site after the soil has been eroded from its place of origin. Sediment laden runoff should be detained on-site so that the soil particles can settle out before the runoff enters receiving waters. Locate sediment basins and traps at low points below disturbed areas. Use earth dikes or swales to route drainage from disturbed areas into the basins. Sediment barriers and sediment fences can be placed below small - disturbed areas on gentle to moderate slopes. Storm water temporarily ponds up behind these barriers, allowing sediment to settle out.

Inspect and maintain control measures. Inspection and maintenance of control measures are vital to the success of an erosion and sediment control program. Most control measures require regular maintenance. Problems often develop during a single storm. Some problems left untreated can result in more erosion damage than might have occurred without any erosion control measures. Inspect control measures frequently, particularly before, during, and after storm events, to ensure that they are working properly. Correct problems as soon as they develop. Assign to an individual the responsibility for routine inspections of operating erosion and sedimentation control practices.

3.2 Five Basic Rules of Planning

Successful erosion control requires minimizing disturbed areas therefore an ESCP should emphasize scheduling and phasing. Project scheduling and phasing is often driven by factors other than erosion control, so contingency planning is essential. Most importantly, the ESCP should be designed and implemented as a living, dynamic plan that can be adapted to address changes in the project as work progresses.

Erosion control measures are required for construction areas where the ground surface will be disturbed by clearing, grading, fills, excavations and other construction activities. When developing an effective ESCP, there are several important concepts to consider:

- Timing - schedule work to minimize overall impacts
- Stage work - identify & process critical areas first
- Minimize disturbance – retain vegetation, create buffers & reduce mass grading
- Pre-construction meetings - during preliminary design & prior to on site grading activities
- Pictures/Video - documentation throughout life of project

Another important concept to keep in mind when developing erosion sediment control plans is that implementing construction practices, which minimize the amount of disturbed land area and avoids or minimizes work on steep slopes, can lead to positive results. For example:

- There is less chance of soil washing off the site onto streets, drainage systems, and adjacent properties.
- Existing water quality facilities are protected by reducing impacts from disturbance activities.
- The number and size of erosion control measures required will be minimized.
- The overall cost of maintaining erosion and sediment control facilities are minimized.
- Top soil is retained on the site, making revegetation and landscaping easier to re-establish.

It is equally important to note that approval of an erosion and sediment control plan by the local jurisdiction does not relieve the applicant's responsibility to ensure that erosion control measures are constructed and maintained to prevent sediment from leaving the construction site. These requirements are upheld throughout the life of the construction site.

3.3 Designer Responsibilities & Designated Persons

A designer puts the ESCP together based upon information obtained from local and regional agencies, and a detailed field site visit. In addition, the designer must, identify potential erosion and sediment problems, develop design objectives, formulate and evaluate alternatives, select the best erosion prevention measures, and develop a clear plan. A determination is made about what best management practices are appropriate. A variety of BMPs should be included on the plan in order to provide adequate tools in the field. By following the step-by-step process listed in Section 3.6, designers can improve overall success.

The designated person, whether contractor or erosion and sediment control specialist, has a defined responsibility to prevent pollution from leaving the site. The person must follow the approved ESCP, and ensure that the site is stable. Even though the ESCP may be followed in detail and appear to have addressed all issues, there will inevitably be obstacles along the way that will require the approved plan be revised. The ESCP must be accurate and reflect existing site conditions. The best scenario includes a good plan, open lines of communication, and defined responsibilities.

For 1200-C permits, the designated person is responsible for monitoring and record keeping of the site conditions as they relate to erosion prevention and sediment control. For projects that are five or more acres, inspections must be conducted by a person certified in an approved erosion and sediment control program. In addition to having appropriate training and experience, the DEQ 1200-C Guidance specifies that the designated person:

- is knowledgeable in the principles and practice of erosion and sediment controls,
- possesses the skills to assess conditions at the construction site that could impact stormwater quality,
- is knowledgeable in the correct installation of the erosion and sediment controls, and
- is able to assess the effectiveness of any sediment and erosion control measures selected to control the quality of stormwater discharges from the construction activity

3.4 Planning Resources

When determining what erosion prevention measures are appropriate for a particular site, it is important to utilizing the best available information. Several resources are available that can inform designers during development of the ESCP and lead to the correct decisions on what BMPs are needed to keep a construction site stable.

3.4.1 Soil Survey Information

Knowing the type of soil found on the project site will help the designer decide upon the degree of erosion protection required. This will ensure that the ESCP is adequate to control soil movement without being overly conservative. Each county has a published survey of soils and that information is found in the Natural Resource Conservation Service Soil Survey, a mapped inventory by county with physical properties and characteristics described for each soil type.

Of prime importance are the predictions of soil behavior for selected land uses. Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. A directory of NRCS county offices can be found on the Internet at https://www.nrcs.usda.gov/wps/portal/nrcs/site/national/home/

3.4.2 Environmental Data

The designer should determine if there are sensitive areas or natural resources that will require protection. State and federal regulatory agencies such as Department of State Lands and the US Army Corps of Engineers and local jurisdictions will have available data that shows the location of protected waterways or natural areas that will need to be taken into consideration when developing the ESCP.

3.4.3 Climate and Precipitation Data

The occurrence and amounts of rainfall is important for the designer when deciding to what extent the erosion control measures must be used. Rain gauges can be used to assist in determining on-site rainfall. Precipitation data may be found by visiting the National Weather Service website at https://www.weather.gov/

West Coast Weather Observation at https://www.weather-forecast.com/topographic-maps/west-coast gives information on temperatures, wind direction, relative humidity, and precipitation all over Oregon. Oregon Coast and Pacific Northwest Weather Forecasts, provides weather predictions as well as current weather data and can be found at https://graphical.weather.gov/sectors/pacnorthwest.php

3.4.4 Topography

From the site visit, determine the drainage patterns from the topography. Does runoff flow from offsite through the construction site? If so, measures should be taken to re-route this water around areas that will have ground disturbance.

Will areas of soil disturbance occur on long or steep slopes? If so, the lengths of the uninterrupted flows should be broken up so that the rainfall runoff will only flow short distances thereby decreasing flow velocity and the erosive force. In flat areas, runoff is slow and soil particles are not moved far from the point of raindrop impact. If the slopes are steep and short, surface cover may be needed to decrease runoff and promote rainfall infiltration into the soil. On steep slopes, soil movement increases dramatically. Constructing on very long slopes and especially, long, steep slopes should be avoided. Those that already exist should not be disturbed.

The Department of Geology and Mineral Industries (DOGAMI) helps increase understanding of Oregon's geologic resources and hazards and has publications that are available free of charge, and can be download at https://www.oregongeology.org/pubs/pubsearch.htm. The U.S. Geological Survey has also published Oregon information, which is available at https://pubs.er.usgs.gov/

3.4.5 Revised Universal Soil Loss Equation (RUSLE)

In order to properly design detention and conveyance structures, a designer must be able to calculate the quantities of water and sediment that will need to be managed by the structure. The design method for calculating soil loss from disturbed land is the Revised Universal Soil Loss Equation (RUSLE). RUSLE estimates soil loss from a slope caused by raindrop impact and overland flow (collectively referred to as "interrill" erosion), plus rill erosion. It does not estimate gully or stream-channel erosion. RUSLE is a tool to estimate the rate of soil loss based on site-specific environmental conditions and a guide for the selection and design of sediment and erosion control systems for the site. RUSLE does not determine when soil loss is excessive at a site, when erosion control systems have failed, or sediment yield once it has left the site. The RUSLE user makes such decisions based upon numerous criteria, of which soil-loss and sediment-yield estimates are on important compound.

The RUSLE formula can be found in this manual on page 3-10 under step 6. For a complete copy of the guidelines and the public domain RUSLE software, please visit: http://fargo.nserl.purdue.edu/rusle2_dataweb/RUSLE2_Index.htm

3.4.6 Agency Contact Information

- Check the website of the local jurisdiction that your project will be in to ensure that you have the most current information on their erosion prevention and sediment control requirements.
- Oregon Seed Certification Service https://seedcert.oregonstate.edu/
- Natural Resource Conservation Service https://www.nrcs.usda.gov/wps/portal/nrcs/site/or/home/
- International Erosion Control Assoc. www.ieca.org
- National Weather Service www.weather.gov
- PNW IECA http://www.ieca.org/IECA/IECA_Events/Chapter_Events/individual_pages/Pacific_Northwest_Chapter.aspx
- West Coast Weather Observations https://www.weather-forecast.com/topographic-maps/west-coast
- Oregon Coast and Pacific NW Weather https://graphical.weather.gov/sectors/pacnorthwest.php
- US Army Corps of Engineers (COE) http://www.usace.army.mil/
- Dept. Of State Lands (DSL) http://www.oregon.gov/DSL/
- OR Dept Of Fish &Wildlife (ODFW) http://www.dfw.state.or.us/
- ODEQ https://www.oregon.gov/deq/wq/wqpermits/Pages/Stormwater-Construction.aspx
- OR Dept. of Agriculture (ODA) http://oregon.gov/ODA/
- OR Dept of Transportation (ODOT) http://oregon.gov/ODOT
- DOGAMI https://www.oregongeology.org/

3.5 Project Scheduling

Following a specified work schedule that coordinates the timing and land disturbing activities and the installation of control measures is perhaps the most cost-effective way of controlling erosion during construction. The removal of ground cover leaves a site vulnerable to accelerated erosion. Construction procedures that limit land clearing, provide the timely installation of erosion control and sedimentation controls, and restore protective cover quickly can significantly reduce the erosion potential of a site.

Construction projects should be phased to reduce the amount and duration of soil exposure to erosion by wind, rain, runoff, and vehicle tracking. The construction schedule is an orderly listing of all major land disturbing activities together with the necessary erosion and sedimentation control measures planned for a project. This type of schedule guides the contractor on work sequencing so that serious erosion and sedimentation problems can be avoided.

The ESCP should indicate in each of the scheduled work activities, how the proposed erosion/sediment control measures will divert flows, limit runoff from exposed areas, stabilize exposed soil and filter sediment. The following activities should be included in the schedule, if applicable.

- Obtain approval of EPSC plan and permits
- Clearing and grubbing for perimeter controls only
- Installation of perimeter controls
- Installation of site drainage measures if called for in ESCP
- Inspection and approval of measures per plan
- Construction phasing
- Clearing and grubbing, grading and trenching for activities other than perimeter control.
- Grading (including off-site activities) related to the project.
- Final grading, landscaping, and stabilization.
- Work on or at bridges and other water course structures.
- Utility installation and removal.
- Work required in any wetland.
- Monitoring and recording of rainfall.
- Inspection of controls.
- Installation and maintenance of permanent controls.
- Long-term establishment of permanent soil stabilization
- Disposal of waste materials generated on-site
- Installation, maintenance and removal of temporary controls.
- Keep inspection logs current.

Note that the construction activities listed above do not usually occur in a specified linear sequence, and schedules will vary due to weather and other unpredictable factors.

Schedules for temporary and permanent erosion control work is required in any wetlands or watercourse. Plans showing proposed clearing work such as grubbing, grading, trenching, bridges, construction, and paving should be submitted to the appropriate Agency for review. In addition, plans for erosion control on haul roads and borrow pits and plans for disposal of waste materials should be submitted. The contractor may submit the ESCP from the project plans if it is correct for the proposed stage of construction, or prepare a modified version, proposing methods, materials, and procedures, to be used for the weather and site conditions at the time of construction, if applicable.

3.6 Developing an Erosion and Sediment Control Plan

The following are recommended steps that can be use in the development and implementation of an acceptable Erosion and Sediment Control Plan. This information will provide the necessary tools to gain jurisdictional approval and reduce overall environmental risks. Once the project site has been assessed, the catch points for cuts and fills, drainage areas and drainage patterns, sensitive areas, size and location of drainage structures, and of disturbance should be located on the base map. Approximate final grades and any known problems such as highly erodible soils or unstable slopes should also be noted. A sample ESCP and details can be found in Appendix A.

Step 1: Identify Potential Issues

- Public opinion
- Environmental interest groups
- Public Agencies
- Federal and State Environmental Regulations

Step 2: Goals and Objectives

- Meet all regulations
- Minimize negative public opinion
- Improve aesthetics
- Enhance the environment
- Decrease liability
- Higher emphasis on stabilizing steep slopes (2:1 or greater)
- Reduce short and long term erosion
- Reduce or eliminate irrigation costs
- Maximize use of on-site materials (cost-effective solutions)
- Reduce overall maintenance

Step 3: Erosion Study

- Sediment sources
- Review relative sources
    - Maps and aerial photos
    - Distinctive minerals
    - Alluvial fans
- Review regional factors
    - Temperature
    - Precipitation
    - Wind
    - Freeze/thaw
    - Snow melt

- Review watershed
    - Watershed size
    - Topography
    - Channel density
    - Soil types
    - Ground cover
    - Land use

Step 4: Selection of Erosion and Sediment Control Materials

- Effectiveness
- Environmental impacts
- Regulatory acceptability
- Material Cost
- Long-term cost (maintenance)
- Public acceptability
- Risk/liability
- Aesthetics

Step 5: Developing the ESCP (where to go?)

- Local planning and zoning department
    - Regulations and ordinances
    - Prior land use
    - Adjacent and downstream uses
    - Site information
- NRCS/District Conservationist
    - Soils
    - Climate
    - Vegetation/habitat
    - Water management
    - Recreational potential
    - Aerial surveys
- U.S. Geological Survey
    - Topographical maps
    - Major drainage ways
- State Environmental Agencies
    - Stream surveys
    - Wildlife habitat
    - ESA
    - Wetlands
    - Sensitive areas
- Local Flood Control
    - Rainfall data
    - Storm records
    - Flood plains

Step 6: Developing the ESCP (collecting data)

- Photo/video documentation
- Field survey and evaluation (existing)
  - ➢ Topography & contours
  - ➢ Existing drainage upstream & downstream
  - ➢ Identify sensitive areas
  - ➢ Soil samples
  - ➢ Soil survey (NRSC)
- Field survey and evaluation (future)
  - ➢ Topography & contour design
  - ➢ Site drainage system type & location
  - ➢ Impervious areas
- Climate and rainfall information
  - ➢ Onsite rain gauges
  - ➢ Meteorologists
  - ➢ Airport
- Critical habitat
  - ➢ Wetlands vegetation profile
  - ➢ Mitigation/enhancement
- Revised Universal Soil Loss Equation (RUSLE)
  - ➢ A = R x K x LS x C x P
  - ➢ A = Average annual rate of erosion in tons/ac/yr
  - ➢ R = Rainfall factor
  - ➢ K = Soil erodibility factor
  - ➢ L = Slope length
  - ➢ S = Slope gradient
  - ➢ C = Cover
  - ➢ P = Conservation practice

Step 7: Lay out Pre-construction Plan & Base Measures

- Adapt the plan to the resources available
- Fit the development to the existing terrain whenever possible
- Plan must be flexible
- Keep communication lines open at all times
- All reports and instructions must be clear
- Determine construction timing and sequence
- Establish primary access point (s) for construction traffic
- Lay out limits of clearing & construction activities
- Restrict all activities in sensitive areas (mark accordingly)
- Establish base measures including sediment control at toe of disturbed area & stabilized construction entrances
- Establish maintenance procedures for EC Measures

Step 8: Identify Measures During Construction

- Install additional base measures as site clearing/disturbances occur, including stockpiles & slope contours
- Determine if construction may occur during wet weather season (October 1st – May 31st)
- Establish & schedule wet weather measures including cover measures over exposed soils
- Continue to establish maintenance procedures for EPSC measures

Step 9: Post Construction Measures

- Establish ground cover or permanent landscaping prior to removing base measures

Step 10: Plans and Specifications ***(Sample ESCP-Appendix A)***

- Project description
- Construction notes
- BMPs standard symbols ***(see appendix A)***
- Names and locations of existing roads, waterways, and drainage features
- Boundaries of environmentally sensitive areas such as wetlands
- Right of way and easements
- Statement of existing conditions to include highly erodible areas (steep slopes)
- Existing and proposed contour lines
- Run-off calculations
- Calculations of desired performance standards
- Description of erosion control treatment areas
- Detailed grass establishment instructions
- Detail for each BMP used
- Wind erosion control during/following construction

Step 11: Operations and Maintenance

- Guidelines
- Maintenance instructions
    - ➢ Provide operating procedures during/after storm events
- Standards of performance
- Periodic inspection reports w/supported pictures
- Vegetation criteria
- Monitoring
    - ➢ Establish procedures for monitoring performance
    - ➢ Provide adjustment to mitigation measures as needed
- Monitoring and maintenance plan
- Maps
    - ➢ Project boundaries
    - ➢ Adjacent areas
    - ➢ Existing and final topographic features
    - ➢ Drainage areas
    - ➢ Location of existing problems
    - ➢ Location of potential problems
    - ➢ Location and extent of BMPs

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CHAPTER 4
EROSION AND SEDIMENT CONTROL MEASURES AND BMPs

This chapter presents best management practices (BMPs) for erosion and sediment control. The BMPs described in this chapter represent commonly accepted practices that are used to prevent erosion and off site sedimentation during construction activities. Information such as advantages, disadvantages, design, inspection, and maintenance requirements for each BMP are included, and should help in choosing the most appropriate measure or control for given site conditions.

In order to maximize the overall benefits of any BMP selection and placement, there must be a thorough understanding of the site characteristics. The details of installation can and should vary in the field depending on the site conditions. Field variations for each type of measure may be needed during the life of the project. The substitution of other cost-effective products or methods that provide equivalent or superior in performance is encouraged but may need to be approved by state and local agencies.

As implied by their name, BMPs are stabilization methods and structural erosion control measures that if installed and maintained properly can be very effective. Table 4-1 represents commonly accepted practices and the effectiveness ratings for basic applications of each erosion and sediment control measure.

Table 4-1 Matrix of temporary and permanent erosion control measures and estimated effectiveness ratings: E=Excellent, M=Moderate

BMP APPLICATION	TEMPORARY/ PERMANENT	RATING	PAGE
EROSION PREVENTION			
Buffer Zone	P	E	4-5
Preserve Natural Vegetation	P	E	4-7
Dust Control	T	M	4-11
Ground Cover	T	E	4-14
Hydraulic Applications	T/P	E	4-18
Matting	T	M	4-22
Plastic Sheeting	T	M	4-30
Seeding Temporary/Permanent	T/P	E	4-34
Sod	P	M	4-41
RUNOFF CONTROL			
Check Dams	T	M	4-44
Diversion Dikes and Swales	T	M	4-50
Grass-lined Swale	T	M	4-54
Outlet Protection	T	E	4-58
Pipe Slope Drain	T	E	4-63
Surface Roughening	T	E	4-69
SEDIMENT CONTROL			
Bio-filter Bags	T	M	4-77
Construction Entrance	T	E	4-80
Dewatering	T	E	4-84
Filter Berm	T	M	4-89
Inlet Protection	T	M	4-94
Oak Mats	T	E	4-104
Pre-Fabricated Barriers	T	M	4-108
Sand Bags	T	M	4-111
Sediment Basin	P	E	4-115
Sediment Fence	T	M	4-121
Sediment Trap	T	E	4-127
Sidewalk Subgrade Gravel Barrier	T	M	4-133
Tire Wash	T	E	4-138
Wattles	T	M	4-143

4.1 Erosion Prevention Best Management Practices

Erosion prevention is the most effective and inexpensive method for reducing overall environmental impacts associated with construction activities. With this in mind, timing, staging, and minimizing the amount of exposed soil and directing surface water runoff away from exposed soil are all excellent ways to minimize erosion during construction. Erosion prevention practices primarily involve preserving natural vegetation when possible or stabilizing exposed soils with temporary covers or permanent vegetation. Reducing the erosion associated with construction vehicular traffic is also covered in this section. Employing the following erosion prevention techniques can reduce erosion by 80 to 95 percent compared with exposed soils.

1. Buffer Zone
2. Preserve Natural Vegetation
3. Dust Control
4. Ground Cover
5. Hydraulic Applications
6. Matting
7. Plastic Sheeting
8. Seeding - Temporary and Permanent
9. Sod

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BUFFER ZONE

4.1.1 Buffer Zone

A buffer zone consists of an undisturbed area or strip of natural vegetation adjacent to a disturbed area that reduces erosion and runoff. This zone should not be confused with the "Natural Buffer Zone" requirement found in the ODEQ 1200-C permit. The buffer zone should not be used as a sediment control measure.

<u>Advantages</u>

- Filters sediment.
- Promotes infiltration.
- Provides habitat.
- Reduces velocity and quantity of runoff, dissipates energy.
- Provides visual screening.
- Can be used to stabilize stream banks.
- Low maintenance.

<u>Disadvantages</u>

- Requires keeping all construction equipment, debris and soils out of the buffer zone.
- Extensive buffer zones can cover large areas of land that are not available for project development.

<u>Design Criteria</u>

- Preserve natural vegetation in clumps, blocks or strips.
- Preserve natural vegetation on unstable, steep slopes.
- Clearly establish construction limits with orange construction safety fence and signs spaced 100 feet apart. Perimeter sediment control should also be used to ensure protection of buffer zone.
- Vegetative buffer zones for streams, lakes or other waterways should meet current regulatory standards for required buffer width. Check with local jurisdiction for specific buffer zone requirements.
- The most common problem with this BMP is non-observance of clearing limits and clearing of the entire site prior to construction. If possible, work with the contractor to establish a phased clearing and grading schedule at the beginning of the project.

<u>Inspection & Maintenance</u>

- Inspect flagging and fencing frequently and repair as needed.

PRESERVE NATURAL VEGETATION

4.1.2 Preserve Natural Vegetation

This BMP involves preserving natural vegetation to the greatest extent possible during the construction process, and after construction where appropriate. Maintaining as much natural vegetation within the perimeter of the project site is the most effective and inexpensive form of erosion prevention control. This method is particularly important in helping to protect sensitive areas such as wetlands, stream corridors, lakes, and near steep slopes. The project manager, inspector and contractor should address and discuss preserving natural vegetation during the Pre-construction meeting. Although this is a proven BMP, it is imperative that all exposed soils are covered in a timely manner.

Advantages

- Helps reduce soil erosion and runoff.
- Saves landscaping costs, provides areas for wildlife, and provides visual screening.
- Retains existing shade and cover habitat.

Disadvantages

- Retaining existing trees could create a safety hazard. If considering removing trees due to hazard concerns ensure these trees are not shown on the site plan as needing to be retained.
- May constrict area available for construction activities.

Design Criteria

- Coordinate with the Landscape Architect and Environmental Professionals assigned to the project when determining what to save and how to save it.
- Vegetation can be preserved in natural clumps or as individual trees, shrubs and vines.
- Clearly establish and mark ground disturbance limits outside the dripline of preserved trees, using orange construction safety fence or flagging if approved.
- Protect vegetation from:
  - ❑ Construction equipment injury above or below the ground level. Injury can occur from scarring, cutting roots, or compaction.
  - ❑ Grade changes, which affect the plants' ability to obtain air, water or minerals. Placing a layer of gravel and a tile system over the roots before a major fill allows air to circulate and protects the plant from the fill.

- Terracing the area around the plant, or leaving the plants on an undisturbed mound can increase the plants' survival chances. Will protect against excavations for utilities and cover exposed roots.

Inspection & Maintenance

- Repair and/or replace damaged fencing.
- Evaluate the condition of the vegetation to ensure it continues to protect against erosion.
- Re-cover and protect exposed plant roots.

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DUST CONTROL

4.1.3 Dust Control

Preventative measures to minimize the wind transport of soil and to reduce dust generated by construction activities.

Advantages

- Reduces movement of soil to offsite areas.
- Increases visibility.
- Prevents traffic hazards.
- Reduces sediment transported by wind and deposited in water resources.

Disadvantages

- Over watering may cause erosion and tracking.
- Most methods require immediate reapplication if disturbed.
- Too little watering fails to control dust.

Design Criteria

- Schedule construction operations so that the least amount of project area is disturbed at one time.
- Apply water over areas that are susceptible to wind erosion or applying other soil-binding palliatives.
- Install construction entrances and stabilizing construction haul roads with crushed rock
- Install temporary or permanent surface stabilization measures immediately after completing land grading. Measures include:
  - ❑ Seeding
  - ❑ Mulching
  - ❑ Matting
  - ❑ Tackifier
  - ❑ Chemical Soil Stabilizers
- Covering stockpiles will reduce potential for wind to release dust.

Inspection & Maintenance

- Maintain dust control measures through dry weather periods until all disturbed areas have been stabilized.
- Immediately re-stabilize areas disturbed by contractor’s operations or other activities.

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GROUND COVER

4.1.4 Ground Cover

Ground cover is a protective layer of straw, mulch or other suitable material applied to the soil surface that provides immediate temporary protection from erosion. Ground cover can be applied manually or by machine. In some cases, straw mulch and/or hydromulch can be used in conjunction with seeding for the establishment of temporary or permanent vegetation in disturbed areas. Mulch also enhances plant establishment by conserving moisture, holding fertilizer, seed, and topsoil in place, and moderating soil temperatures.

<u>Advantages</u>

- Provides immediate protection.
- Conserves moisture
- Acts as a thermal layer for seed
- If used in conjunction with seed, allows seed growth through the mulch
- Protects seeding from direct heat, moisture loss and transport due to runoff
- Used for dust control

<u>Disadvantages</u>

- Thick mulches can delay germination.
- Can be blown or washed away if not correctly applied.
- Must be removed prior to applying fill material.

<u>Design Criteria</u>

- Divert concentrated runoff away from areas to be covered.
- Refer to Table 4-2, which outlines ground cover type, quality, and application rate.
- Refer to **<u>Appendix C</u>** for *Mulch and Seed Application Rate Worksheet*.
- Additional measures may be required to improve effectiveness on slopes.
- On sites where chopped straw is applied, the straw needs to be anchored using a liquid tacking agent.
- The straw mulch should not be moldy, caked, decayed or of otherwise low quality. May be required to submit verification from the supplier that the straw is free of noxious weeds. This verification is especially important when using straw mulch near natural areas.

<u>Inspection & Maintenance</u>

- Maintain specified thickness of the cover. See Table 4-2
- Re-cover and/or protect with a net or blanket any areas that experience erosion. If the erosion problem is drainage related, fix the drainage problem first and re-cover

the eroded area. If mulched areas are damaged by concentrated runoff and erosion is evident, prompt implementation of additional practices and BMPs may be necessary.

- Hydraulically treated areas shall be inspected and monitored after installation and periodically thereafter.
- Hydraulic mulches and tackifiers are interim measures until the permanent erosion-resistant cover is established. If the hydraulic mulch or tackifiers were applied as stand alone (without vegetation) treatments for erosion and dust control, the product longevity must match the length of time that the soil will remain bare or until revegetation occurs. Periodic inspections will assure the intended purposes will be met.
- Areas that fail to establish cover adequate to prevent erosion should be re-covered as soon as such areas are identified.

Table: 4-2 Ground Cover Application

Material	Quality Standards	Application Rate Per acre	Depth of Material	Considerations
Straw	Air dried, free from unwanted seeds & coarse materials	2-2 ½ tons	2 inches min. uniform spread	Use where the mulching effects is to be maintained < 3 months. When chopped straw is applied, use a tackifier or stamped in.
Yard Debris Compost	Well composted organic matter free of metals, plastics and other foreign matter	3-6 tons	1 inch 4:1 slopes 2 inch 3:1 slopes 3 inch 2:1 slopes	Excellent soil amendment. Compost size: ¾ x 0 on 3:1 slopes or less. 1 ½ x 0 on 2:1 slopes.
Wood or Cellulose fiber	Dyed green, should not contain growth inhibiting factors	2000 lbs.	N/A	Apply with hydromulcher. May need to double the rate depending on soil and slope. Use tackifier as recommended by manufacturer.
Wood Chips or Grindings	Green or air-dried free of objectionable coarse materials	5-6 tons	1-3 inches depending on slope	Very durable. Apply with mulch blower, excavation equipment, or by hand. Not suitable for areas that require close mowing.
Gravel or Crushed Rock	Washed ¾- 1 ½ inch	9yds/1000 ft^2	3 inches	Excellent for short slopes and where subject to foot traffic. Larger pit-run can be used on steep slopes prone to sub-surface water (springs).

HYDRAULIC APPLICATIONS

4.1.5 Hydraulic Application

Hydraulic application is a mechanical method of applying erosion control materials to bare soil in order to establish erosion-resistant vegetation on disturbed areas and critical slopes. By using hydraulic equipment, ground covers such as, soil amendments, mulch, tackifying agents, Bonded Fiber Matrix (BFM) and liquid co-polymers can be uniformly broadcast, as homogenous slurry, onto the soil. These erosion and dust control materials can often be applied in one operation.

Advantages

- Provides rapid installation. Seed, fertilizer, mulch, tackifier, soil amendments, Bonded Fiber Matrix, and chemical stabilization can be applied in a one-step procedure.
- Generally requires less seedbed preparation, the surface soil may be left irregular with large clods, stones, or rock outcropping exposed.
- Uniformly distributes seed and mulch material.
- Increases favorable conditions for quick germination and growth.
- Can be used effectively on steep slopes and other areas where access is limited and where mulch would be difficult to otherwise anchor
- Can be used in areas where soil stabilization, seeding, and mulching practices would result in unacceptable levels of ground disturbance.
- Can be used where site conditions, such as irregular soil surfaces, existing vegetation, and shallow soils preclude the installation of erosion mats.
- Can be used for dust control.

Disadvantages

- Generally more expensive than broadcast or drilling seed applications.
- Thick mulch applications can delay germination.
- Can be blown or washed away if not adequately tackified.
- Required application rates can vary significantly dependent on site preparation.
- Application during wet weather can be difficult.

Design Criteria

- Divert concentrated runoff from above treated areas.
- Wood fiber mulch or wood/paper mulch should be applied at a rate of 2000 to 2500 lbs per acre.
- Bonded Fiber Matrix (BFM) is considered a liquid blanket and can be applied on steep 1:1 slopes at application rates between 3000 and 4000 lbs per acre, depending upon soil type and irregularities.

- When seeding, maintain sufficient moisture level using permanent or temporary irrigation.
- On sites where straw mulch has been applied, the straw needs to be anchored using a liquid tacking agent.
- If the hydraulic mulch or tackifiers were applied as stand alone (without vegetation) treatments for erosion and dust control, the product longevity must match the length of time that the soil will remain bare or until re-vegetation occurs.
- Refer to **Appendix C** for Hydraulic Application Tables for seed and mulch.

Inspection & Maintenance

- Re-mulch and protect with additional BMPs in any areas that experience erosion. If the erosion problem is drainage related, fix the drainage problem first then make necessary repairs.
- Hydraulic mulches and tackifiers shall provide the necessary erosion protection until permanent erosion-resistant cover is established. If sheet or rill erosion is evident then prompt re-application of treatments shall be necessary.
- Areas that fail to establish 80% healthy stand of grass cover to prevent erosion should be properly covered using one of the ground cover applications.

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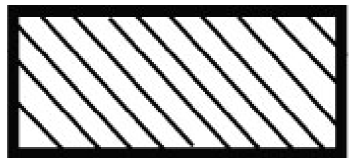
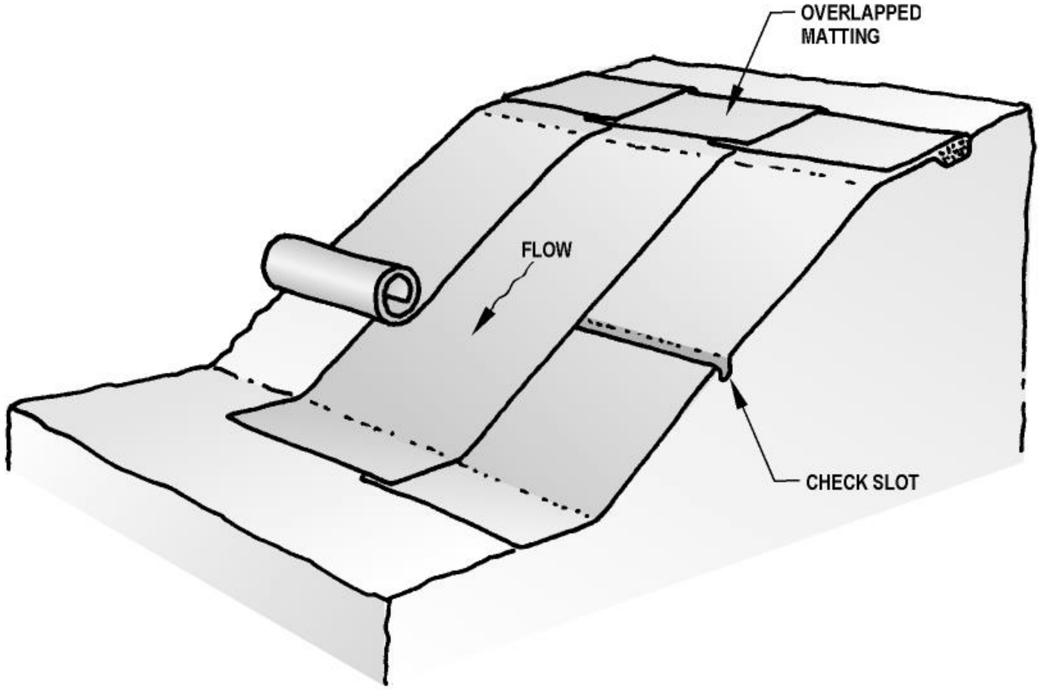
MATTING



4.1.6 Matting



Matting is a class of products that are rolled, blanket-like materials used to stabilize and protect disturbed sloped areas. Matting can also be referred to as blankets, fabric and nets. A wide range of materials and combination of materials are used to produce matting including, but not limited to straw, jute, wood fiber, coir (coconut fiber), plastic netting, and Bonded Fiber Matrix. The selection of matting materials for a site can make a significant difference in the effectiveness of the BMP.

When selecting matting consider these questions:

1. How long will the matting be required to provide protection?
2. How steep is the slope?
3. What is the soil type?
4. What is the shear stress on the channel bottom?
5. Is the site within a natural area or sensitive area?

Advantages

- Immediate cushioning against splash erosion from raindrop impact.
- Does not generate high-velocity runoff and, therefore, offers temporary slope protection, which is superior to plastic sheeting.
- Captures a great deal of sediment due to its open, porous structure.
- Usually easy to install.

- Provides long-term protection, based on matting selection.

Disadvantages

- Correct installation is critical to the effectiveness of these products. Good ground contact during installation prevents runoff concentrating under the blanket and causing significant erosion (tenting).
- Soil surface must be graded smooth with no surface irregularities.
- Limited protection capabilities when used as flexible channel liner.
- Synthetic mats made from non-biodegradable material may not be appropriate for placement in sensitive areas, due to the potential impact on wildlife.

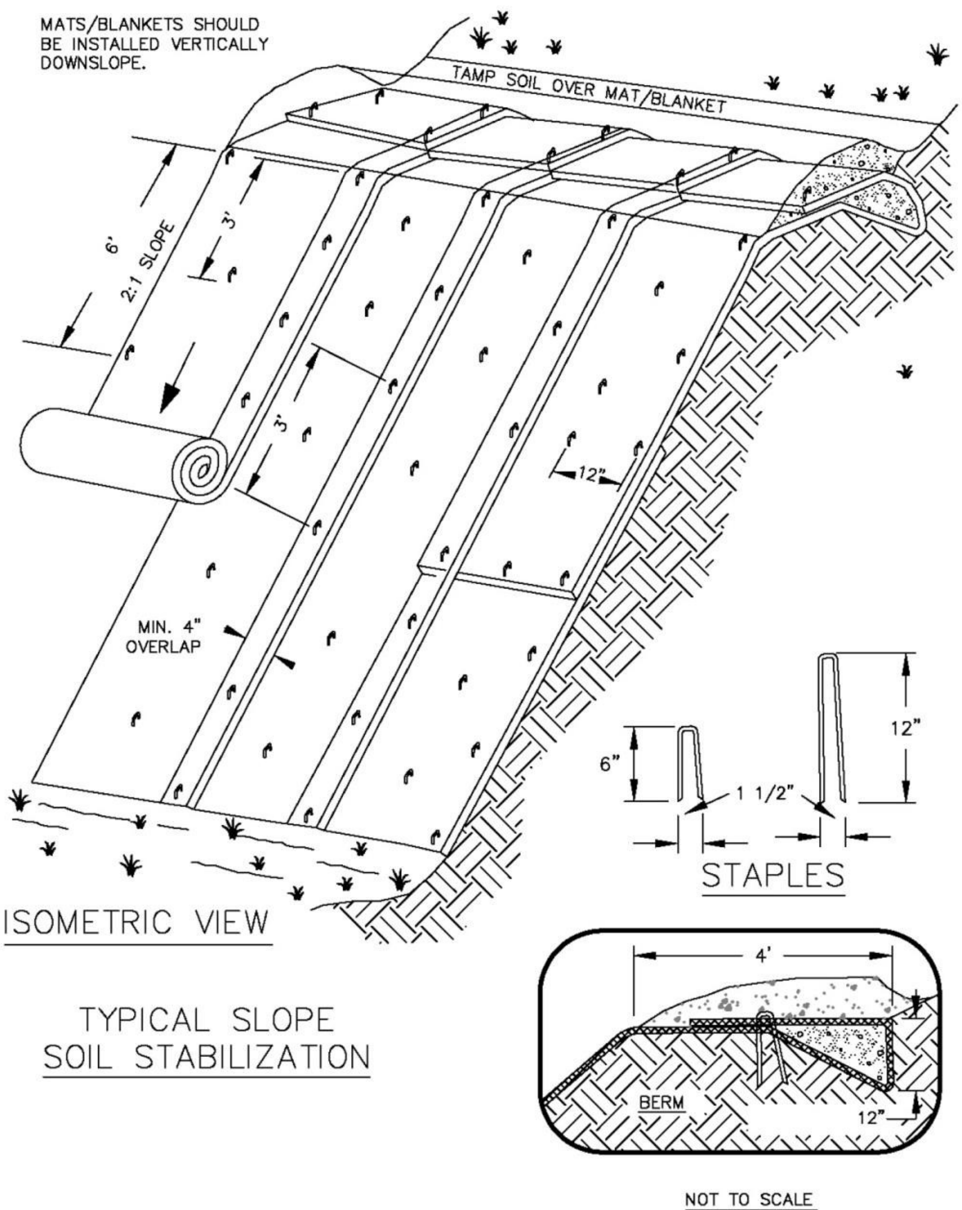
Design Criteria

- Generally used on slopes 2:1 and steeper.
- Surface must be graded smooth.
- Remove all debris and undulations larger than 2 inches in any dimension.
- Apply seed and fertilizer prior to matting.
- Install so that matting is in complete contact with soil surface.
- See **Table 4-3** for matting application and refer to manufacturer's specifications for staple pattern.
- Organic matting materials (excelsior, jute and coir) biodegrade and are useful for applications requiring stabilization for up to three months. Use organic blankets, which retain moisture and provide organic matter to the soil, for slope protection and short-term waterway protection and to improve the speed and success of revegetation.
- Excelsior brand (aspen wood fiber), woven straw, and coir (coconut fiber) blankets may be installed without mulch because they provide sufficient surface protection.
- Synthetic mats are made from non-biodegradable material and will remain in place for years and offers long-term stabilization (some photodegradation does occur). This matting option is not recommended for use near sensitive areas.
  - Turf Reinforcement Mats (TRM) are made from polymer netting or monofilaments formed into a Synthetic 3-D mat. TRMs protect seed and increase germination and acts as part of the root structure; giving the turf higher strength.
  - Erosion Control and Revegetation Mats (ECRM) are composed of heat-fused monofilaments or monofilaments stitched between netting and act as permanent mulch. ECRM allow growth through the mat.
- Channel or swale applications:
  - Lengthwise overlap: Min. 12 inches

  - Crosswise overlap: Min. 6 inches
  - Avoid joining material in center of ditch or swale
- Slope application:
  - Lengthwise overlap: Min. 6 inches
  - Crosswise overlap: Min. 6 inches
  - At top of slope, entrench matting material in a 6 inch X 6 inch trench and staple at 12 inch intervals
  - At bottom of slope, extend matting material 2 feet beyond the toe of the slope, turn material under 4 inches and staple at 12 inch intervals
  - On 4:1 slopes, rolls can be placed in horizontal strips
  - Matting material must be stapled in place as they are installed down the slope face every 4 feet until you reach the bottom. This keeps blanket in relaxed position, eliminating the potential for under-rilling.

Inspection & Maintenance

- Repair any damaged areas of the matting material and staple into the ground any areas not in close contact with the ground surface.
- If erosion occurs, repair and protect the eroded area.



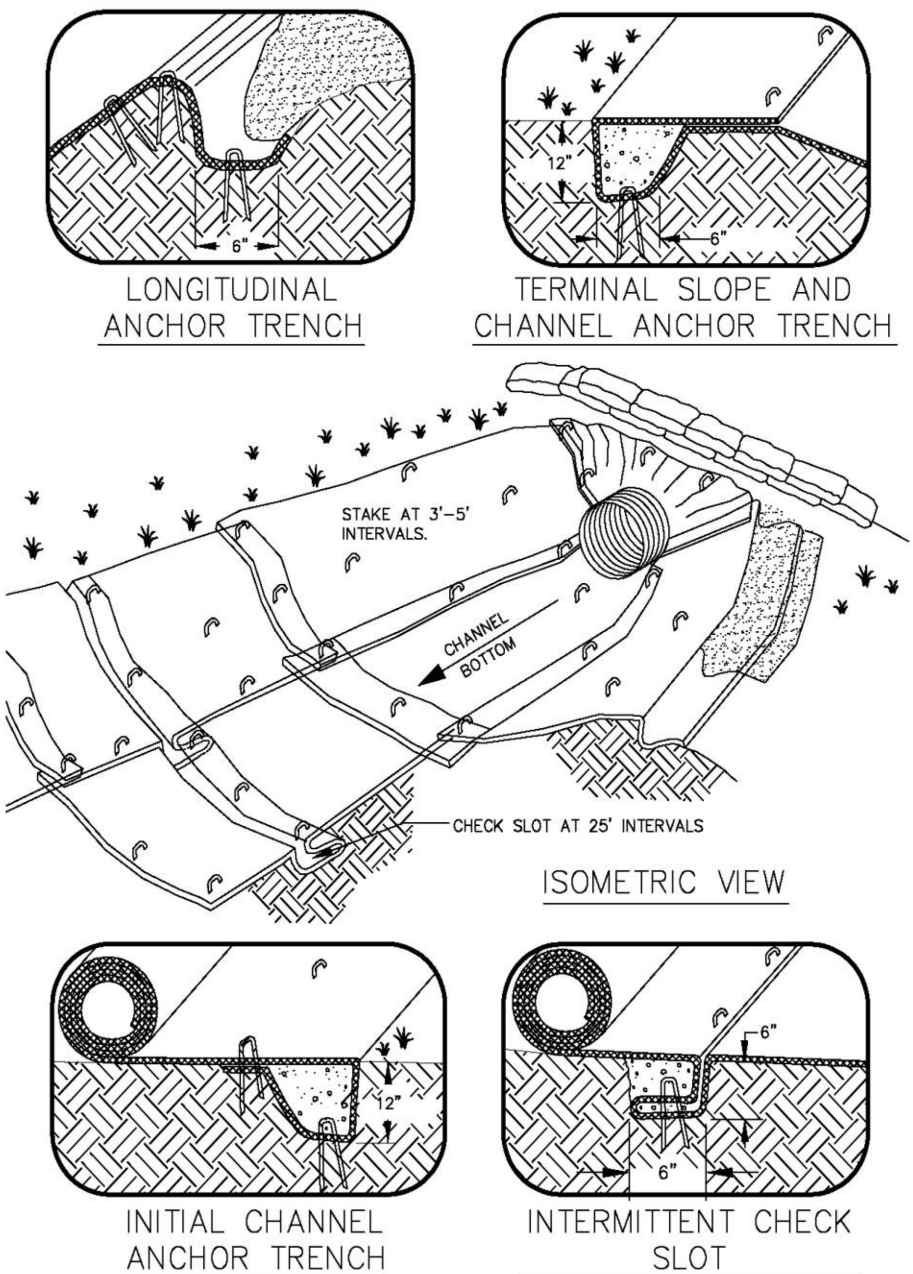
NOTES:

1. SLOPE SURFACE SHALL BE FREE OF ROCKS, CLODS, STICKS AND GRASS. MATS/BLANKETS SHALL HAVE GOOD SOIL CONTACT.
2. APPLY PERMANENT SEEDING BEFORE PLACING BLANKETS.
3. LAY BLANKETS LOOSELY AND STAKE OR STAPLE TO MAINTAIN DIRECT CONTACT WITH THE SOIL. DO NOT STRETCH.
4. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.

MATTING SLOPE INSTALLATION

DRAWING NO. 805

REVISED 10-31-19



NOTES:

1. CHECK SLOTS TO BE CONSTRUCTED PER MANUFACTURERS SPECIFICATIONS.
2. STAKING OR STAPLING LAYOUT PER MANUFACTURERS SPECIFICATIONS.

MATTING CHANNEL INSTALLATION

DRAWING NO. 800

REVISED 10-31-19

Table 4-3 Matting Specifications

Matting Type	Slope/Channel Application	Netting Type
Straw	3:1 or less	Type 1 - Photo degradable polypropylene top/bottom Type 2 - 100% Bio degradable (used near sensitive habitat areas)
Straw/Coconut	2:1 or less	Type 1 – Photo degradable polypropylene top/bottom Type 2 – 100% Bio degradable (used near sensitive habitat areas)
Coconut	1:1 or less Low flow channels	Type 1 – Photo degradable polypropylene top/bottom Type 2 – 100% Bio degradable (used near sensitive habitat areas)
Jute	3:1 or less Short, 2:1 slopes	100% Bio degradable
Excelsior	2:1 or less Low flow channel	Photo degradable extruded plastic mesh top/bottom
Coir fabric	1:1 or less 8-10 fps channel	Type 1 – 1 inch grid 100% Bio degradable (4-10 year life) Type 2 – ½ inch grid 100% Bio degradable (4-10 year life) Type 3 – ¼ inch grid 100% Bio degradable (4-10 year life)
TRM	High flow channels 8-20 fps	Three dimensional synthetic polyolefin fibers mechanically bonded between two nets (not recommended for use near natural areas)

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PLASTIC SHEETING

4.1.7 Plastic Sheeting

Provides immediate protection to slopes and stockpiles. Plastic sheeting has been known to transfer erosion problems because water will sheet flow off the plastic at high velocity. This is usually attributable to poor application, installation and maintenance. Use alternatives to plastic covering whenever possible.

Advantages

- Provides immediate, short-term erosion protection to slopes that are prone to erosion and stockpiles.
- Fairly quick and easy to install.

Disadvantages

- Plastic sheeting may concentrate sunrays and burn the vegetation beneath it.
- Smooth plastic sheeting can generate high velocity runoff.
- Plastic breaks down quickly when exposed to ultraviolet radiation.
- Plastic, when it is not removed, can clog drainage system inlets and outlets.
- If not properly anchored, wind may transport plastic.

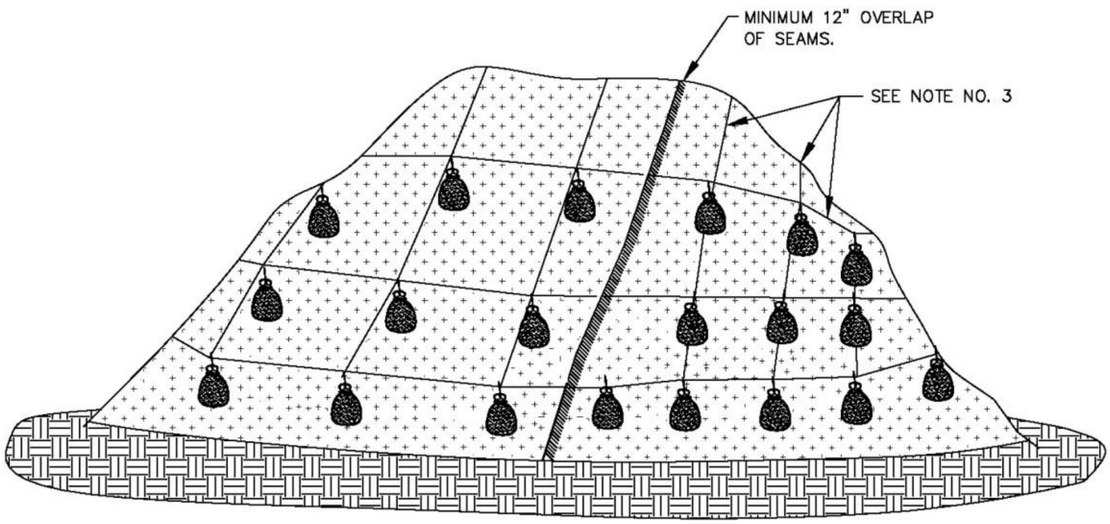
Design Criteria

- Do not use plastic covering upslope of areas such as steep and/or unstable slopes that might be adversely affected by concentrated runoff.
- When possible, install an interceptor dike and/or pipe slope drain at the top of the plastic to divert flows away from the plastic.
- Toe-in the top of the sheeting in a 6 inch X 6 inch trench backfilled with compacted native material.
- Install a gravel berm, riprap, or other suitable protection at the toe of slope in order to dissipate runoff velocity.
- Anchor the plastic using sandbags or other suitable tethered anchoring system spaced on a 10 foot grid spacing.
- Overlap seams 1-2 feet, tape, roll and stake the seams and then weigh down the entire length.

Inspection & Maintenance

- Replace torn sheets and repair open seams.
- Completely remove and replace plastic when it begins to deteriorate.
- Completely remove all plastic once it is no longer needed.
- Check anchoring system and repair or add anchors.

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.



PLASTIC SHEETING

NOTES:

1. MINIMUM 12" OVERLAP OF ALL SEAMS REQUIRED.
2. PERIMETER SEDIMENT CONTROL BMP TO BE INSTALLED A MIINIMUM OF 3' FROM TOE OF STOCKPILE.
3. COVERING MAINTAINED TIGHTLY IN PLACE BY USING SANDBAGS OR APPROVED EQUAL ON ROPES WITH A MAXIMUM 10' GRID SPACING IN ALL DIRECTIONS.
4. PLASTIC TO EXTEND MINIMUM 1' BEYOND TOE OF SLOPE.
5. AS APPROPRIATE, BMP'S SHALL BE INSTALLED TO CONVEY WATER DISCHARGE FROM STOCKPILE AREAS.

PLASTIC SHEETING

DRAWING NO. 810

REVISED 10–31–19

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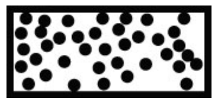
SEEDING
TEMPORARY/PERMANENT



4.1.8 Seeding (Temporary/Permanent)

A well-established vegetative cover is one of the most effective methods of reducing erosion. Vegetation should be established on construction sites as the slopes are finished, rather than waiting until all the grading is complete. To ensure seed germination and adequate vegetation establishment, temporary or permanent seeding applications should be completed prior to September 1st of that year.

Advantages

- Eliminates splash erosion.
- Traps sediment.
- Promotes infiltration.
- Reduces runoff velocities.
- Provides excellent stabilization.
- Relatively inexpensive erosion control measure.
- Effective for dust control

Disadvantages

- Needs sufficient time for seed to establish.
- Requires mulch or other cover until vegetation is established.
- May require fertilizer and lime to establish on poor soils.
- May require irrigation.
- Must be removed prior to applying fill material.

Design Criteria

The following sections present general information regarding seeding, bed preparation, mulching and fertilizing.

Selection Criteria

Standard grass and legume seed mixes for erosion control purposes are developed by local or regional distributors for site specific applications. Often more than one grass species is selected so that at least one species will do well given the extreme seasonal fluctuations that occur in the region.

Seedling vigor is an important plant characteristic to consider for erosion control seeding because the goal is to have rapid establishment and a dense fibrous root system. This holds the soil in place and provides a thick canopy over the soil to break the raindrop velocity. Some grasses do well early in the season and can act as nurse or cover crops until the slower growing species can establish. Seed mixes are developed for specific climatic zones around the state to match the optimum growing conditions for each species.

One grass seed characteristic that is considered is the season that predominant growth will occur. Grass species are often characterized as being either warm or cool season grasses. A warm season grasses, such as bluegrass, will have its predominant growth during the warm months of the year. Conversely, cool-season grasses, like hard fescue, have its predominant growth in the cool weather and produces seeds in the early spring. To optimize establishment, a cool or warm season grass, or both, may be used depending on whether the seed is planted in the spring or fall.

Another seed characteristic of importance in erosion control is the method by which the grass develops, grows and spreads. Grasses can be either rhizomatous, whereas the grass plant will send out runners that will start new growth, a bunch grass, or a sod-forming grass. Rooting depth is important and grasses are characterized as being deep, moderate and shallow rooting for erosion control purposes. The mixture of rooting depths provides optimum support for soils and best enables the removal of water by the roots at the various zones in the soil.

<u>Seed Purity</u>
All seed furnished to the operator should be those specified in the project plan and should be measured by Pure Live Seed (PLS) weight. Pure Live Seed refers to the portion of a seed lot that is live seed of the desired kind. The purpose of measuring the application on a PLS basis is so that trash and empty seeds do not confuse seeding rate calculations.

All seeds applied for temporary erosion control must be certified in accordance with the Standard Specifications. Seed certification insures varietal purity and seed quality. The seed label must have the following information included:

- Origin.
- The kind and variety of each seed in a mixture, of 3% or more.
- Percent of germination - the percentage of the pure seed that has started to grow by the end of the specified test period. Germination declines with the age of the seed, the variety and storage conditions - always check the date of the test. Total germination for the purpose of PLS calculations is equal to the percent germination from seed test plus percent hard seed.
- Percent of pure seed - the percentage of seed without dirt, dust, chaff, straw, empty kernels, weed, other crops, and other foreign matter. Purity, inert matter, weed seed, other crop seed, and hard seed percentages are shown on the seed tag - they add up to 100%.
- Percent and kind of other crop – the percentage of crop seed other than the specified crop as labeled.

- Percent of inert matter - the percentage by weight of broken seeds one-half or less of full size and all other dead foreign material.
- Percent of weed seed - the percentage by weight of seeds considered weeds by law.
- Percent of noxious weed seed - the percentage of seed considered noxious by law. Refer to Oregon Department of Agriculture website: https://www.oregon.gov/ODA/programs/MarketAccess/SeedRegProgram/Pages/OregonSeedLaws.aspx
- Name and number per pound of restricted noxious weed seeds present.
- Percent of hard seed - the percentage by weight of the labeled crop that remain sound but do not germinate at the end of the test periods. They may germinate later.
- Test date (month and year).
- Name and address of labeler.
- Lot weight.

The label must be correct. The purity, germination and other information on the tag must be backed by a seed lab analysis report. High quality seed germinates well, has a high purity percentage, and is free of noxious weeds. The identity, purity and uniformity of the seed must be maintained at all times. The seed is tested and must meet the minimum seed standards. Lots showing Oregon prohibited weeds are not approved. Seed must meet minimum viability standards. Oregon State University Extension Service keeps a listing of seed varieties that are certified in the OSU Extension Certified Seed Handbook. The seed variety must be approved by the OSU Seed Certification Board to be eligible for certification or meet the standards for certification.

Application and Establishment

- Temporary grass cover measures must be fully established prior to the wet weather season. Other ground cover measures will have to be implemented if establishment is not obtained. In order to establish an 80% healthy stand of grass, all seeding applications should be completed prior to September 1st.
- Apply permanent seeding when no further disturbances are planned.
- Seed should be applied immediately after seedbed preparation while the soil is loose and moist.
- Apply seed before applying straw mulch or other ground cover applications.
- Hydromulch shall be applied with grass seed at a rate of 2000 lb./acre. On slopes steeper than 10%, hydroseed and mulch shall be applied with a bonding agent (tackifier). Application rate and methodology to be in accordance with seed supplier recommendations. (See Appendix C for help)

- Dry, loose, weed-fee straw used as mulch shall be applied at double the hydromulch application requirement (4000 lb./acre). Anchor straw by working in by hand or with equipment (rollers, cleat tracks, etc).
- Permanent or temporary irrigation is recommended and should be supplied, especially in abnormally hot or dry weather or on adverse sites. Water application rates should be controlled to provide adequate moisture without causing runoff.

<u>Site Preparation</u>

- Bring the seedbed area to final grade, remove all rocks and debris, and smooth surface undulations larger than 2 inches.
- Divert concentrated flows away from areas that are to be seeded and during establishment.
- For optimum seeding conditions, preserve topsoil and stockpile material until final grades are established. Spread topsoil over new grades or:
    - Conduct soil test to determine pH and nutrient content.
    - Roughen the soil by harrowing, tracking, grooving or furrowing.
    - Apply amendments as needed to adjust pH to 6.0-7.5. Incorporate these amendments into the soil.
- The seedbed should be firm but not compact. The top 4-6 inches of soil should be loose, moist and free of large clods and stones.
- If the seedbed has been idle long enough for the soil to become compact, the topsoil should be harrowed with a disk, spring tooth drag, spike tooth drag, or other equipment designed to condition the soil for seeding.
- Harrowing, tracking or furrowing should be done horizontally across the face of the slope, so ridges are along the slope contour.

<u>Seeding</u>

- Seed to soil contact is the key to good germination.
- Apply seed at the rates specified using calibrated seed spreaders, cyclone seeders, mechanical drills, or hydroseeder so the seed is applied uniformly on the site
- Broadcast seed should be incorporated into the soil by raking or chain dragging, and then lightly compacting to provide good seed-soil contact.
- Apply mulch and tackifier or matting, as specified, over the seeded areas.
- To prevent seed from being washed away, confirm installation of all required surface water controls.
- Double the rate of seed application when mulch and seed are applied in a single application.

- Recommended erosion control grass seed mixes are as follows. Similar mixes designed to achieve erosion control may be substituted if approved by local jurisdiction:
  1. Dwarf Grass Mix (low height, low maintenance)
     Dwarf Perennial Ryegrass, 80% by weight
     Creeping Red Fescue, 20% by weight
     Application rate: 100 pounds minimum per acre
  2. Standard Height Grass Mix
     Annual Ryegrass, 40% by weight
     Turf-type Fescue, 60% by weight
     Application rate: 100 pounds minimum per acre

Fertilizer

- Slow-release fertilizers are more efficient and have fewer environmental impacts. Areas being seeded for final landscaping may require soil tests to determine the exact type and quantity of fertilizer needed to prevent the over-application of fertilizer.
- Use non-phosphorus fertilizer on disturbed areas within 50 feet of water bodies and wetlands.
- The use of stockpiled topsoil or compost reduces the need for fertilizer and improves the overall soil quality.
- Provide project-specific application rates

Mulch

- Refer to Ground Cover and Matting sections of this chapter.
- Straw mulch in loose condition is preferred for seeding during the wet season on slopes 3:1 or flatter.
- Straw mulch may be required during the dry season if:
  - Grass growth is expected to be slow;
  - The soils are highly erodible;
  - There is a water body close to the disturbed area; or
  - Significant precipitation is anticipated before the grass will provide effective cover.
- The straw mulch shall not be moldy, caked, decayed or of otherwise low quality.
- Can be applied on top of the seed or applied with the seed during hydroseeding. The application rate of seed per acre should be increased if seed and mulch are applied in a single application.

Hydroseed

- Refer to Hydraulic Application section of this chapter.
  Hydroseeding requires a mulch or green dye tracer as a visual aid during application.
- On slopes steeper than 2:1, hydroseeding requires an increased rate of tackifier to be applied.
- During the dry season, hydroseeding with wood fiber mulch is adequate.

Inspection & Maintenance

- Newly seeded areas need to be inspected frequently to ensure the grass is growing.
- If the seeded area is damaged due to runoff, additional BMPs may be needed. Re-seed and mulch damaged areas.
- Spot seeding can be done on small areas to fill in bare spots where grass did not grow properly.
- If spot seeding is ineffective, use an alternate method, such as sod or matting.
- Re-seed and protect with mulch any areas affected by erosion. If the erosion is caused by concentrated runoff, fix the runoff problem and then re-seed, mat the area.

4.1.9 Sod

Establishes permanent turf for immediate erosion protection and stabilizes drainage ways.

Advantages

- Provides immediate, effective protection, and is aesthetically pleasing.
- Provides high-density vegetation, which is superior to a recently seeded area.
- Placement can occur any time that soil moisture is adequate and the ground is not frozen.

Disadvantages

- Can be more costly than other BMPs.
- Availability is seasonal.
- Irrigation may be required if installed in summer.
- Difficult to mow if installed on slopes steeper than 3:1.
- Installations in grassed waterways may roll up if not anchored or drained properly.
- Time necessary for root establishment may be lengthy.

Design Criteria

- Use sod as a short or long-term cover.
- Use sod around inlets located off paved areas.
- Use sod that is generally weed free, has uniform thickness (approximately 1 inch thick) and dense root mat for mechanical strength.
- Generally inappropriate for bioswales. Sod can be used for lining ditches or waterways carrying intermittent flows.
- The following steps are general recommendations for sod installation:
  - Shape and smooth the surface to final grade in accordance with the approved grading plan.
  - Fertilize as per supplier's recommendations. Use non-phosphorus fertilizer on disturbed areas within 50 feet of water bodies and wetlands.
  - Work lime and fertilizer into soil 1-2 inches deep and smooth the surface.
  - Lay sod strips perpendicular to the direction of water flow, beginning at the lowest area to be sodded. Wedge strips securely into place and square the ends of each strip to provide for a close, tight fit. Stagger joints at least 12 inches. Staple sod onto 3:1 and steeper slopes.
    - Roll the sodded area and irrigate.
    - Not for use in high velocity channels/ditches

Inspection & Maintenance

- Inspect sod area frequently for soil moisture content and root establishment.
- Re-tack, re-sod or re-seed as necessary.
- If it is impossible to establish a healthy ground cover due to frequent saturation, instability, or some other cause; remove the sod, seed the area with an appropriate mix, and protect with matting.

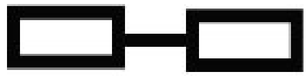
4.2 Runoff Control Best Management Practices

The greater the volume and velocity of surface water runoff on construction sites, the more sediment and other pollutants can be transported to streams, wetlands, and lakes. Diverting runoff away from exposed soils can greatly reduce the amount of soil eroded from a site. Decreasing runoff velocities reduces erosion and the amount of pollutants carried off-site.

Runoff controls divert runoff from exposed areas and reduce runoff velocities. Examples of runoff control BMPs that divert runoff from exposed areas include diversion swales, pipe slope drains and grass-lined swale. Examples of runoff control BMPs that reduce runoff velocities include check dams, outlet protection and surface roughening.

1. Check Dam
2. Diversion Dike/Swale
3. Grass-lined Swale
4. Outlet Protection
5. Pipe Slope Drain
6. Surface Roughening

CHECK DAM



4.2.1 Check Dam

A check dam is a small dam or weir constructed across a swale or ditch to reduce velocities of concentrated flows, thereby reducing erosion in the swale or ditch. Check dams can not only prevent gully erosion from occurring before vegetation is established, but can also allow a significant amount of suspended sediment to settle out.

Advantages

- Prevent erosion and promote settling of sediment in runoff.
- When carefully located and constructed, check dams may function as permanent installations.
- Reduces flow velocity
- Inexpensive and easy to install.
- Rock can be spread into ditch and used as a channel lining when the check dam is no longer necessary.
- Some pre-fabricated check dams are reusable.

Disadvantages

- Removal may be costly for some types of check dams.
- Suitable only for a limited drainage area.
- May reduce hydraulic capacity of the channel.
- May create turbulence downstream, causing erosion of the channel banks.
- Ponded water may kill grass in grass-lined channels.
- May be an obstruction to construction equipment.

Design Criteria

- Check Dams can be constructed from a variety of materials.
  - ❑ Rock: Rock material only.
  - ❑ Bio-filter Bags: Bio-filter bags staked to the ground.
  - ❑ Sand Bags
  - ❑ Pre-fabricated Check Dam System: A manufactured system specifically designed to slow water so that suspended particles settle out. Field fabricated systems are not allowed.
- Use in temporary or permanent channels not yet vegetated when installing channel lining is not feasible.
- Use in small open channels that drain 10 acres or less.
- Not for use in streams or rivers.

- Construct rock check dams sized to stay in place given the expected design flow velocity. Typical rock size of 3-6 inch. Place rock by hand or by mechanical means, avoid dumping the rock.
- Bridge entire ditch or swale width and ensure the center of the dam is 6 inches lower than the outer ends.
- Remove check dams from grass-lined ditches and swales once the grass is established, unless intended for permanent installation.
- Seed, mulch, or mat the area where the check dams were, immediately following removal.
- Space check dams according to the following table.

Table 4-4 Spacing for check dams

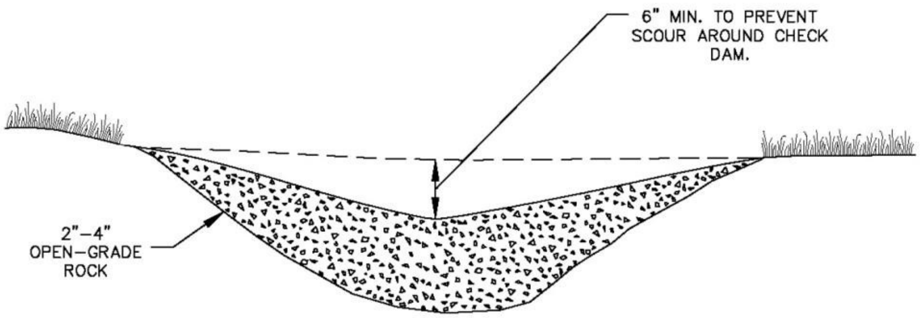
Ditch Grade	Minimum Weir Depth		
	6 inch	12 inch	18 inch
6%	**	16 ft O.C.	26 ft O.C.
5%	**	20 ft	30 ft
4%	**	26 ft	40 ft
3%	15 ft	33 ft	50 ft
2%	25 ft	50 ft	80 ft

** Not Allowed

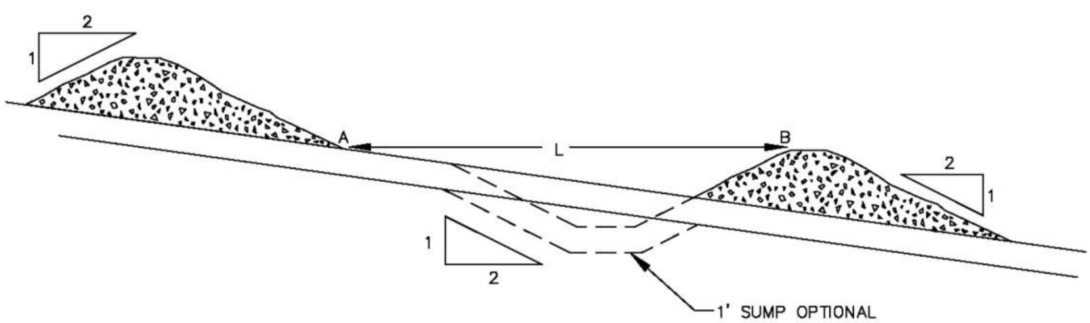
<u>Inspection & Maintenance</u>

- Remove sediment once it reaches one-third the depth of the check dam.
- Replace rock check dam when filtering capacity is reduced by one-half.

FOR FURTHER INFORMATION
ON DESIGN CRITERIA SEE
CHAPTER 4 OF CLEAN WATER
SERVICES EROSION PREVENTION
AND SEDIMENT CONTROL
PLANNING AND DESIGN MANUAL.



ROCK CHECK DAM



SPACING BETWEEN CHECK DAMS

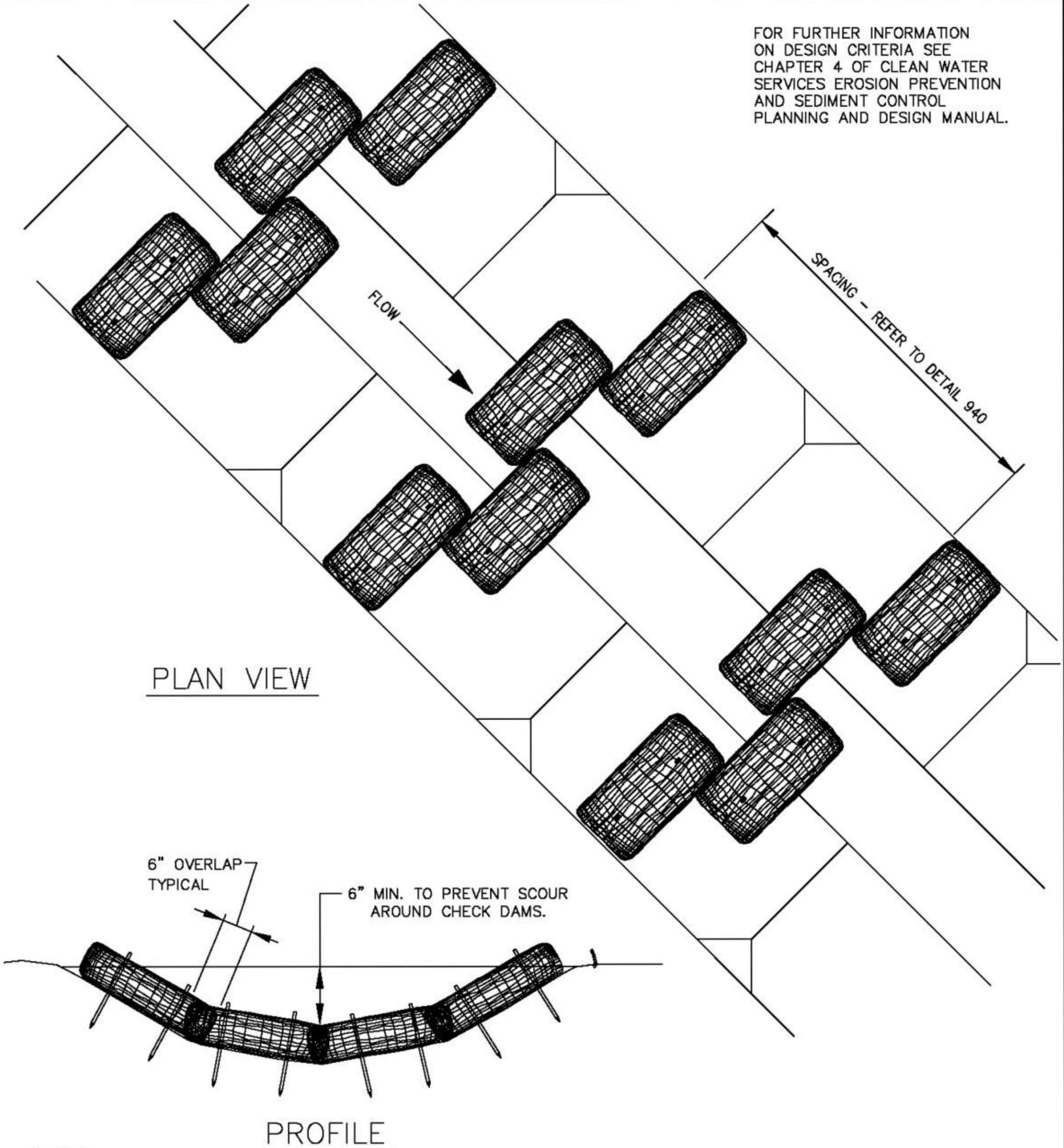
NOTES:

1. L = THE DISTANCE SUCH THAT POINTS A AND B ARE OF EQUAL ELEVATION.
2. SEE DRAWING #940 FOR HEIGHT AND SPACING OF CHECK DAMS.

CHECK DAM
ROCK

DRAWING NO. 840

REVISED 10–31–19



NOTES:

1. STAKING OF BAGS REQUIRED USING (2) 1"X2" WOOD STAKES OR APPROVED EQUAL PER BAG.
2. SURFACE MUST BE SMOOTH BEFORE APPLICATION.
3. CHECK DAMS CAN BE CONSTRUCTED USING STRAW WATTLES OR OTHER MATERIALS AS APPROVED BY THE DISTRICT OR CITY.

CHECK DAM
BIO–FILTER BAG

DRAWING NO. 845 REVISED 10–31–19

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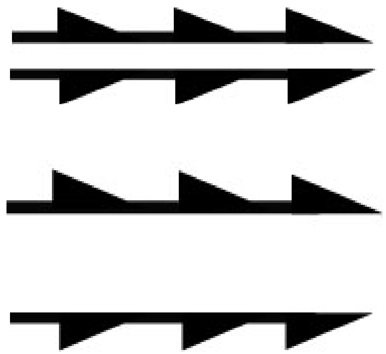
DIVERSION DIKE/SWALE



Diversion Dike/Swale

Diversion Dike

Diversion Swale

4.2.2 Diversion Dike/ Swale

A diversion dike/swale is a ridge of compacted soil or a lined swale with vegetative lining located at the top, base or somewhere along a sloping disturbed area. The dike or swale intercepts and conveys smaller flows along low-gradient drainage ways to larger conveyances such as ditches or pipe slope drains or to a stabilized outlet. Dikes and swales may be used singly or in combination with each other.

Advantages

- Provides a practical, inexpensive method to divert runoff.
- Can handle flows from large drainage areas.
- Use on-site material and equipment to construct.

Disadvantages

- If improperly constructed, can contribute to erosion caused by concentrating the flow.
- High flow velocity can damage vegetation.
- Not effective for preventing illegal discharge.

Design Criteria

- Refer to Table 4-5 Dike Design Criteria and Table 4-6 Swale Design Criteria.
- Install the dike and/or swale horizontally at intervals across a disturbed slope. Space horizontal interceptor dikes and swales according to Tables 4-5 and 4-6.
- For slopes of erodible soils, steeper than 2:1 with more than 10 ft. of vertical relief, construct benches or shorten distance between dikes or swales.
- If the dike or swale intercepts runoff from disturbed areas, discharge the runoff to a stable conveyance system that routes the runoff to a sediment trap or basin.
- If the dike or swale intercepts runoff that originates from undisturbed areas, discharge the runoff to a stable conveyance system that will route the runoff downslope of any disturbed areas and release the water at a stabilized outlet.
- May need matting to protect seed bed and channel from erosion.

Table 4-5 Diversion dike design criteria

Top Width	2 ft. min.	
Height	18 in. min. Measured from upslope toe and at a 90% standard proctor compaction ASTM D698.	
Side Slopes	2H:1V or flatter	
Grade	Topography Dependent	
Dike grade	Maximum 5%	
Slope of Disturbed Area vs. Horizontal Spacing	<5%	300 ft
	5-10%	200 ft
	10-25%	100 ft
	25-50%	50 ft
Slope Stabilization	<5% Seed and mulch within 5 days following dike construction	
	5-40% Stabilize immediately using either sod, riprap or appropriate matting.	
Outlet	Upslope side of dike provides positive drainage to the outlet. Provide energy dissipation as necessary to prevent erosion. Release sediment-laden runoff to a sediment trapping facility.	

Table 4-6 Diversion swale design criteria

Bottom Width	2 ft. min. The bottom should be level across the swale.	
Depth	1 ft.	
Side Slopes	2:1 or flatter	
Grade	Maximum 5% with positive drainage to a suitable outlet.	
Slope of Disturbed Area vs. Horizontal Spacing	<5%	300 ft.
	5-10%	200 ft.
	10-25%	100 ft.
	25-50%	50 ft.
Slope Stabilization	Temporarily seed or line with riprap 12 in. thick and press into the bank approximately 3-4 in.	
Outlet	Level spreader or riprap to stabilized outlet/sedimentation pond.	

Inspection & Maintenance

- Inspect and repair as necessary after every major storm.
- Minimize construction traffic over temporary dikes and swales.
- Immediately repair damage resulting from runoff or construction activities.
- If the dike or swale regularly overflows, increase the capacity and/or frequency of the dikes/swales.
- Clean out clogged pipes (as part of the swale system) under roads.

4.2.3 Grass-lined Swale

A grass-lined swale is a channel with a vegetative lining constructed to convey and dispose of concentrated surface runoff.

Advantages

- Does not generate high velocity runoff and offers temporary slope protection, which is superior to plastic sheeting.
- Offers storage opportunity for runoff.
- Captures a great deal of sediment due to the filtering effect of vegetation.
- Usually easy to install.

Disadvantages

- May require temporary irrigation to establish vegetation.
- Should not be used until vegetation is completely established.

Design Criteria

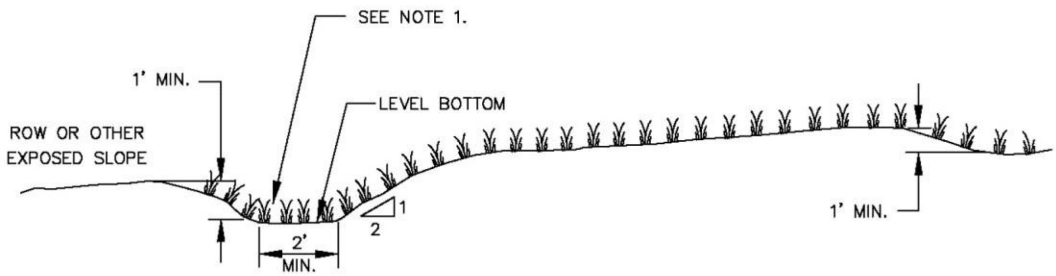
As a minimum, grass-lined channels should carry a peak runoff from a 10-year storm event without eroding. Where flood hazards exist, increase the capacity according to the potential for damage. The allowable design velocity for grassed-lined channels is based on soil conditions, type of vegetation, and the method of establishment. The channel shape may be parabolic, trapezoidal, or v-shaped, depending on the need and site conditions. Small check dams or flow spreaders may be necessary to minimize channelization.

Inspection & Maintenance

- During the initial establishment, grass-lined channels should be repaired and grass re-established as necessary.
- After grass has become established, the channel should be checked periodically to determine if the channel is withstanding flow velocities without damage.
- Check the channel for debris, scour, or erosion and immediately make repairs. It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping or scour holes and make repairs immediately.
- Remove all significant sediment accumulations to maintain the designed carrying capacity.
- Keep the grass in a healthy, vigorous condition at all times, since it is the primary erosion protection for the channel.

- Permanent grassed waterways should be seasonally maintained by mowing and/or irrigating, depending on the type of vegetation selected.
- Newly seeded areas need to be inspected frequently to ensure the grass is growing.
- If the seeded area is damaged due to runoff, additional storm water measures such as check dams or matting may be needed.

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.



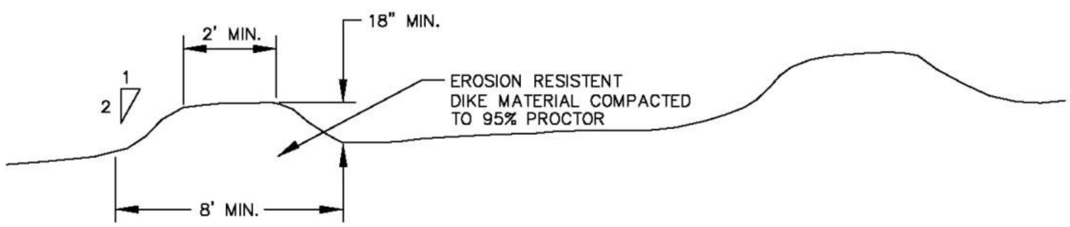
BOTTOM WIDTH – 2 FEET MINIMUM; THE BOTTOM WIDTH SHALL BE LEVEL.

DEPTH – 1 FOOT MINIMUM.

SIDE SLOPE – 2H:1V OR FLATTER.

GRADE – MAXIMUM 5 PERCENT, WITH POSITIVE DRAINAGE TO A SUITABLE OUTLET (SUCH AS SEDIMENTATION POND)

DIVERSION SWALE



DIVERSION DIKE

SLOPE	SPACING
<5%	300 FEET
5–10%	200 FEET
10–40%	100 FEET

NOTE:

1. ESTABLISH VEGETATION AND/OR APPLY APPROVED EROSION PREVENTION BMPS IMMEDIATELY UPON CONSTRUCTION.

DIVERSION DIKE / SWALE

DRAWING NO. 850 REVISED 10–31–19

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OUTLET PROTECTION

4.2.4 Outlet Protection

Outlet protection reduces the speed of concentrated flow, thereby preventing scour at conveyance outlets. By dissipating energy, outlet protection lowers the potential for downstream erosion. Outlet protection includes riprap-lined basins, concrete aprons, and settling basins. Outlet protection prevents scour at storm water outlets, and minimizes the potential for downstream erosion.

<u>Advantages</u>

- Many techniques are effective and relatively inexpensive and easy to install.
- Removes sediment and reduces velocity.

<u>Disadvantages</u>

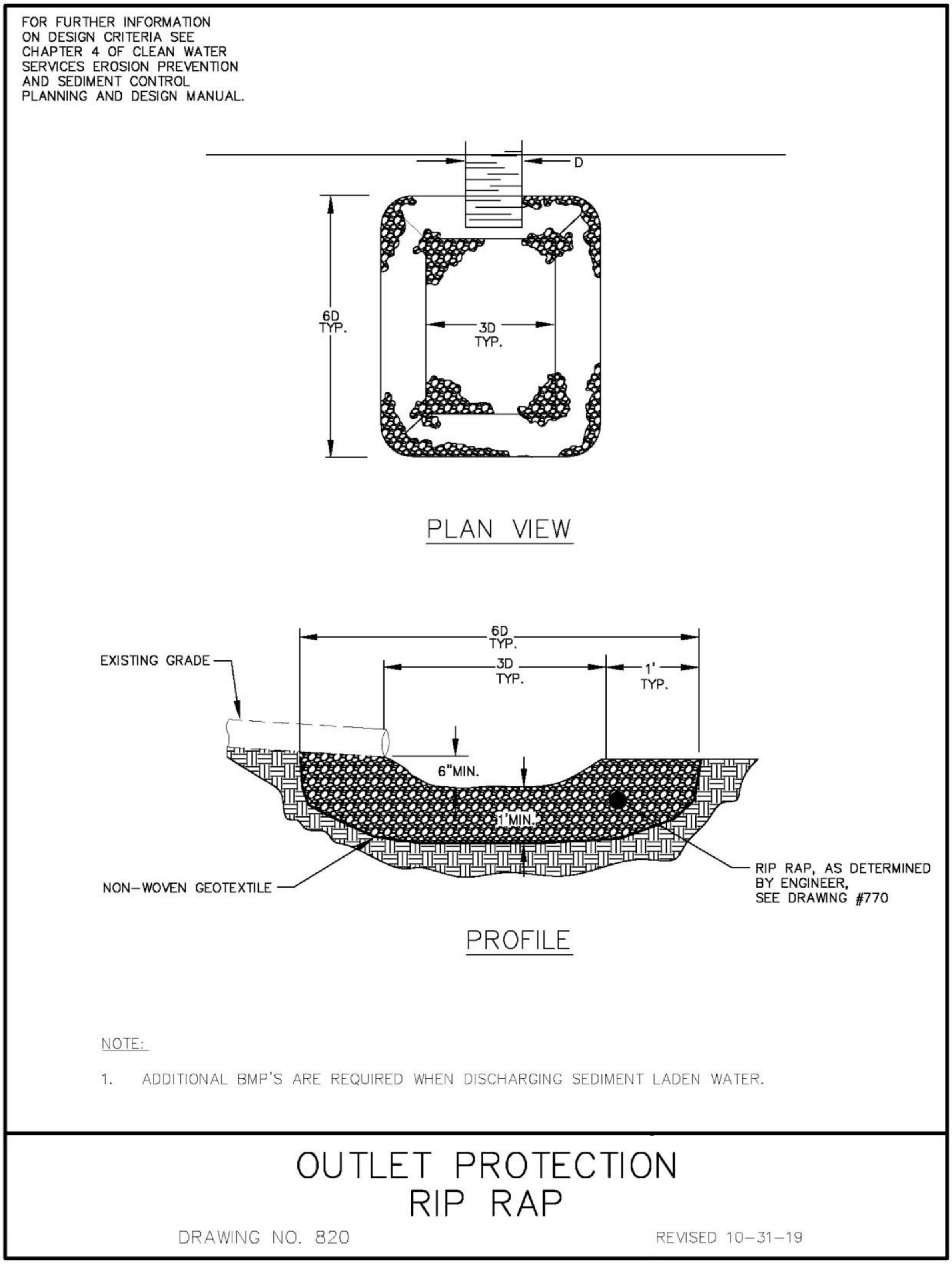
- Can be unsightly.
- May be difficult to remove sediment without removing and replacing the structure itself.
- Rock outlets with high velocity flows may require frequent maintenance.

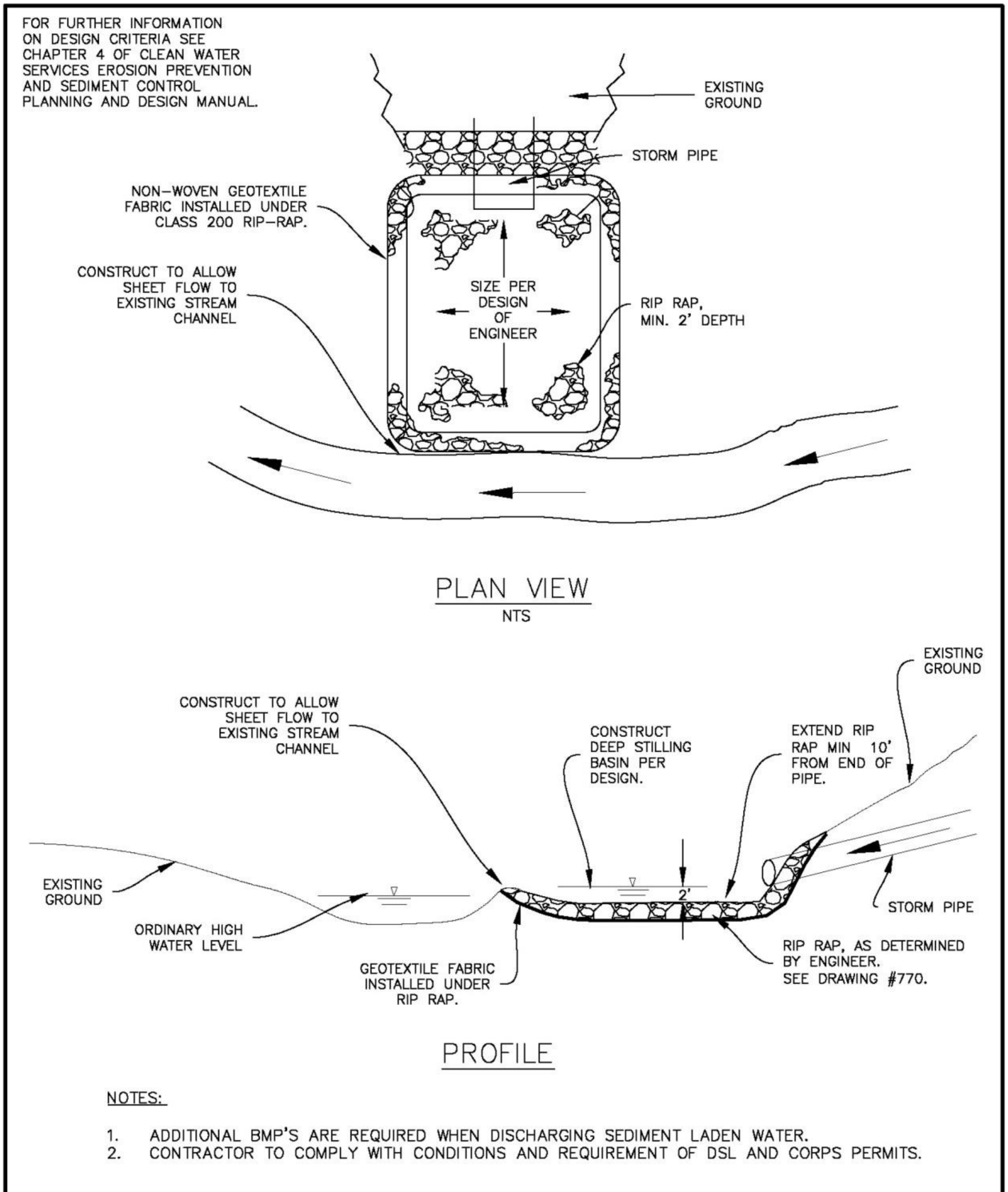
<u>Design Criteria</u>

- Use the standard detail for outlet protection as a minimum. Consider site conditions to determine if a more complex energy dissipater may be required.
- Use at the outlets of ponds, pipe slope drains, ditches, or other conveyances, and where runoff is conveyed to a natural or man-made drainage feature such as a stream, wetland, lake, or ditch.

<u>Inspection & Maintenance</u>

- If there is scour at the outlet, repair damage and evaluate if outlet needs additional protection.
- Remove accumulated sediment frequently.


FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.
D
6D TYP.
3D TYP.
PLAN VIEW
6D TYP.
3D TYP.
1' TYP.
EXISTING GRADE
6"MIN.
1'MIN.
NON-WOVEN GEOTEXTILE
RIP RAP, AS DETERMINED BY ENGINEER, SEE DRAWING #770
PROFILE
NOTE:
1. ADDITIONAL BMP'S ARE REQUIRED WHEN DISCHARGING SEDIMENT LADEN WATER.
OUTLET PROTECTION
RIP RAP
DRAWING NO. 820
REVISED 10-31-19



OUTLET PROTECTION
STILLING BASIN

DRAWING NO. 825 REVISED 10-31-19

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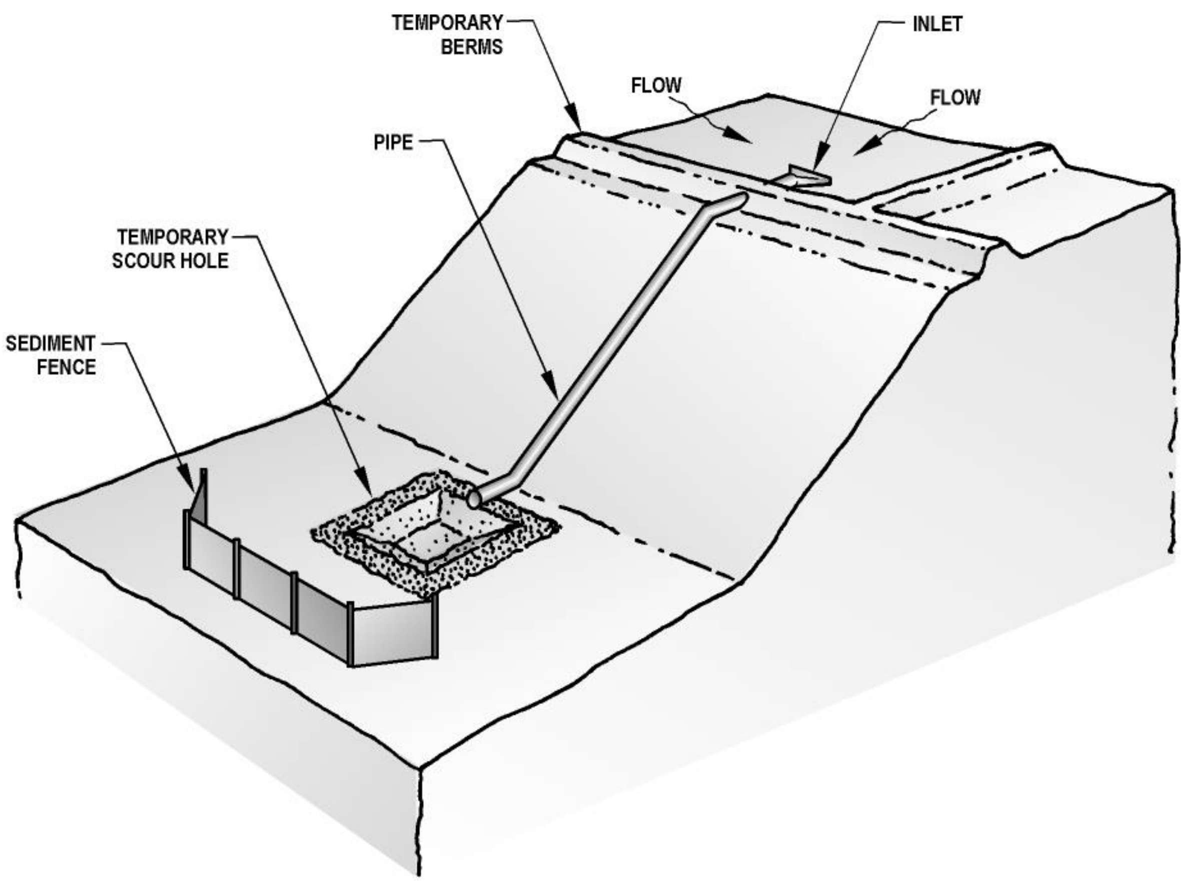
PIPE SLOPE DRAIN

4.2.5 Pipe Slope Drain



A pipe slope drain is a pipe extending from the top to the bottom of a cut or fill and discharging into a stabilized watercourse, a sediment trapping device or onto a stabilized vegetated area. The pipe slope drain carries concentrated runoff down steep slopes without causing gullies, erosion, or saturation of slide-prone soils.

<u>Advantages</u>

- Effective method of conveying water down steep slopes.
- Reduces or eliminates erosion.
- Easy installation and little maintenance.

<u>Disadvantages</u>

- Drain can be under-designed or incorrectly located.
- Area cleared for drain installation requires stabilization to prevent erosion from occurring under the pipe.

- Outfall systems constructed of pipe segments, which are banded and/or gasketed together, could develop leaks causing erosion and failure of the system. Failures on erodible or steep slopes can cause downstream sedimentation or even mudflows.
- Adjustment of pipe lengths is necessary as cut and fill slopes are extended.

Design Criteria

- Capacity – Peak runoff from a 10-yr storm. Inlet control is a critical factor when sizing pipes. Unless they are individually designed, size drains according to Table 4-7.
- Use on any slope where a large amount of flow must be collected and conveyed to avoid erosion.
- Use in areas where clean water should be kept separate from sediment-laden water.
- If a permanent measure is needed, it should be designed as part of the project drainage facilities.

Table 4-7 Slope drain sizes

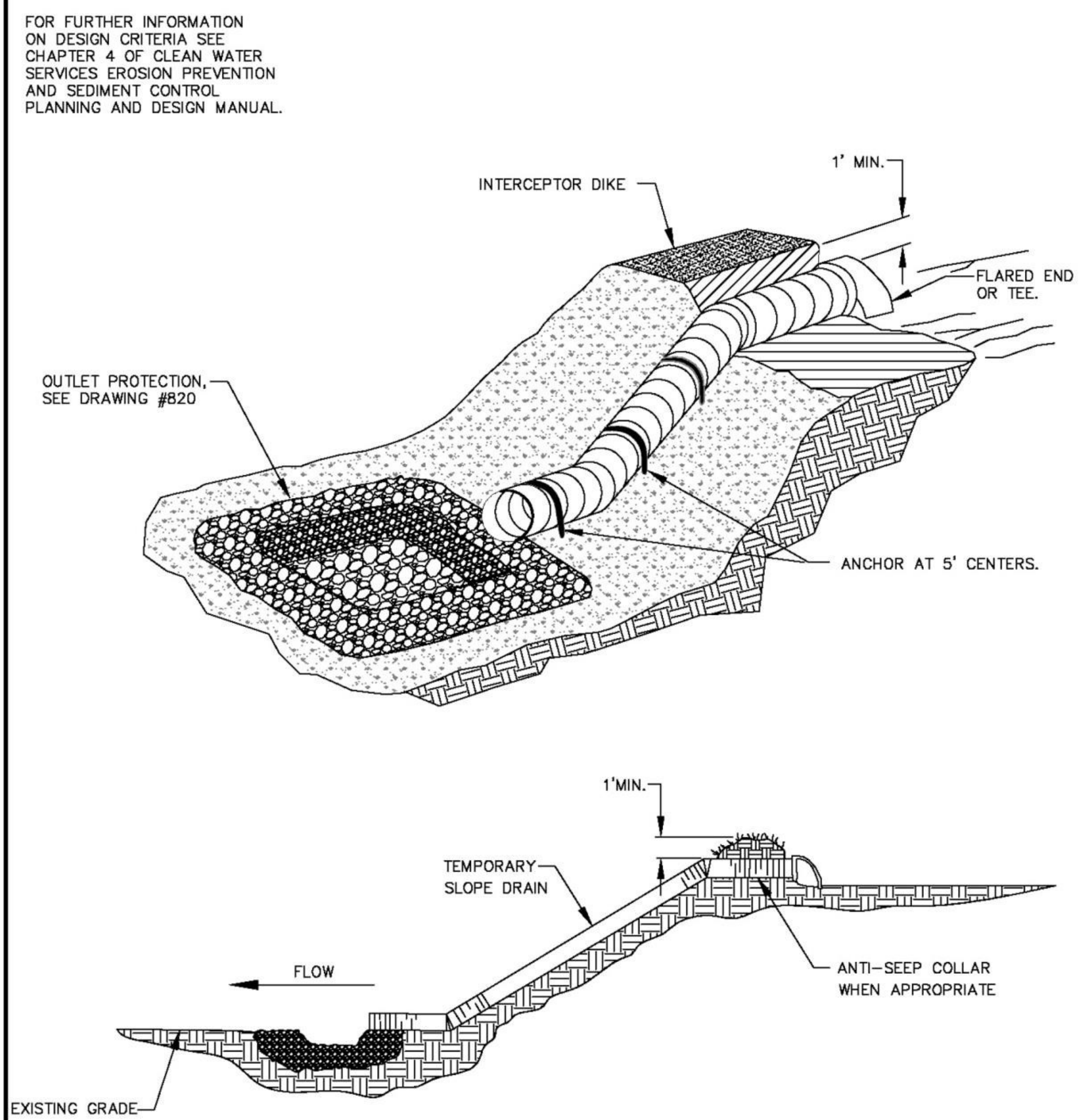
Contributing Drainage Area (Maximum)	Pipe Diameter
0.50 acre	12 inch
0.75 acre	15 inch
1.00 acre	18 inch

- Consider using continuously fused, welded or flange-bolted mechanical joint systems with proper anchoring or HDPP (high-density polyethylene pipe) for outfalls on steep slopes.
- Show the entrance sloped toward the pipe inlet.
- At the inlet, show interceptor dikes that are at least 12 in. higher at all points than the top of the inlet pipe and placed to direct water into the pipe.
- If the pipe slope drain will convey sediment-laden runoff, direct the runoff to a sediment retention facility.
- If the runoff is not from a disturbed area or is conveyed from a sediment trap or pond, convey the runoff to a stabilized discharge point.
- Energy Dissipation – Scour holes or riprap-lined stilling basins prevent most scour problems at outfalls.

- Consider site conditions to determine if a more complex energy dissipater may be required.
- The special provisions and typical notes on the ESCP should include the following installation notes/details:
    - ❑ Minimize disturbance during installation. In some circumstances, this requires HDPP installed by hand.
    - ❑ Slope anchor details.
    - ❑ Immediately stabilize any area disturbed during installation or maintenance.
    - ❑ Securely connect the standard flared end section at the entrance to the slope drain, using watertight connecting bands.
- Pipe should be staked securely to prevent movement
    - ❑ Securely fasten together the slope drain sections with gasketed watertight fittings, and securely anchor the sections into the soil.
    - ❑ Stabilize the area below the outlet following the energy dissipater.

<u>Inspection & Maintenance</u>

- Adjust lengths of pipe when cut and fill slopes are extended.
- Regularly check the inlet and outlet points, especially following heavy rains. If there are signs of undercutting or water is going around the point of entry, reinforce the head wall with compacted earth or sand bags.
- Regularly check connection points for signs of erosion. Tighten fittings and repair erosion as needed.
- Immediately repair and install appropriate protection if erosion occurs at the outlet.



PIPE SLOPE DRAIN

DRAWING NO. 815

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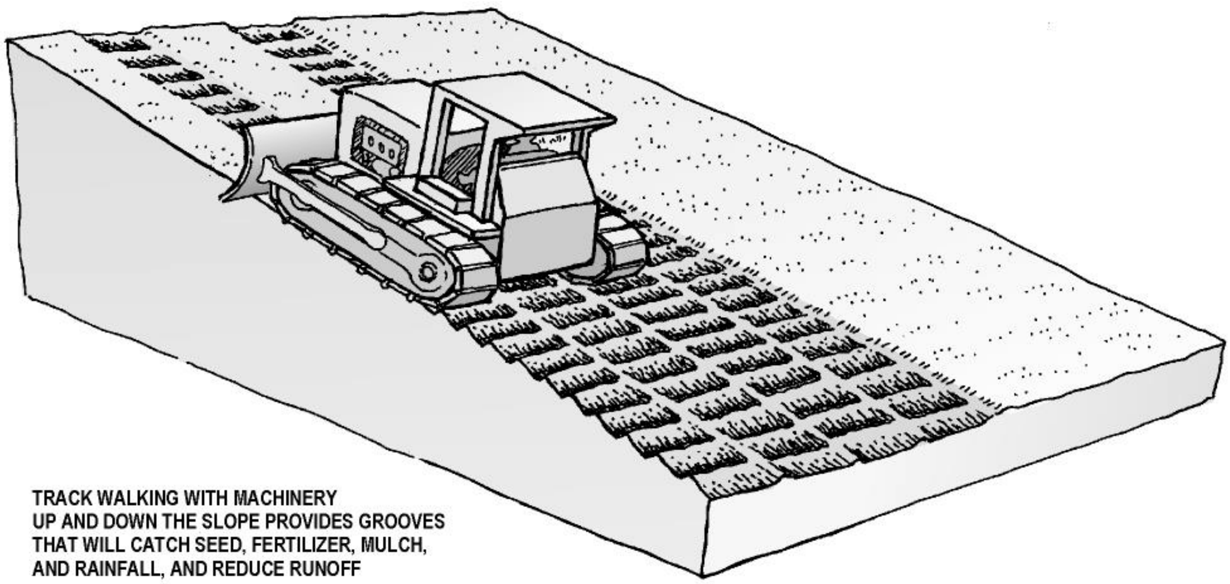
SURFACE ROUGHENING

4.2.6 Surface Roughening



Surface roughening leaves the slopes in a roughened condition after clearing or creating a rough soil surface with horizontal depressions or grooves intended to trap seed and reduce runoff velocity. Roughening can be accomplished by ‘track walking’ slopes with tracked equipment, by using a serrated wing blade attached to the side of a bulldozer, or by other agricultural equipment.

<u>Advantages</u>

- Grooves can trap seed.
- Can increase vegetation establishment.
- Can reduce runoff velocity and increase infiltration.
- Can provide some instant protection from sheet erosion.
- Can trap soil eroded from the slopes above.

<u>Disadvantages</u>

- Tracking with a bulldozer or other heavy equipment may compact the soil.
- May increase time to finish slopes.
- Should not be relied upon as sole means of erosion control.
- Surface roughening should be done well prior to any forecasted storm event.
- Not appropriate for all types of soil, for example very sandy soil.

Design Criteria

- Use on all slopes to be seeded.
- Use on slopes 3:1 or less, but can be used on steeper slopes in conjunction with the addition of staging sediment barriers.
- Immediately seed and mulch roughened areas to obtain optimum seed germination and growth.
- Height of track grousers should be 1 ½ inches or greater.
- Tracking should be accomplished by driving equipment **up** and **down** slope to create horizontal depressions/grooves.

Cut Slope Roughening

- Stair-step grade or groove the cut slopes that are steeper than 3:1.
- Use stair-step grading on all erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with the same subsoil are particularly suited to stair-step grading.
- Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.
- Do not make individual vertical cuts more than 2 feet high in soft materials or more than 3 feet in rocky materials.
- Groove the slope using machinery to create a series of ridges and depressions that run across the slope, on the contour.

Fill Slope Roughening

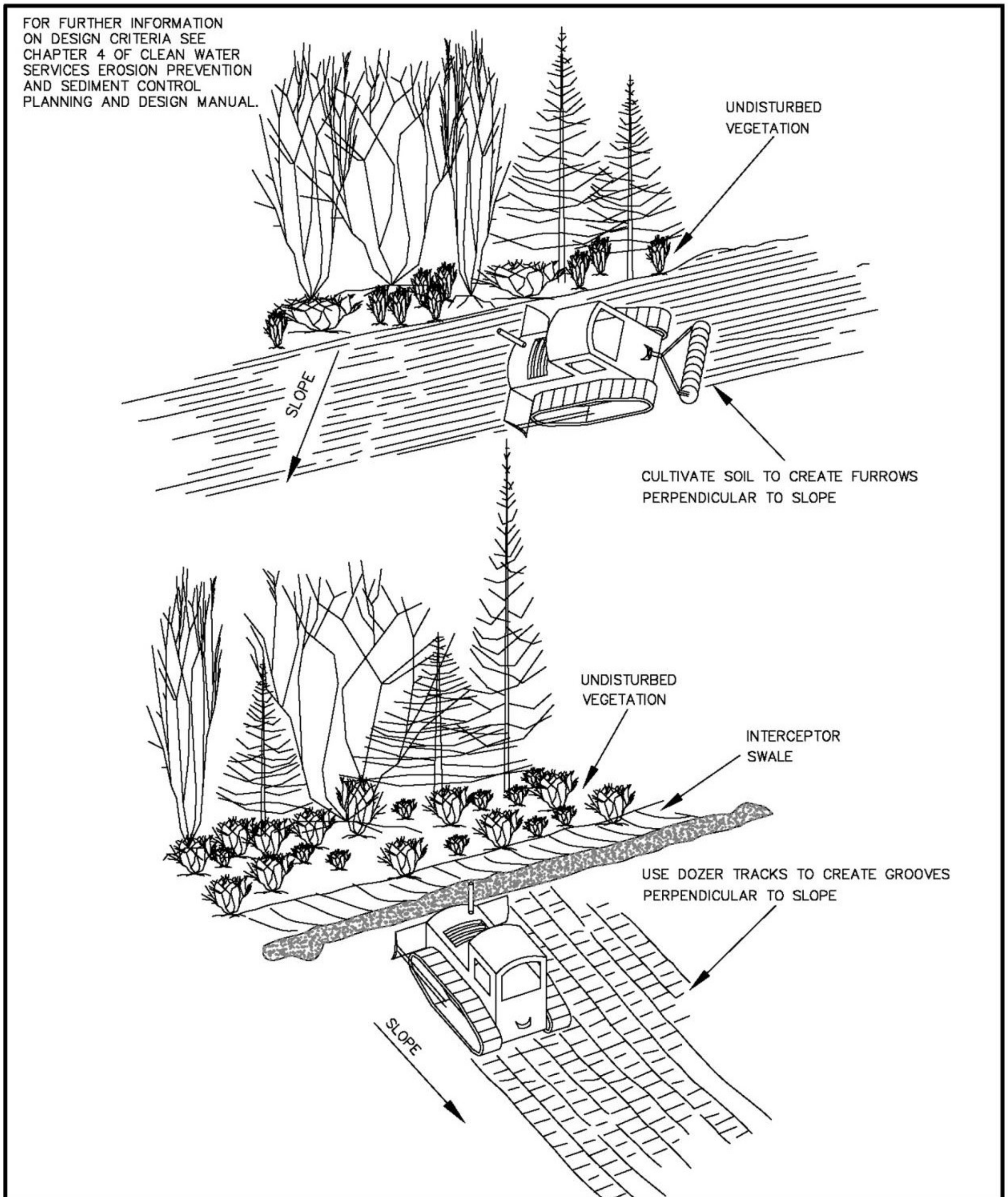
- Place fill slopes with a gradient steeper than 3:1 in lifts not to exceed ½ foot, and make sure each lift is properly compacted.
- Ensure that the face of the slope consists of loose, uncompacted fill 4-6 inches deep.
- Use horizontal grooving along the contour or tracking to roughen the face of the slopes, if necessary.
- Apply seed, fertilizer and straw mulch, and then track or punch the mulch with a bulldozer.
- Do not blade or scrape the final slope face.

Cuts, Fills, and Graded Areas

- Make mowed slopes no steeper than 3:1.
- Roughen these areas to shallow grooves by normal tilling, disking, harrowing, or use a cultipacker-seeder. Make the final pass of any such tillage on the contour.
- Excessive roughness is undesirable where mowing is planned.

Inspection & Maintenance

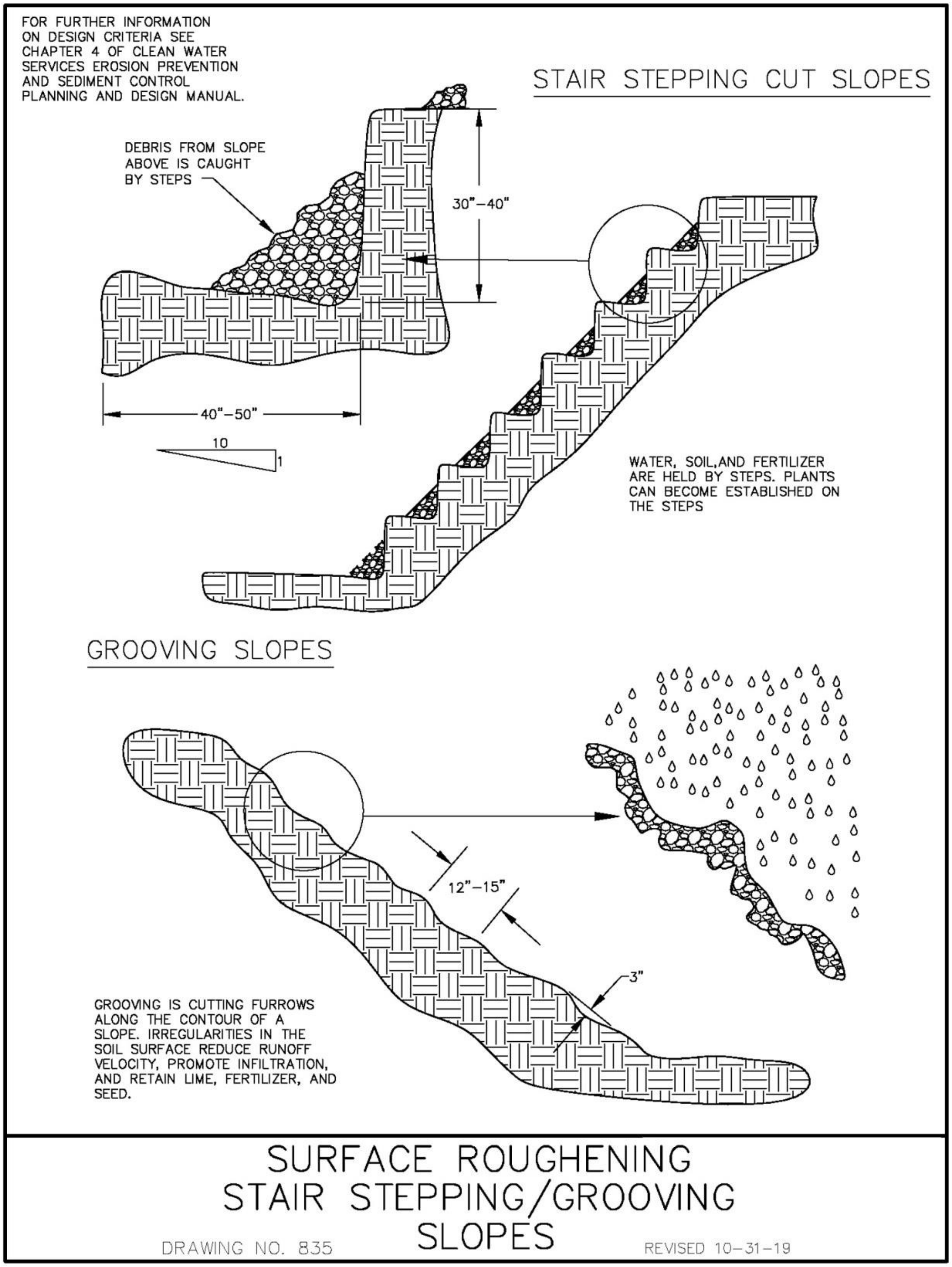
- Check the seeded slopes for rills and washes. Fill these areas slightly above the original grade, then re-seed, mulch, or mat as soon as possible.



SURFACE ROUGHENING
CAT TRACKING

DRAWING NO. 830

REVISED 10–31–19


FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.
STAIR STEPPING CUT SLOPES
DEBRIS FROM SLOPE ABOVE IS CAUGHT BY STEPS
30"–40"
40"–50"
10
1
WATER, SOIL,AND FERTILIZER ARE HELD BY STEPS. PLANTS CAN BECOME ESTABLISHED ON THE STEPS
GROOVING SLOPES
12"–15"
3"
GROOVING IS CUTTING FURROWS ALONG THE CONTOUR OF A SLOPE. IRREGULARITIES IN THE SOIL SURFACE REDUCE RUNOFF VELOCITY, PROMOTE INFILTRATION, AND RETAIN LIME, FERTILIZER, AND SEED.
SURFACE ROUGHENING
STAIR STEPPING/GROOVING
SLOPES
DRAWING NO. 835
REVISED 10–31–19

4.3 Sediment Control Best Management Practices

Once soil erosion occurs, sediment trapping or removal techniques can reduce the amount of sediment and associated pollutants that leave the site, thus protecting nearby streams, wetlands, and lakes. Sediment controls are usually placed around the perimeter of a disturbed area and where concentrated water leaves the site. Sediment controls are the last line of protection for a site and should be used in conjunction with other site controls. Sediment control BMPs should be in place before land clearing and grading begins. It is important to note that sediment controls, if poorly maintained, can become sources of sediment and other pollutants during larger storms.

1. Bio-filter Bags
2. Construction Entrance
3. Dewatering
4. Filter Berm
5. Inlet Protection
6. Oak Mats
7. Pre-Fabricated Barriers
8. Sand Bags
9. Sediment Basin
10. Sediment Fence
11. Sediment Trap
12. Sidewalk Subgrade Gravel Barrier
13. Tire Wash
14. Wattles

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BIO-FILTER BAGS

4.3.1 Bio-filter Bags

Biofilter bags are used to minimize the transport of sediment from a construction site by providing a temporary physical barrier to sediment and reducing runoff velocities. Typically manufactured from 100% recycled wood-product waste placed in plastic mesh bags. May also be used for inlet protection, refer to section 4.3.5 in this manual.

Advantages

- Relatively low cost.
- Can be used in place of sediment fences at toe of slope, with proper staking.
- Wood-product can be recycled or used on site when no longer needed.
- Installation is simple, can be done by hand.
- Bags are easy to move, replace and reuse on paved surfaces.
- Are good short-term solution in situations where minor concentrated flows are causing erosion.

Disadvantages

- Generally effective for only a few months.
- Can be easily damaged by construction equipment or by traffic in paved areas.
- Can become clogged with sediment and cease to filter runoff.
- If improperly installed can allow undercutting or end-flow.
- Not effective where water velocities or volumes are high.
- Lightweight, which results in higher buoyancy if not properly installed.
- Low sediment retention capacity may require frequent maintenance.

Design Criteria

- Bio-filter bags should be clean 100 percent recycled wood product waste. Standard size 10x8x30 inches, weight approximately 45 pounds, with ½ inch plastic netting.
- May be left in place or used as mulch once they have served their purpose.
- Surface area should be smooth prior to application.
- Use (2) 1x2 inch stakes per bag, driven 12 inches into ground.
- Ends of bags must be overlapped 6 inches to prevent piping between joints.

Inspection & Maintenance

- Check that stakes are secure and ends of bags are tightly overlapped. Check that undercutting or end-flow is not occurring.
- Inspect plastic mesh bags for tears.
- Remove sediment when 1/3 height of bag has accumulated.
- Replace damaged bags as needed.

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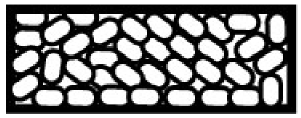
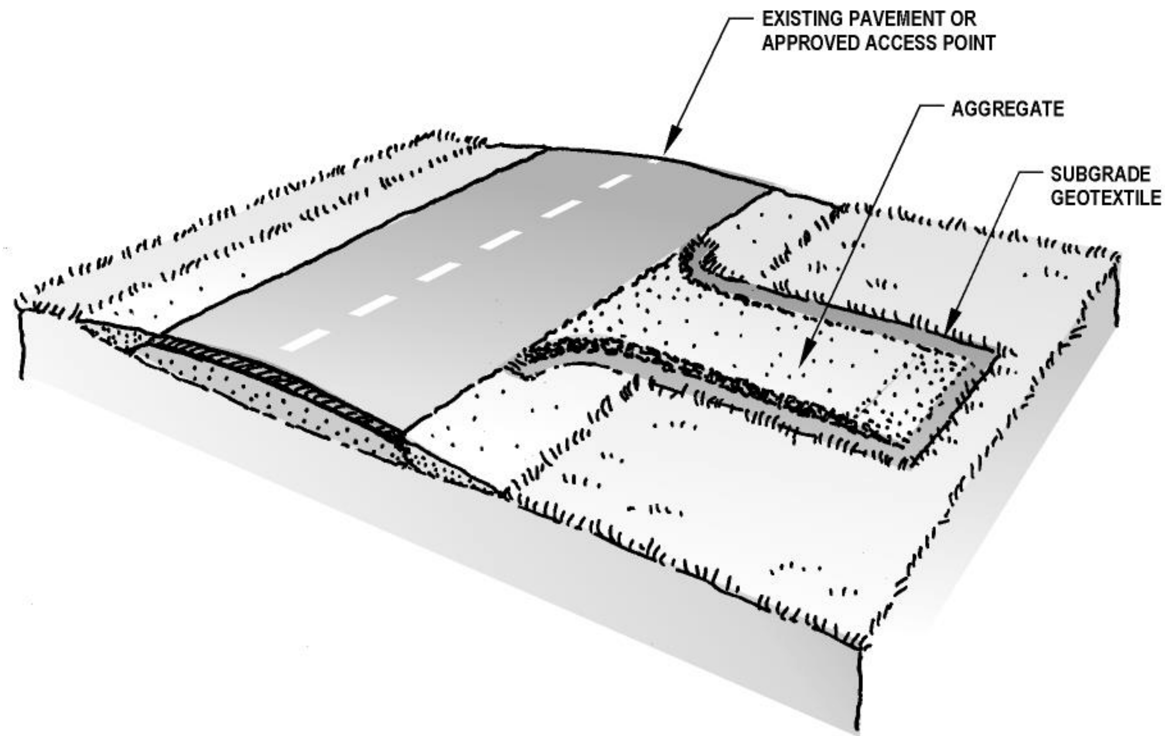
CONSTRUCTION ENTRANCE



4.3.2 Construction Entrance



A construction entrance is a stabilized rock pad, placed at construction site ingress/egress locations to reduce the amount of sediment transported onto paved roads by vehicles or runoff. The construction entrance may also include a curb ramp designed out of wood.

Advantages

- Reduces traffic hazards caused by debris on public roadways.
- Reduces sediment and other debris from entering roadways, which can then be washed into the storm system.

Disadvantages

- Only effective if erosion and sediment control employed elsewhere onsite.
- Only effective if installed at every location where significant construction traffic leaves the site.
- Can fill with sediment quickly and require frequent maintenance and/or replacement of rock. In some cases may require the installation of a tire wash.

Design Criteria

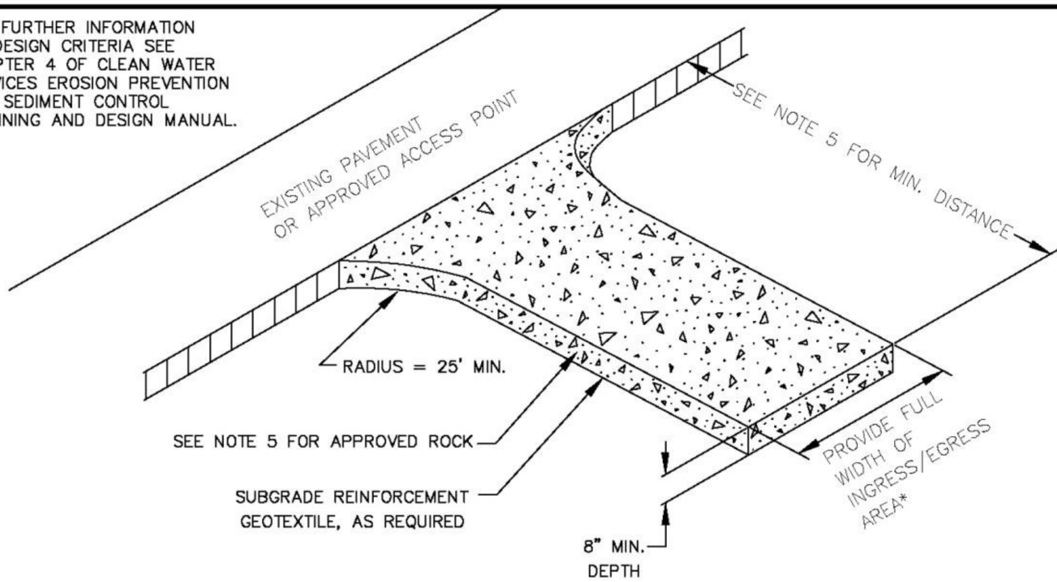
- Install construction entrance prior to any site work.
- Whenever possible, construct the pad on a firm, compacted subgrade.

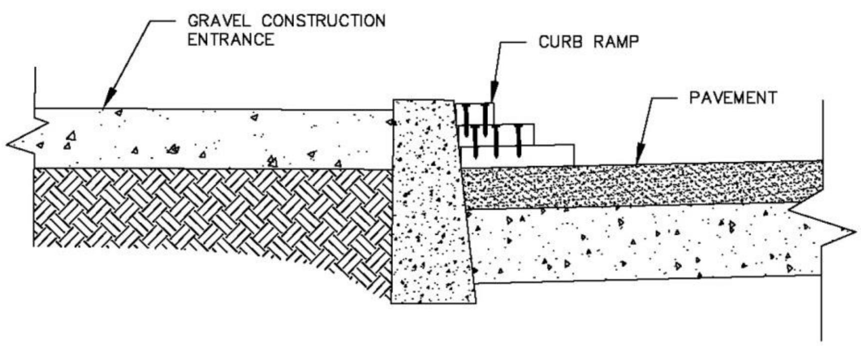
- Install geotextile under rock when subgrade is not stable or is “pumping” up into the pad.
- **Minimum length:**
  - 20 ft. – all single family sites.
  - 50 ft. – all other development sites.
- **Minimum width:**
  - 20 ft. – all construction sites.
- **Minimum Depth:**
  - 8 in. – all construction sites.
- **Rock Size:**
  - ¾” x 0 - all single family sites
  - 3-6 in. – all other construction sites
- Do not install rock on paved surfaces. (Use wood curb ramps.)
- Use clean rock only.
- Wood curb ramps should be made out of 2x6 material, nailed together.
- Include a tire wash facility if the entrance does not prove effective in retaining sediment onsite.

<u>Inspection & Maintenance</u>

- Requires ongoing inspection.
- Immediately sweep up and remove or stabilize onsite any sediment that is tracked onto pavement.
- If the sediment poses a threat to public safety and street sweeping proves ineffective, consider washing the street and collecting the water in a sediment pond or sump before it leaves the site.
- Add or replace rock as needed to maintain the specified dimensions.
- Immediately remove any rock, which is carried from the pad to the roadway.

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.





NOTES:

1. THE ENTRANCE SHALL BE MAINTAINED IN A CONDITION THAT WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC RIGHT–OF–WAYS. THIS MAY REQUIRE TOP DRESSING, REPAIR AND/OR CLEAN OUT OF ANY MEASURES USED TO TRAP SEDIMENT.
2. WHEN NECESSARY, WHEELS SHALL BE CLEANED PRIOR TO ENTRANCE ONTO PUBLIC RIGHT–OF– WAY.
3. WHEN WASHING IS REQUIRED, IT SHALL BE DONE ON AN AREA STABILIZED WITH CRUSHED STONE THAT DRAINS INTO AN APPROVED SEDIMENT TRAP OR SEDIMENT BASIN.
4. WHERE RUNOFF CONTAINING SEDIMENT LADEN WATER IS LEAVING THE SITE VIA THE CONSTRUCTION ENTRANCE, OTHER MEASURES SHALL BE IMPLEMENTED TO DIVERT RUNOFF THROUGH AN APPROVED FILTERING SYSTEM.
5. DIMENSIONS
   SINGLE FAMILY
   20' LONG BY 20' WIDE 8" DEEP OF ¾" MINUS CLEAN ROCK.
   COMMERCIAL/SITE DEVELOPMENT
   50' LONG BY 20' WIDE 3–6" CLEAN ROCK, GOVERNING AUTHORITY MAY REQUIRE GEOTEXTILE FABRIC TO PREVENT SUB–SOIL PUMPING.

CONSTRUCTION ENTRANCE

DRAWING NO. 855

REVISED 10–31–19

DEWATERING

4.3.3 Dewatering

Dewatering operations are common on construction sites that encounter groundwater or other water that needs to be filtered prior to off-site discharge. This section assumes that material is uncontaminated groundwater. Filtration is the separation of sediment from a fluid by passing the fluid through a permeable medium that will trap a high percentage of the particles. The equipment necessary for filtration applications associated with water containing sediment includes weir tanks, gravity boxes, non-contained sediment bags, sand media filtration, Chitosan or other flocculants and bag/cartridge chambers. There are two types of filtration systems, gravity and pressure.

Advantages

- Excellent for utility work such as repairs, replacements, or new installations.
- Depending upon the choice of filtration systems, can remove small particles of silt and clays.
- Can be used as an alternate to sediment trap/basin on smaller sites.
- Can hold large amounts of sediment, which reduces overall maintenance.
- Can be used in conjunction with other types of filters as a pre-filter.
- Can be easily mobilized from site to site.

Disadvantage

- Can have limited storage capacity depending upon the site.
- Can have limited ability to remove silts and clays, depending upon the dewatering system.
- May require heavy equipment to load and unload system.
- May be cost prohibitive.

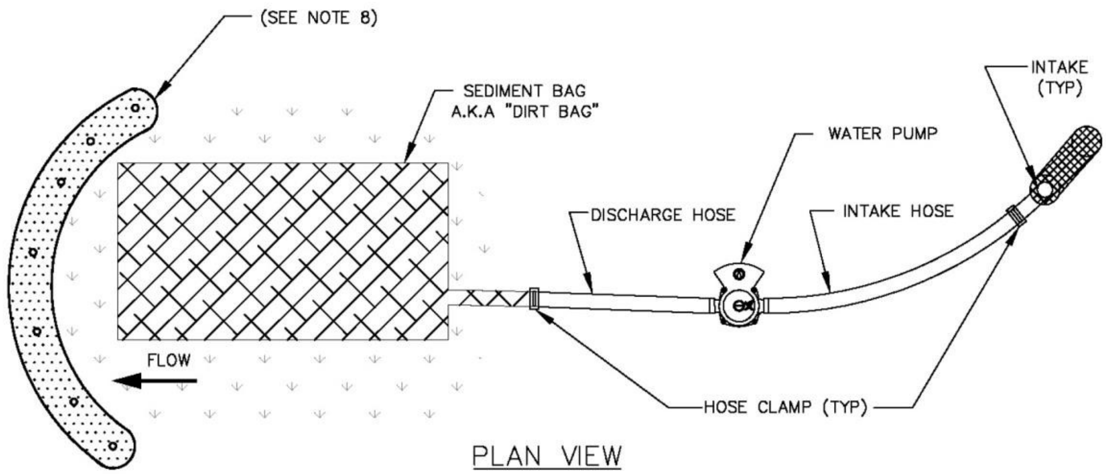
Design Criteria

- Determine soil type prior to selecting type of dewatering system.
- Select an appropriate location to place system that will reduce overall impacts.
- If removing large particles such as sand, weir tanks, and filter boxes are effective.
- If removing smaller particular such as silt and clay, Cartridge Filter Units and Chitosan can be effective.
- Filter bags can remove large particles until fabric pores start to fill in or cake over then filter capacity increases to smaller sand and silt.
- Filter bags that are used to dewater should be placed in a heavily vegetated area to increase their efficiency.

- Rock berms, bio-filter bags, can be installed as an alternate, or in conjunction with other systems.

Inspection & Maintenance

- Ongoing inspection is necessary in order to detect any malfunctions or operation of equipment.
- Periodic inspection of discharge areas.
- Inspection protocol for use of Chitosan must be followed. Refer to state and local jurisdiction for requirements.
- Remove sediment when it reaches 1/3 capacity of a sediment barrier.
- Material must be placed in an approved location on site or exported from site.



PLAN VIEW

NOTES:

1. THE SEDIMENT BAG SHALL BE MANUFACTURED USING A POLYPROPYLENE 8 OZ. NON-WOVEN GEOTEXTILE SEWN INTO A BAG WITH A DOUBLE NEEDLE, USING A HIGH STRENGTH THREAD.
2. EACH STANDARD SEDIMENT BAG MUST HAVE A FILL SPOUT LARGE ENOUGH TO ACCOMMODATE A 4" DISCHARGE HOSE. STRAPS ARE ATTACHED TO SECURE THE HOSE AND PREVENT PUMPED WATER FROM ESCAPING WITHOUT BEING FILTERED.
3. THE SEDIMENT BAG SHALL MEET OR EXCEED OVERALL BAG REMOVAL EFFICIENCY RATE OF 97.55%.
4. WATER BEING DISCHARGED FROM THE SEDIMENT BAG MUST BE FREE OF ALL SEDIMENT PRIOR TO LEAVING THE SITE OR ENTERING INTO THE STORM SYSTEM.
5. SEDIMENT BAG IS FULL WHEN IT NO LONGER CAN EFFICIENTLY FILTER SEDIMENT OR ALLOW WATER TO PASS AT A RATE LESS THAN 50% OF MANUFACTURER'S DESIGNED FLOW RATE.
6. DURING USE, THE SEDIMENT BAG MUST BE MONITORED.
7. DISPOSE OF USED SEDIMENT BAG OFF SITE OR AS APPROVED BY CWS.
8. WHEN APPROPRIATE, INSTALL DOWNSTREAM SEDIMENT CONTROL MEASURES PER CWS STANDARDS.
9. FOR BEST RESULTS, PLACE SEDIMENT BAG ON FLAT SURFACE.
10. SEDIMEMT BAG SHOULD BE PLACED ON EXISTING VEGETATION, ROCK, OR BED OF STRAW. SEDIMENT BAG SHOULD NOT BE PLACED ON BARE GROUND.

SEDIMENT BAG

DRAWING NO. 950

REVISED 10-31-19

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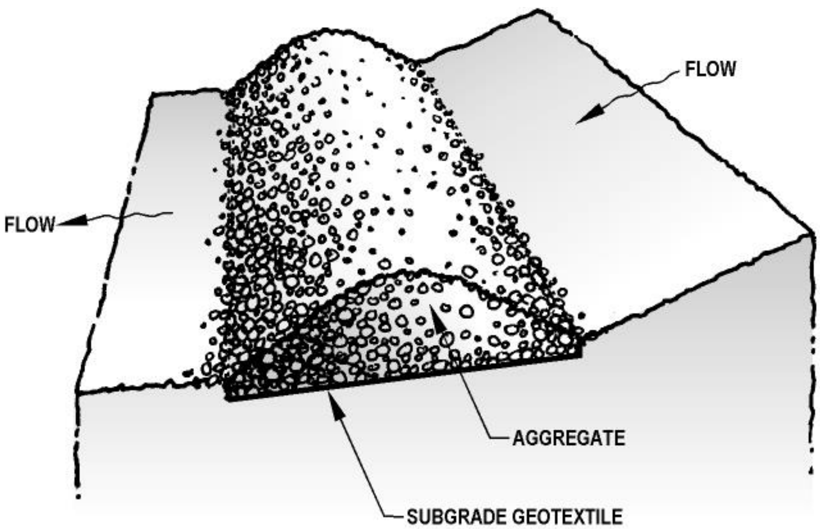
FILTER BERM

4.3.4 Filter Berm

A filter berm is intended to control erosion and sedimentation by reducing the rate of surface runoff. Filter berms can be composed of aggregate or compost.



AGGREGATE BERM - Retains sediment in gravel or crushed rock berm.

Advantages
- Very efficient method for sediment removal.
- Reduces runoff velocity.

Disadvantages
- More expensive than some other measures because requires clean gravel or crushed rock rather than materials found onsite.
- Clogging from mud and soil may make maintenance difficult.
- Has a limited life span.

Design Criteria
- Use 6 inch. maximum washed and well-graded gravel or crushed rock with less than 5% fines.
- Berm Dimensions:
  - Height and side slopes: 1 foot high with 3:1 side slopes.
  - Length: 8 foot per 1 cubic foot per second flow, based on the peak flow for the 10-year storm.
  - If used as slope application, use Table 4-8 for spacing requirements.
  - Used primarily as a base measure (toe of slope)

Table 4-8 Barrier Spacing For General Applications

INSTALL PARALLEL ALONG CONTOURS AS FOLLOWS		
% Slope	Slope	Maximum Spacing on Slope
10 % Flatter	10:1 or Flatter	300 ft
10 > % < 15	10:1 > x < 7.5:1	150 ft
15 > % < 20	7.5:1 > x < 5:1	100 ft
20 > % < 30	5:1 > x < 3.5:1	50 ft
30 > % < 50	3.5:1 > x < 2:1	25 ft

COMPOST BERM - Can be used in place of sediment fence, straw wattles, compost sock, etc. (For sheet flow only.)

Advantages

- Very efficient method for sediment removal.
- Reduces runoff velocity.
- Compost retains a large volume of water.
- The mix of particle sizes in the compost filter material retains as much or more sediment than traditional perimeter controls, such as sediment fences, while allowing a larger volume of clear water to pass through the berm.
- Low removal cost as compost berm can be spread/tilled into surface as a soil amendment when no longer needed or can be seeded and left in place.

Disadvantages

- Initial cost may be higher than some other more commonly used measures.
- Clogging from mud and soil may make maintenance difficult.
- Has a limited life span.

Design Criteria

- Use mature, good quality material with sufficient particle size distribution. .
- Berm Dimensions:
  - Height and side slopes: 1 -1.5 feet high and 2-3 ft width at base.
  - If used as slope application, use Table 4-9 for spacing requirements.
  - To be used solely for sheet flow and installed along contours of slope

Table 4-9 Compost Berm Spacing and Minimum Dimensions

Slope	Slope Length	Min. Berm Dimensions (height x width)
<50:1	250 ft	1 ft x 2 ft
50:1 - 10:1	125 ft	1 ft x 2 ft
10:1 - 5:1	100 ft	1 ft x 2 ft
3:1 - 2:1	50 ft	1.3 ft x 2.6 ft
>2:1	25 ft	1.5 ft x 3 ft

<u>Inspection & Maintenance</u>

Aggregate Berm

- Remove and replace rock when filtering capacity is reduced by half to maintain performance.
- Remove sediment accumulation when it reaches one-third of the barrier height.

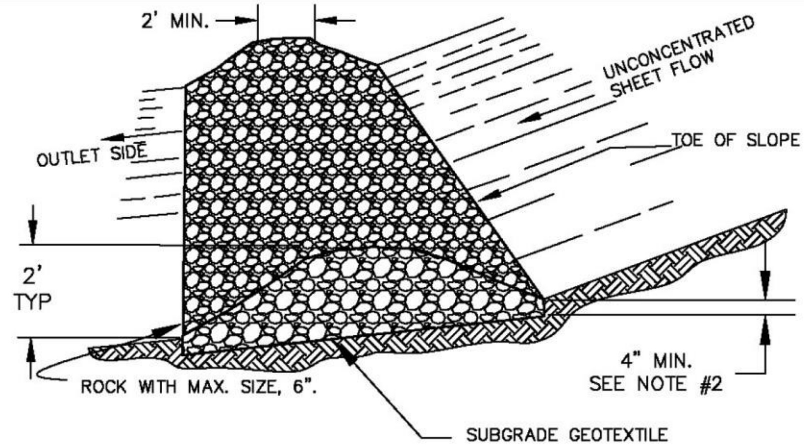
Compost Berm

- Check for under-cutting or piping under berm.
- Inspect for channel formation parallel to the berm, which indicates it is acting as a flow barrier.
- Immediately repair any damage and install additional berms as needed.
- Remove sediment accumulation when it reaches one-third of the barrier height.

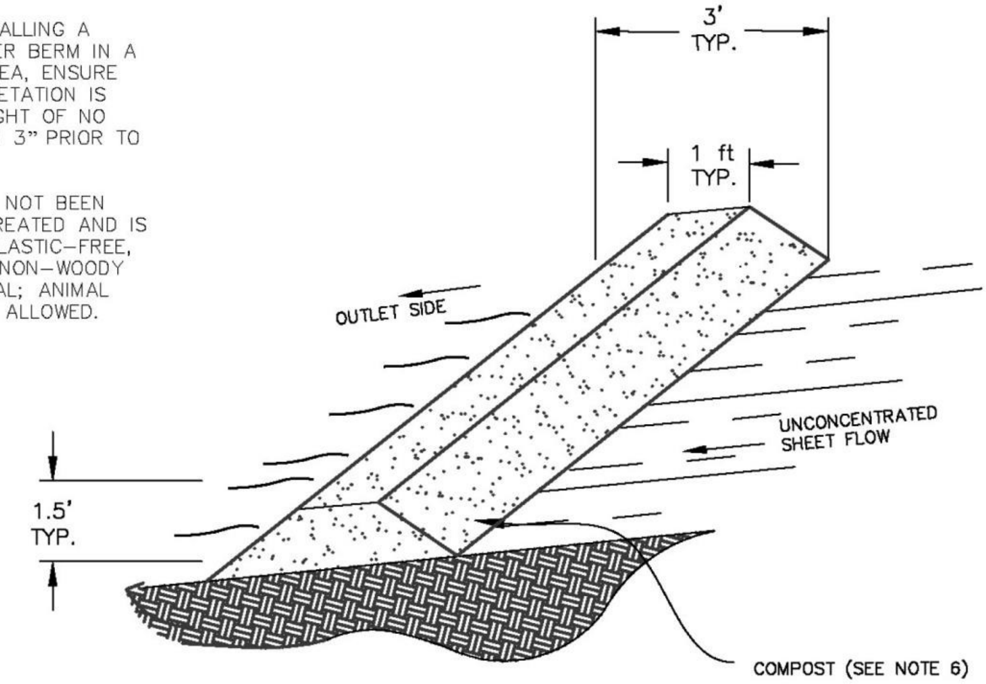
FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

NOTES:

1. DIRECT THE OUTLET SIDE OF THE ROCK/COMPOST FILTER BERMS ONTO A STABILIZED AREA, SUCH AS VEGETATION AND/OR ROCK.
2. EMBED ROCK FILTER BERM A MIN. OF 4" INTO THE EXISTING GROUND/EMBANKMENT.
3. USE ROCK FILTER BERM ON 3H:1V OR FLATTER SIDE SLOPES. WITHIN THE SAFETY CLEAR ZONE. USE 6H:1V OR FLATTER ON SIDE SLOPES.
4. PLACE COMPOST FILTER BERMS ALONG OR ON THE GROUND CONTOUR WITH THE ENDS TURNED UP SLOPE.
5. PRIOR TO INSTALLING A COMPOST FILTER BERM IN A VEGETATED AREA, ENSURE THAT THE VEGETATION IS CUT TO A HEIGHT OF NO GREATER THAN 3" PRIOR TO INSTALLATION.
6. COMPOST HAS NOT BEEN CHEMICALLY TREATED AND IS WEED-FREE, PLASTIC-FREE, DECOMPOSED, NON-WOODY PLANT MATERIAL; ANIMAL WASTE IS NOT ALLOWED.



ROCK FILTER BERM



COMPOST FILTER BERM

FILTER BERMS
ROCK/COMPOST

DRAWING NO. 890

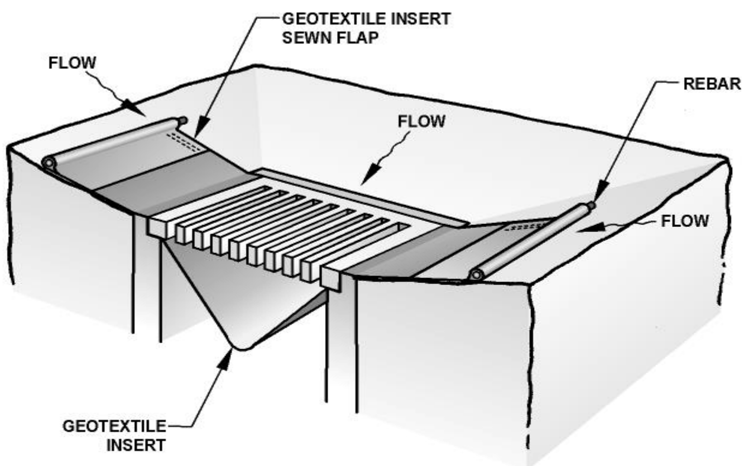
REVISED 10-31-19

INLET PROTECTION

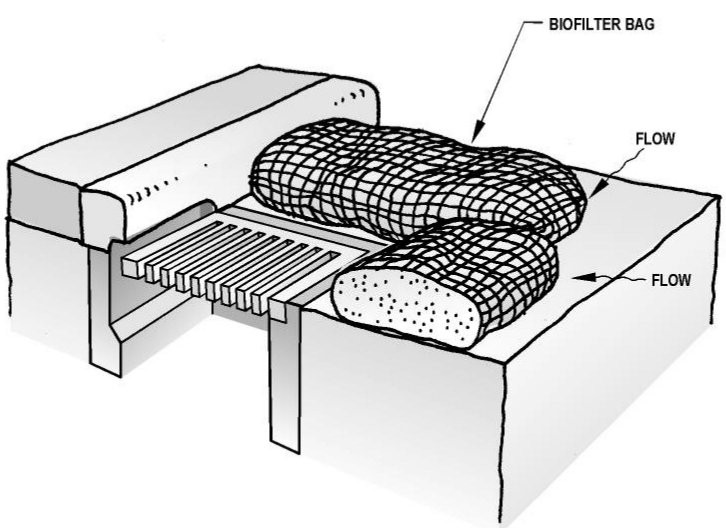
4.3.5 Inlet Protection

Inlet protection prevents coarse sediment from entering storm drainage systems by filtering runoff and retaining sediment before it reaches a drainage inlet or storm sewer system. There are many options and variations of inlet protection available.

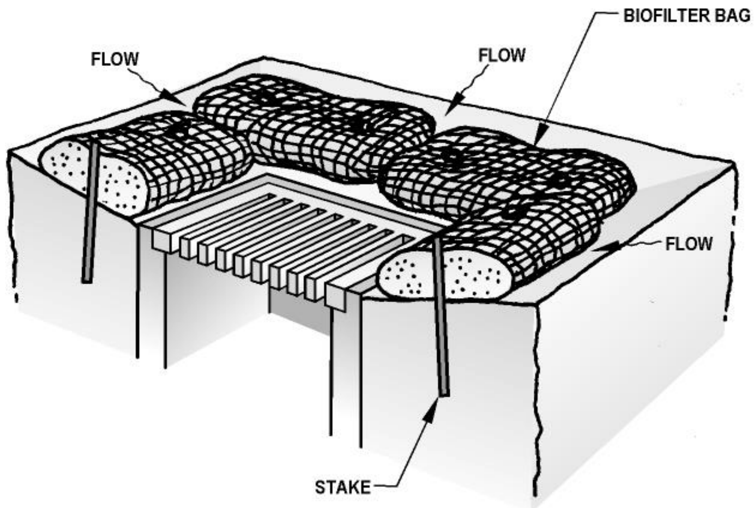
Inlet Protection – Masonry / Aggregate



Inlet Protection - Prefabricated Filter Insert



Inlet Protection – Biofilter Bags Around Catch Basin



Inlet Protection – Biofilter Bags around Area Drain

Advantages

- Prevents sediment from entering the storm drain system.
- Reduces amount of sediment leaving the site.

Disadvantages

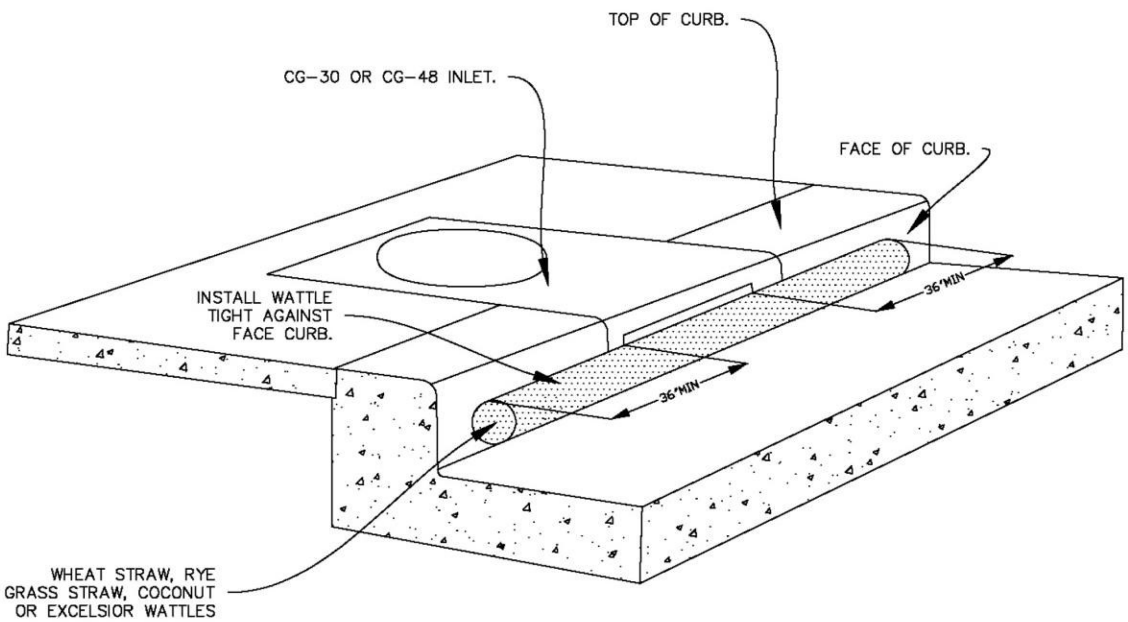
- May result in ponding of water above the catch basin.
- Sediment removal may be difficult under high-flow conditions.
- May result in a traffic hazard.
- Short-circuiting of flow may occur if not properly installed.
- Useful only for low flows having low sediment loading.
- Improper installation, maintenance or removal may introduce sediment into the storm drain system.

Design Criteria

- Place at all inlets down gradient of construction activities.
- Place inlet protection in areas where water can pond, and where ponding will not have adverse impacts.
- Inlet protection must allow for overflow in a severe storm event.
- Addition measures must be considered depending upon soil type
- Inlet protection types include:
  - Type 3 - Filter Fabric
  - Type 4 - Biofilter bags
  - Type 5 - Catch basin insert
  - Type 6 – Bone bags

Inspection & Maintenance

- Clean inlet protection during and after each significant storm and remove sediment from behind structure after every storm.
- If the rock becomes clogged with sediment, it must be carefully removed from the inlet and either cleaned or replaced.
- Assess the impacts of allowing water to pond at the inlet and provide an overflow weir or some other type of relief as needed.
- Use mechanical means to remove sediment deposits (shovel, broom, sweeper/vactor unit).
- Remove sediment accumulated on or around the protection as needed to maintain intended functions.
- Repair or replace materials as needed to ensure proper functioning.
- Remove inlet protection when construction activity is complete.



PERSPECTIVE VIEW SHOWING WATTLE
ALONG GUTTER AT CURB INLET

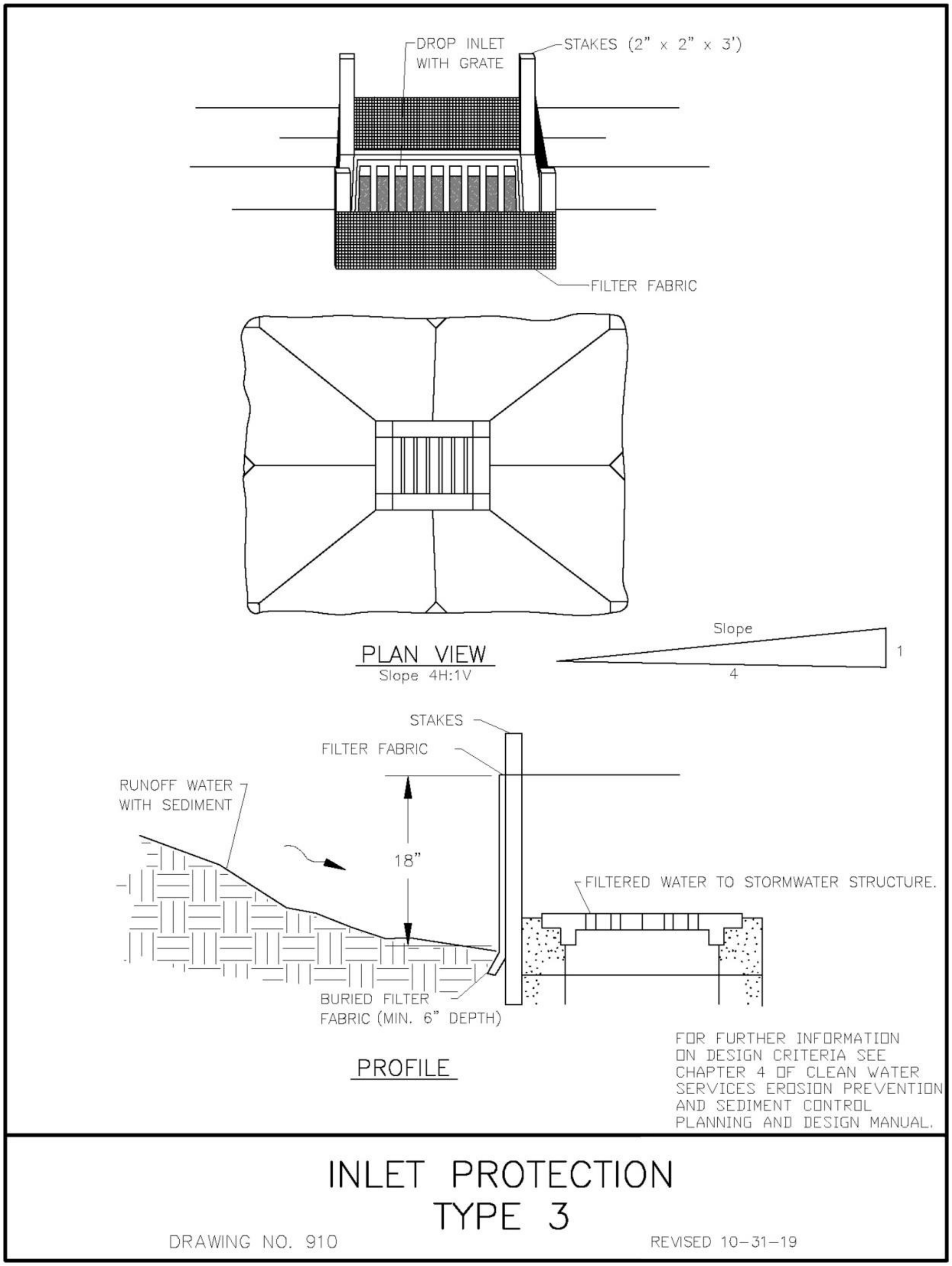
NOTES:

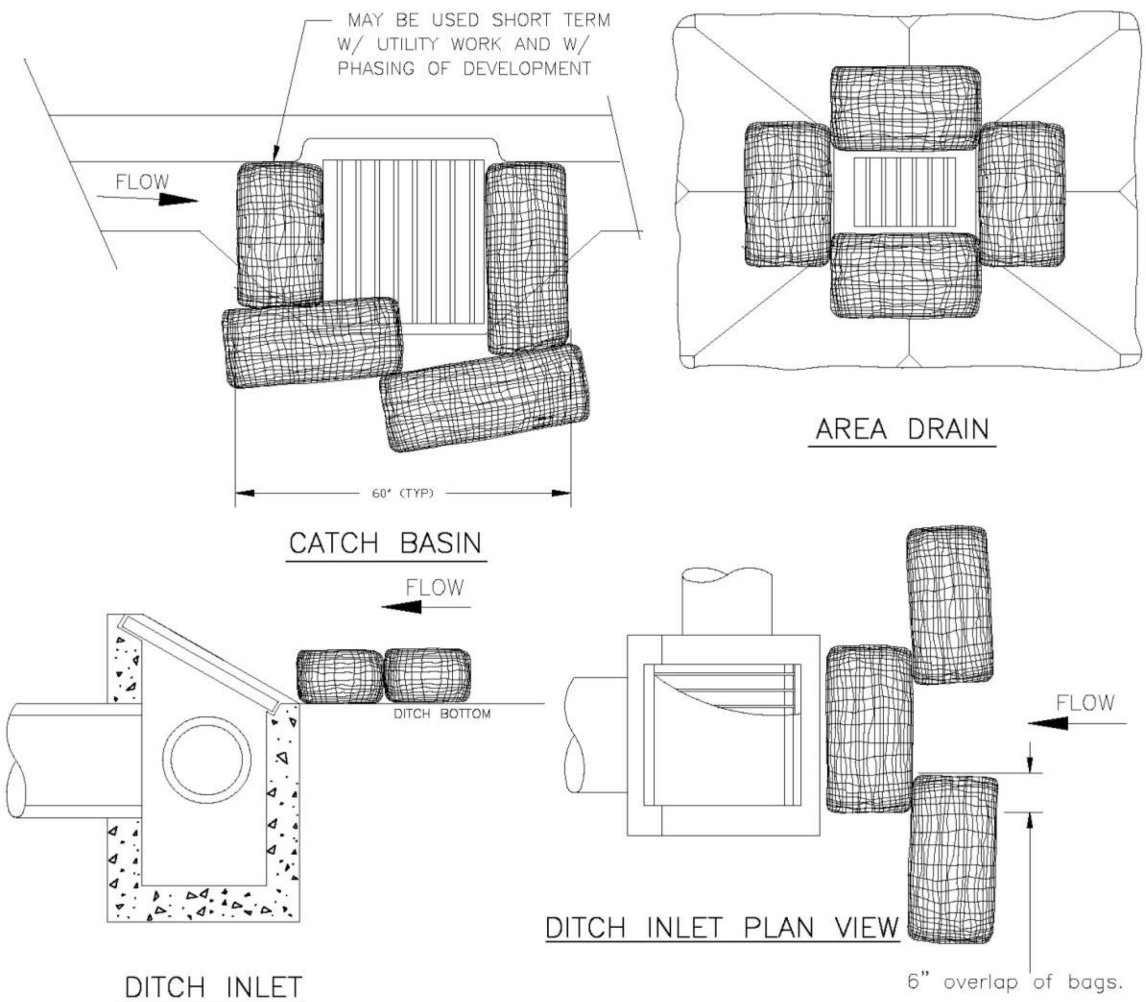
1. ONLY ALLOWED USE OF APPLICATION IS ON CURB AND GUTTER INLETS.
2. INSTALL WATTLE ALONG INLET WITH WATTLE EXTENDING A MIN OF 36" BEYOND INLET OPENINGS IN EACH DIRECTION.
3. WATTLE MUST BE INSTALLED TIGHTLY AGAINST CURB. MAY REQUIRE ADDITIONAL MEASURES TO ENSURE WATTLE REMAINS TIGHT AGAINST CURB, SUCH AS USING ZIP TIES TO SECURE WATTLE TO INLET'S TRASH BARS OR USING SANDBAGS TO WEIGHT DOWN WATTLE.
4. REPLACE WATTLE AS NECESSARY TO PREVENT SEDIMENT FROM ENTERING THE STORM SYSTEM.

CURB AND GUTTER
INLET PROTECTION

DRAWING NO. 905

REVISED 10-31-19


DROP INLET
WITH GRATE
STAKES (2" x 2" x 3')
FILTER FABRIC
PLAN VIEW
Slope 4H:1V
Slope
1
4
STAKES
FILTER FABRIC
RUNOFF WATER
WITH SEDIMENT
18"
FILTERED WATER TO STORMWATER STRUCTURE.
BURIED FILTER
FABRIC (MIN. 6" DEPTH)
PROFILE
FOR FURTHER INFORMATION
ON DESIGN CRITERIA SEE
CHAPTER 4 OF CLEAN WATER
SERVICES EROSION PREVENTION
AND SEDIMENT CONTROL
PLANNING AND DESIGN MANUAL.
INLET PROTECTION
TYPE 3
DRAWING NO. 910
REVISED 10-31-19



NOTES:

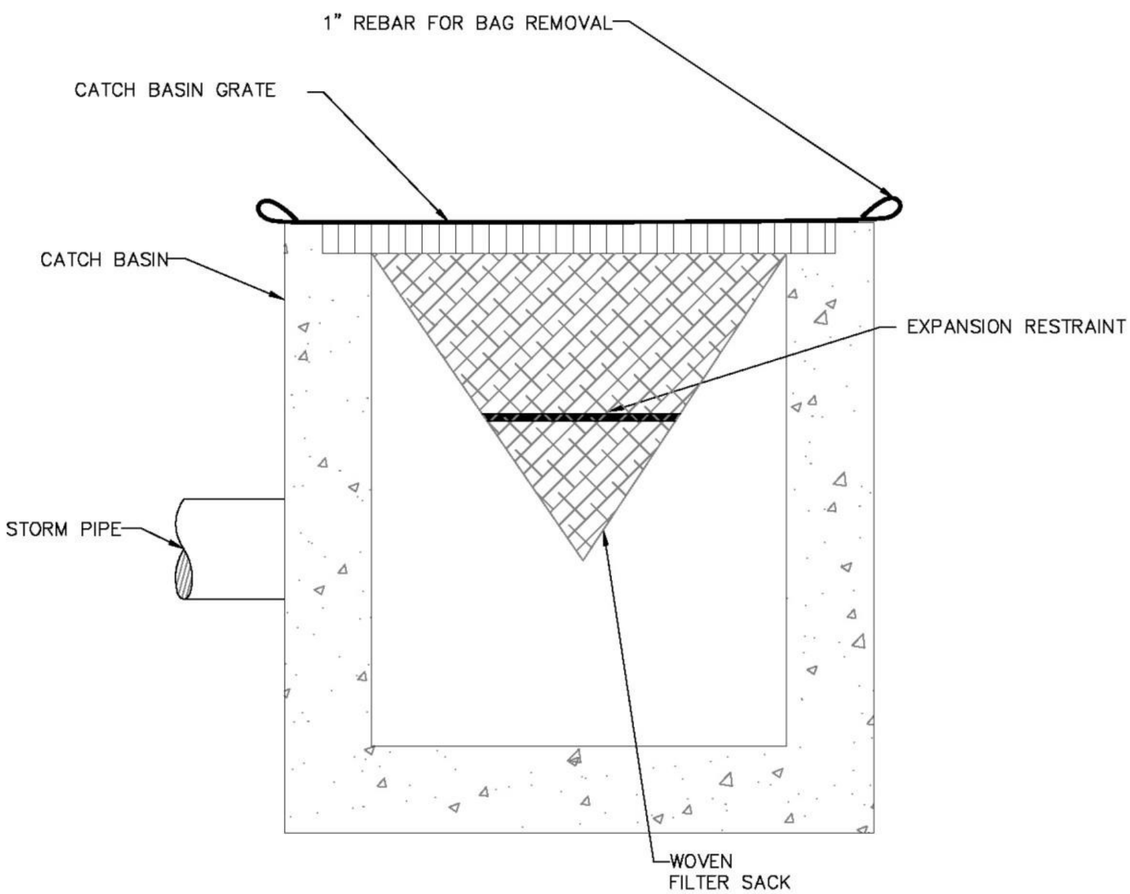
1. ADDITIONAL MEASURES MUST BE CONSIDERED DEPENDING ON SOIL TYPES.
2. BIO-FILTER BAGS SHOULD BE STAKED WHERE APPLICABLE USING (2) 1"x2" WOODEN STAKES OR APPROVED EQUAL PER BAG.
3. WHEN USING 30" BIO-BAGS TO PROTECT A CATCH BASIN YOU HAVE 4 BAGS AND THEY SHALL BE OVERLAPPED BY 6".

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

INLET PROTECTION
TYPE 4

DRAWING NO. 915

REVISED 10-31-19



CATCH BASIN INSERT

NOTE:

1. RECESSED CURB INLET CATCH BASINS MUST BE BLOCKED WHEN USING FILTER FABRIC INLET SACKS. SIZE OF FILTER FABRIC INLET SACKS TO BE DETERMINED BY MANUFACTURER.

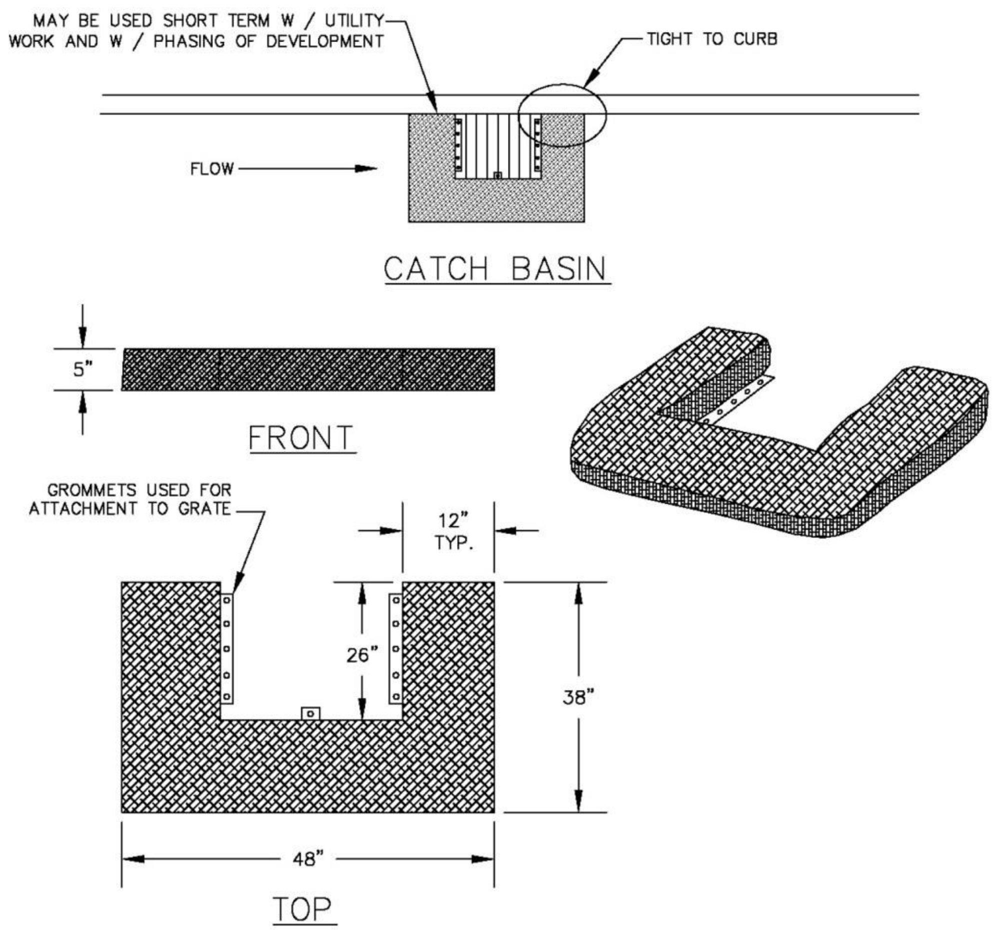
FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

INLET PROTECTION
TYPE 5

DRAWING NO. 920

REVISED 10-31-19

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.



INSTALLATION NOTES:

1. INSTALL SOLID FABRIC SIDE DOWN MESH SIDE UP.
2. ATTACH TO CATCH BASIN GRATE AT A MINIMUM OF 3 LOCATIONS TIGHT TO CURB WITH 1/4" ZIP TIES.

MAINTENANCE NOTES:

1. ANY VISIBLE SIGN OF SEDIMENT ACCUMULATION TO BE CLEANED UP AT THE END OF EACH WORKDAY.
2. REPLACE U – SHAPED FILTER BAG AS NECESSARY TO PREVENT WOOD CHIPS FROM ENTERING THE STORM SYSTEM.

INLET PROTECTION TYPE 6

DRAWING NO. 925

REVISED 10–31–19

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Oak Mats

4.3.6 Oak Mats

Oak mats are stabilized platforms, located at specified points of construction for the purpose of temporary or permanent ingress and egress. Oak mats have two benefits: reduce overall tracking from construction sites, and creates a stable pad for heavy equipment, especially when working around sensitive areas such as wetlands and streams.

Advantages

- Provides a solid working platform
- Reduces tracking
- Significantly lighter then conventional steel sheets
- Can be used several times
- Use lifting cables for easy of loading and unloading
- Excellent alternative for linear projects

Disadvantages

- Not suitable for all construction sites
- Depending upon the site, can be expensive
- Will deteriorate with age

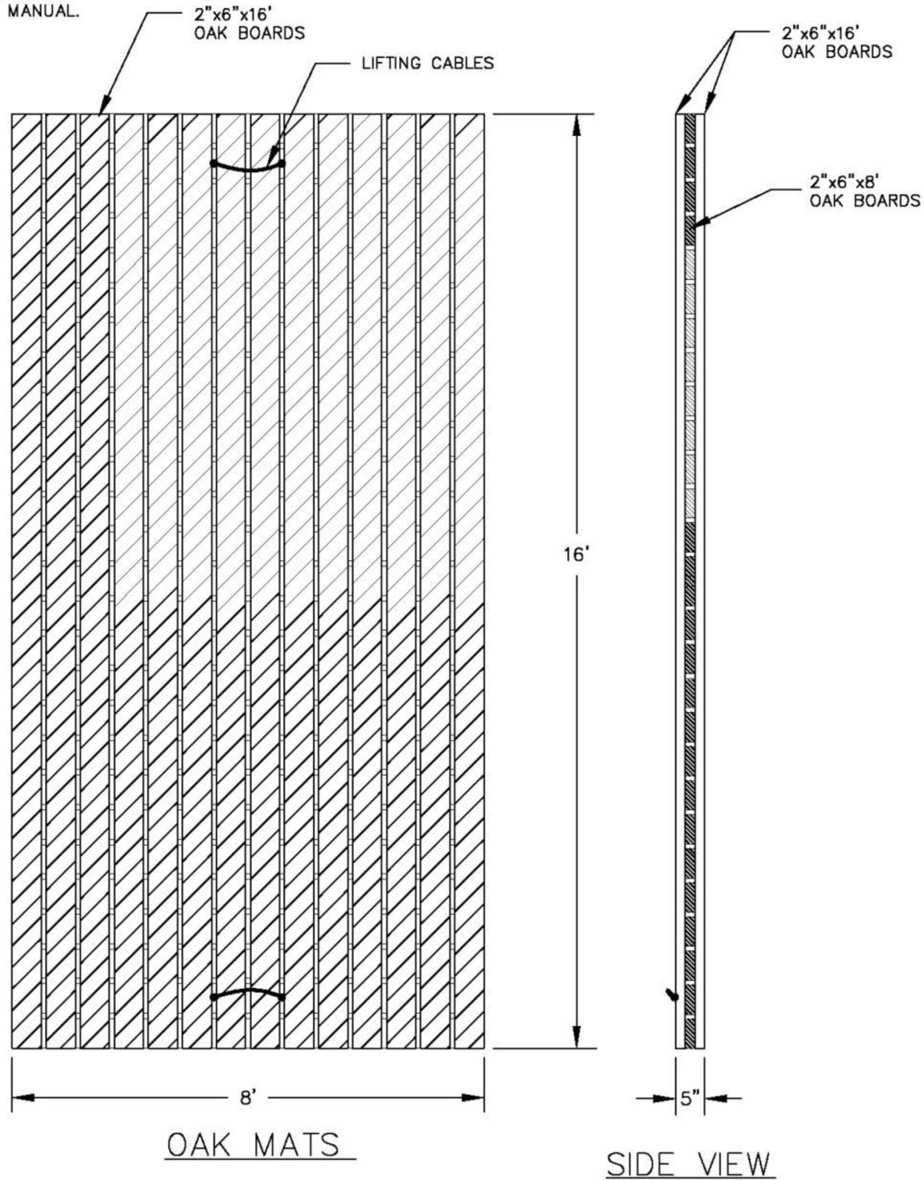
Design Criteria

- Dimensions: 8'x16'x4 ½ " (3 Ply Laminated oak or equivalent)
- Built-in lifting cables at each end
- Used for temporary or permanent access
- Built to withstand heavy equipment such as cranes, dump trucks, and back hoes
- On linear projects, that parallel streams or wetlands install as a continuous working pad to reduce soil "pumping"
- Minor excavation of surface area may be required prior to installation of mats

Inspection & Maintenance

- Requires on-going inspection
- Remove any soil deposits from equipment and vehicles prior to driving on mats.
- Immediately sweep up and remove any material that has been tracked offsite.
- Remove and replace mats when they no longer stable or wood has become broken or separated
- Check lifting cables to make certain they are in working order

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.



NOTES:

1. CONSTRUCTED OF 2"x6" OAK.
2. ALTERNATE MATTING SYSTEMS TO BE APPROVED BY CITY/DISTRICT.

OAK MATS

DRAWING NO. 860

REVISED 10–31–19

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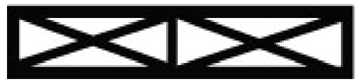
PRE-FABRICATED BARRIER



4.3.7 Pre-Fabricated Barrier System

Pre-fabricated barrier systems typically consist of a triangular shaped dike, usually made of foam or other flexible, lightweight material. The dike is wrapped in geotextile, which extends from the bottom of the dike to provide aprons on the upslope and downslope sides of the dike. The dike is anchored by trenching and stapling the aprons. Barrier materials, section lengths and weights vary among manufacturers. Other pre-fabricated barriers consist of water filled hinged panels that act as a sediment basin or toe of slope base measure. The purpose of these systems is to hold run-off for designed periods of time in order to allow for settling of soil.

<u>Advantages</u>

- Can be lightweight.
- Installation is relatively simple.
- Can be used to divert and slow velocity of small drainage areas.
- Reusable.
- Can retain larger suspended soils particles.

<u>Disadvantages</u>

- The foam type can be easily damaged by construction equipment.
- Not effective in steep swales, channels or ditches.
- If improperly installed, can allow undercutting or end-flow.
- Not effective where water velocities or volumes are high.
- Installation must be done exactly as specified by manufacturer.
- Not intended for use on steep slope applications.

<u>Design Criteria</u>

- Used primarily as a base measure.
- Install in accordance with plans, special provisions and manufacturer's recommendations.
- Specify drainage area.

<u>Inspection & Maintenance</u>

- Check that undercutting or end-flow is not occurring.
- Check that barrier is not otherwise damaged.
- Check that aprons are securely anchored.
- Check that flow is not becoming channeled behind barrier (parallel to barrier),
- Remove sediment accumulation behind barrier when sediment reaches one-third the barrier height.
- Replace damaged sections as needed.

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SAND BAGS

4.3.8 Sand Bags

Sandbags are manufactured from durable, weather resistant tightly woven Geotextile fabric material sufficient to prohibit leakage of the filler material. The bags should measure 24 x 12 x 6 inches and be filled with firmly packed sand weighing at least 75 lbs.

<u>Advantages</u>

- Relatively low cost.
- Installation is simple, can be done by hand.
- Bags are easy to move, replace and reuse on paved surfaces.
- Are a good short-term solution in situations where concentrated flows are causing erosion.
- Can be used to divert and slow velocity of small flows.
- Can be used in concrete lined ditches capture sediment and reduce water velocity.

<u>Disadvantages</u>

- Generally effective for only a few months.
- Can be easily damaged by construction equipment or by traffic in paved areas.
- Can contribute sediment to runoff if bags rupture.
- Cannot be staked and are not appropriate on steep slope applications.
- Not effective in steep swales, channels or ditches.
- If improperly installed, can allow undercutting or end-flow.
- Not effective where water velocities or volumes are high: can get washed away.

<u>Design Criteria</u>

- Generally used in ditches and/or swales as a check dam.
- Can be used on highway or road projects to divert run-off.
- Ends of bags must be tightly abutted and overlapped to direct flow away from bag joints.

Inspection & Maintenance

- Check that ends of bags are tightly abutted. Check that undercutting or end-flow is not occurring.
- Remove sediment accumulated behind bags when sediment reaches one-third of the barrier height.
- Replace damaged bags as needed.

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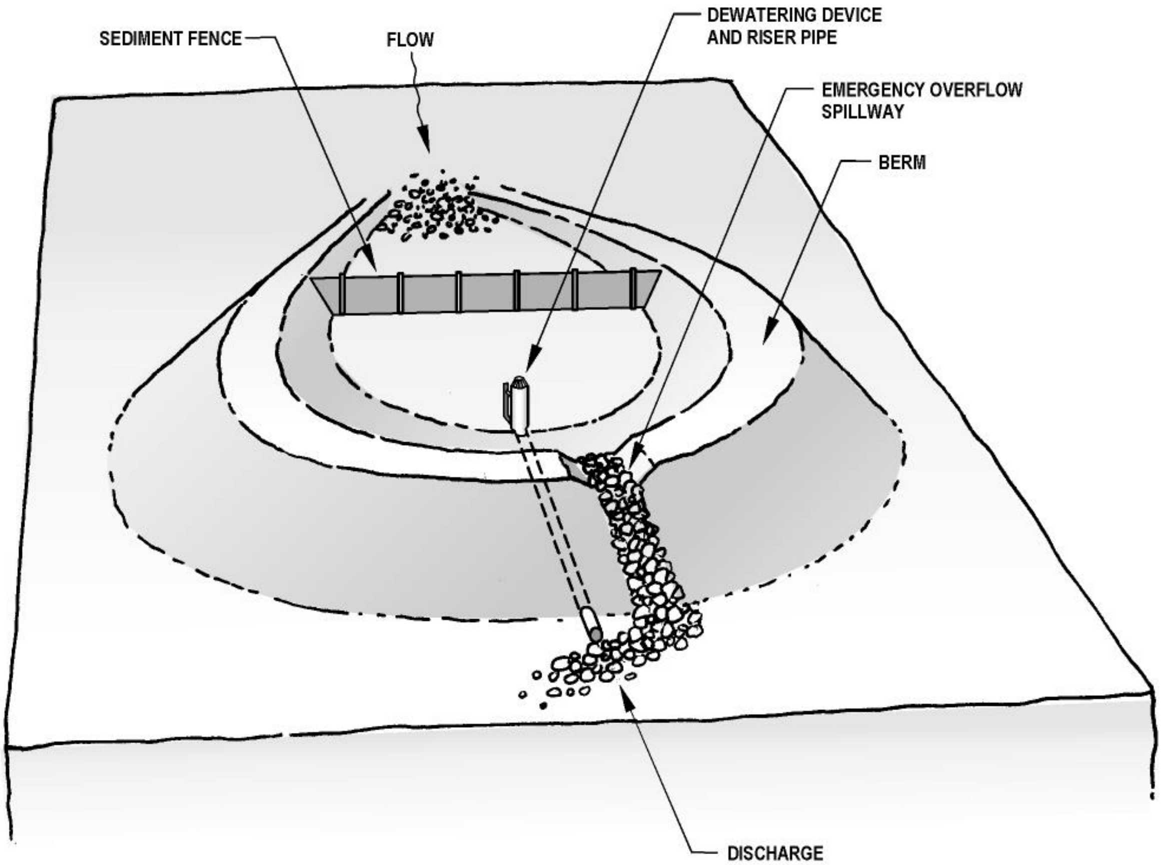
SEDIMENT BASIN

4.3.9 Sediment Basin



A temporary sediment basin has one or more inflow points and baffles to spread the flow, wet storage and dry storage, a securely anchored riser pipe, a dewatering device and an emergency overflow spillway. A sediment basin should serve a drainage area less than 10 acres in size and have a design life of approximately 1-year.

Basins are large facilities that treat runoff from large drainage areas. Because of this, basins have limited application on linear construction projects. The applications, advantages and disadvantages of basins are included here for the designer's edification.

<u>Combining with Permanent Drainage Facilities</u>

- If a project includes a permanent storm water retention/detention pond, the rough-graded or final-graded facility could function as a basin during construction. Design features of the permanent structure, such as surface area, retention time and outlet control, should meet the design requirements of the temporary facility.

Completion of the permanent facility should occur only when all upstream control structures are in place and stabilization of contributing drainage areas is complete.

- Sediment fence should be installed around perimeter to protect against potential breach.
- If a project includes an infiltration facility, the roughly excavated facility could be used as a basin, providing the facility provides the surface area and retention time required by the basin. Excavate the sides and bottom of the facility to a minimum of 2 foot above final grade with a backhoe working at “arms length” to minimize disturbance and compaction of the infiltration surface.
- Any required pretreatment facilities should be fully constructed prior to any release of sediment-laden water to the facility. Pretreatment and shallow excavations are intended to prevent the clogging of soil with fines.

<u>Advantages</u>

- Protect downstream riparian properties from sediment deposits.
- Prevent reduced downstream capacity due to sediment deposition and clogging of downstream facilities..
- Remove particles up to medium silt size 0.02 mm.
- Surface water conveyances can be connected to the facility as site development proceeds.

<u>Disadvantages</u>

- May become an attractive nuisance. Care must be taken to adhere to all safety practices.
- Failure of a basin, which is not properly located could result in loss of life, damage to homes or buildings or interruption of services such as transportation or power.
- Maintenance and sediment removal is essential for adequate performance.
- Does not reduce turbidity resulting from fine silts and clays in runoff. Basins are more effective when used in conjunction with other measures such as seeding and mulching.

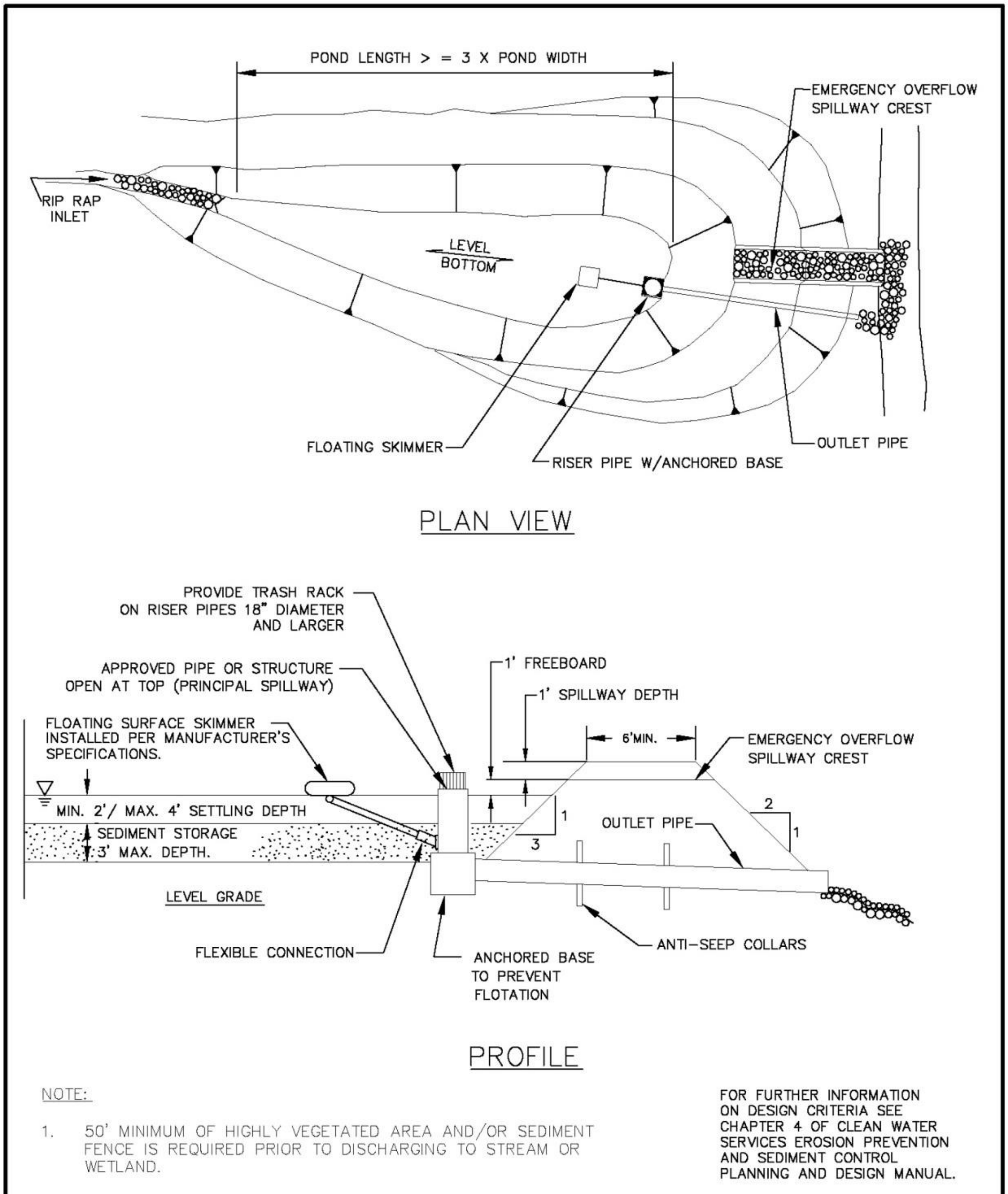
<u>Design Criteria</u>

- Water temperature in the basin may be too high for direct release. Always moderate the water temperature before it drains into a lake, stream or waterway. Whenever possible, release the trap discharge onsite onto a relatively level, densely grassed area at least 50 feet from a waterway or wetland.
- Require installation of a staff gauge to aid in determining sediment depth.

- The designer may want to route surface water collected from disturbed areas to a sediment basin prior to release from the site.
- A qualified engineer should design temporary sediment basins.

Inspection & Maintenance

- All damages caused by soil erosion or construction equipment shall be repaired before the end of each working day.
- Remove sediment when the sediment storage zone is half-full. This sediment shall be placed in such a manner that it will not erode from the site. The sediment shall not be deposited downstream from the embankment or in or adjacent to a stream or floodplain.
- When temporary structures have served their intended purpose and the contributing drainage area has been properly stabilized, the embankments and resulting sediment deposit shall be leveled or otherwise disposed of in accordance with the approved erosion and sediment control plan.



SEDIMENT BASIN

DRAWING NO. 935

REVISED 10-31-19

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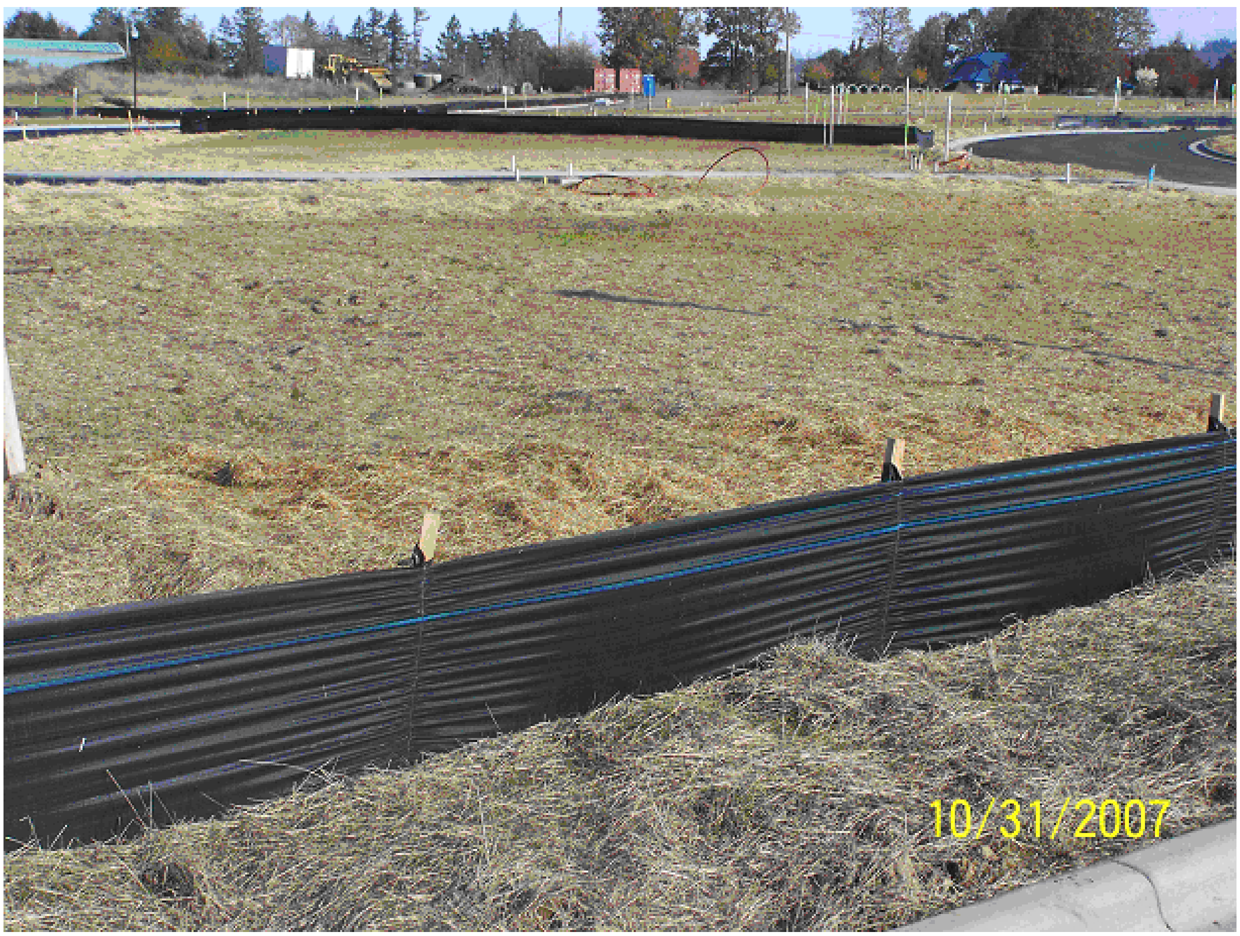
SEDIMENT FENCE



4.3.10 Sediment Fence

Sediment fencing is a temporary sediment trap consisting of an entrenched geotextile stretched across and attached to supporting posts. Sediment fences are adequate to treat flow depths consistent with overland or sheet flow. Standard or heavy-duty sediment fence fabric must meet specific ASTM requirements, outlined in **Table 4-10.**

Advantages

- Reduces runoff velocity.
- Requires minimal ground disturbance to install.
- Relatively inexpensive.

Disadvantages

- Applicable to small drainage areas and overland flow; not applicable to concentrated flows.
- Incorrect geotextile or installation decreases sediment fence performance.
- Requires frequent maintenance and inspection.

Design Criteria

- See **Table 4-11** for Sediment Fence Fabric Specifications
- Install sediment fence along ground contours according to **Table 4-10**
- Sediment fence should only be used for sheet and rill erosion. Not meant to be used in areas of concentrated flows.
- Standard or heavy-duty sediment fence filter fabric shall have manufactured stitched loops with 2”x 2”x4’ stake. Stakes shall be installed on/towards the construction side.
- Sediment fences should be installed a minimum of 3 feet from toe of slope in order to maximize storage.
- A trench should be excavated 6 inches deep along the line of the posts.
- Trench should be backfilled and the soil compacted on both sides of the sediment fence.
- Posts should be spaced a maximum of 6 feet apart and driven securely into the ground a minimum of 12 inches.
- When sediment fence approaches its termination point, turn fence uphill and extend one full panel (6 ft).
- When joining two or more sediment fences together, join the two end stakes by wrapping the two ends at least 1½ turns and driving the joined stakes into the ground together.
- Height of a sediment fence should not exceed 3 feet. Storage height and ponding height should never exceed 1.5 feet.

Table 4-10 Barrier spacing for general application

BARRIER SPACING FOR GENERAL APPLICATION

INSTALL PARALLEL ALONG CONTOURS AS FOLLOWS		
% Slope	Slope	Maximum Spacing on Slope
10 % Flatter	10:1 or Flatter	300 ft
10 > % < 15	10:1 > x < 7.5:1	150 ft
15 > % < 20	7.5:1 > x < 5:1	100 ft
20 > % < 30	5:1 > x < 3.5:1	50 ft
30 > % < 50	3.5:1 > x < 2:1	25 ft

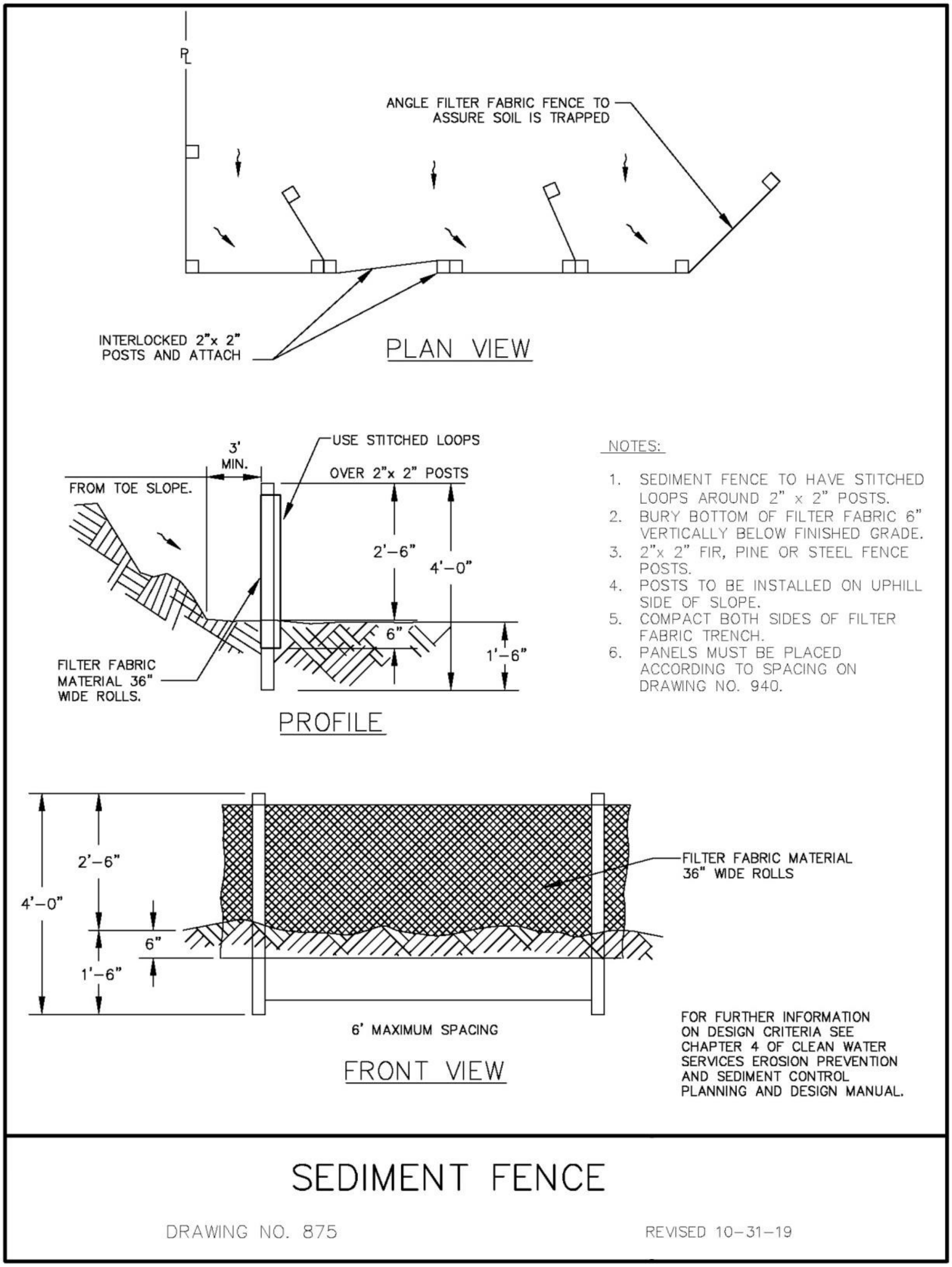
Table 4-11 Sediment Fence Fabric Specifications

WOVEN POLYPROYLENE SEDIMENT FENCE FABRIC

PROPERTY	TEST PROCDURE	MINIMUM FABRIC VALUE
Grab Tensile Strength	ASTM D-4632	180 lbs.
Grab Elongation	ASTM D-4632	15%
Trapezoid Tear	ASTM D-4533	70 lbs.
Mullen Burst	ASTM D-3786	300 psi
Puncture	ASTM D-4833	80 lbs
Permitivity	ASTM D-4491	.07 sec-1
Permeability	ASTM D-4491	.005 cm/sec
A.O.S.	ASTM D-4751	50 U.S. Sieve
UV Resistance (500 hrs)	ASTM D-4355	90%

Inspection & Maintenance

- Immediately repair any damage.
- Remove accumulated sediment once it has reached 1/3 the height of the sediment fence or 1 ft maximum.
- Inspect for channel formation parallel to the fence, which indicates the geotextile is acting as a flow barrier.
- Replace deteriorated or clogged geotextile.
- Check for under cutting or piping under fence.


PL
ANGLE FILTER FABRIC FENCE TO ASSURE SOIL IS TRAPPED
INTERLOCKED 2"x 2" POSTS AND ATTACH
PLAN VIEW
USE STITCHED LOOPS OVER 2"x 2" POSTS
3' MIN.
FROM TOE SLOPE.
2'-6"
4'-0"
6"
1'-6"
FILTER FABRIC MATERIAL 36" WIDE ROLLS.
PROFILE
NOTES:
1. SEDIMENT FENCE TO HAVE STITCHED LOOPS AROUND 2" x 2" POSTS.
2. BURY BOTTOM OF FILTER FABRIC 6" VERTICALLY BELOW FINISHED GRADE.
3. 2"x 2" FIR, PINE OR STEEL FENCE POSTS.
4. POSTS TO BE INSTALLED ON UPHILL SIDE OF SLOPE.
5. COMPACT BOTH SIDES OF FILTER FABRIC TRENCH.
6. PANELS MUST BE PLACED ACCORDING TO SPACING ON DRAWING NO. 940.
2'-6"
4'-0"
6"
1'-6"
FILTER FABRIC MATERIAL 36" WIDE ROLLS
6' MAXIMUM SPACING
FRONT VIEW
FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.
SEDIMENT FENCE
DRAWING NO. 875
REVISED 10-31-19

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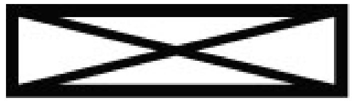
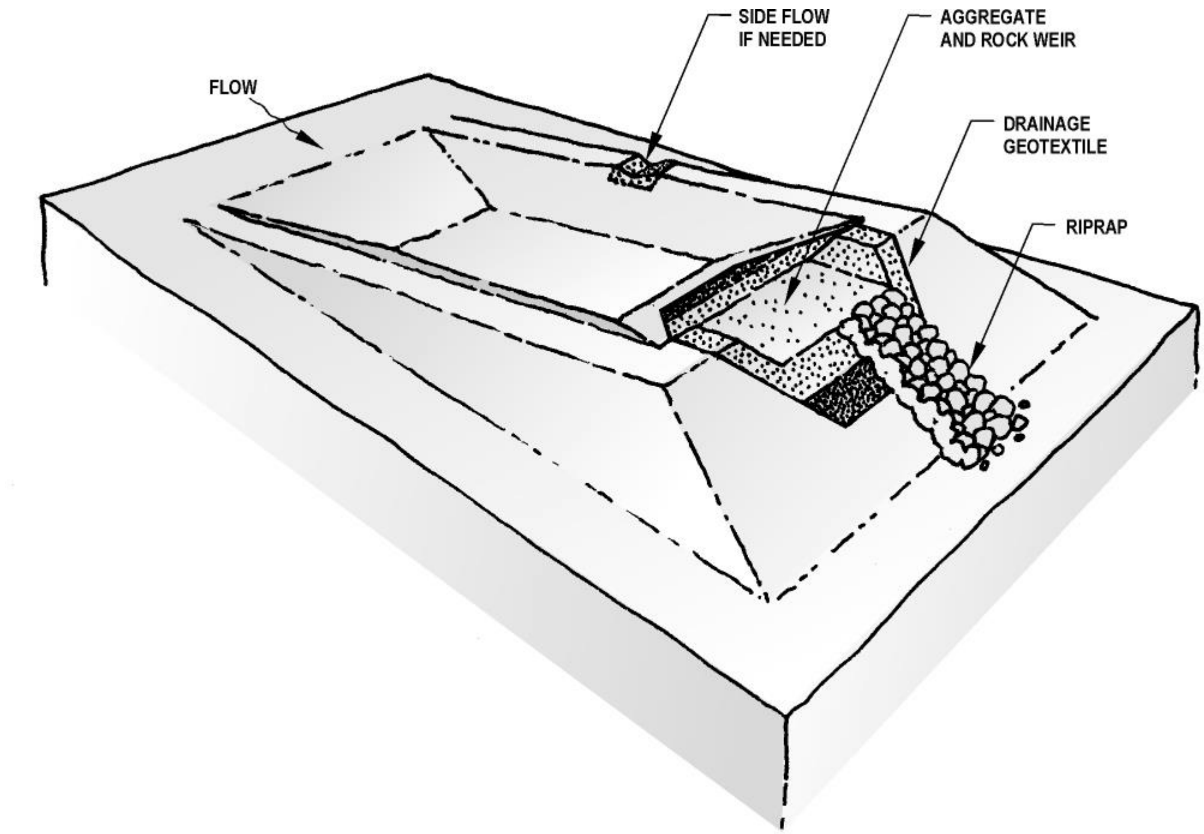
SEDIMENT TRAP



4.3.11 Sediment Trap



A sediment trap consists of a small, temporary ponding area, with a rock weir or perforated riser pipe at the outlet, formed by excavation or by constructing a weir. The sediment trap serves drainage areas 5 acres and smaller. They are a retention structure designed to remove sediment from runoff by holding a volume of water for a length of time, allowing particles 0.02 mm and larger to settle out. Sediment retention should be used as a last line of defense when included in an ESCP and never used by itself.

<u>Combining with Permanent Drainage Facilities</u>

- If a project includes a permanent storm water retention/detention pond, the rough-graded or final-graded facility could function as a trap during construction. Design features of the permanent structure, such as surface area, retention time and outlet control, should meet the design requirements of the temporary facility. Completion of the permanent facility should occur only when all upstream control structures are in place and stabilization of contributing drainage areas is complete.

- If a project includes an infiltration facility, the roughly excavated facility could be used as a trap or basin providing the facility provides the surface area and retention time required by the trap or basin. Excavate the sides and bottom of the facility to a minimum of 3 foot above final grade with a backhoe working at "arms length" to minimize disturbance and compaction of the infiltration surface.
- Additionally, any required pretreatment facilities should be fully constructed prior to any release of sediment-laden water to the facility. Pretreatment and shallow excavations are intended to prevent the clogging of soil with fines.

Advantages

- Protects downstream riparian properties from sediment deposits.
- Prevents reduced downstream capacity due to sediment deposition and clogging of downstream facilities.
- Can remove particles up to medium silt size (0.02 mm).
- Surface water conveyances can be connected to the facility as site development proceeds. The designer may want to route surface water collected from disturbed areas of the site through a sediment trap prior to release from the site.

Disadvantages

- May become an attractive nuisance. Care must be taken to adhere to all safety practices.
- Maintenance and sediment removal is essential for adequate performance.
- Intended to serve areas 5 acres and smaller.
- Does not reduce turbidity resulting from fine silts and clays in runoff. Traps are more effective when used in conjunction with other measures such as seeding and mulching.

Design Criteria

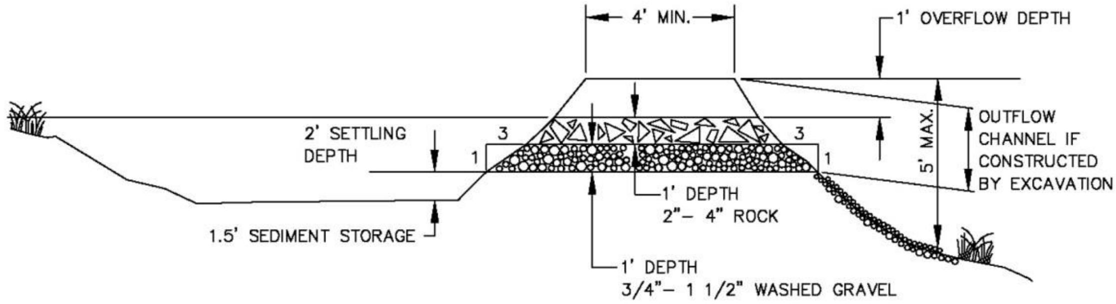
- Construct prior to any upslope clearing and grading.
- Locate in a low area where the trap will intercept all or most of the runoff from the disturbed area before it enters a waterway. Consider having contingency plans in case structure fails.
- Locate the trap so that it is readily accessible for maintenance.
- Provide for diversion dikes and ditches, as needed, to collect and divert water toward the trap.
- Sediment storage volume can be calculated using the RUSLE assuming a minimum one year sediment accumulation period for design purposes. To convert tons of sediment as calculated to cubic feet, multiply 0.05 tons per cubic foot.

- Determine the bottom surface area of the sediment trap using the calculated sediment volume and the maximum 1.5 depth.
- Determine the total trap dimensions by adding an additional 2 feet of depth for settling volume (before overtopping of spillway) above the sediment storage volume, while not exceeding 3:1 side slopes.
- Design the trap with a level bottom, 3:1 or flatter side slopes and a L:W ratio of 3.
- Construct the trap as the first step in the clearing and grading of the site.
- Form the trap by excavation or by construction of compacted embankment. If the trap is formed by embankment, the designer should note that dam safety regulation may apply to heights exceeding 5 foot. The embankment should be stabilized using a cover method such as seeding, mulching or erosion control matting.
- Water temperature in the trap may be too high for direct release. Always moderate the water temperature before it drains into a lake, stream, wetland or waterway.
- Evaluate locations for the release of the trap discharge based upon site specific restrictions. Release the trap discharge onsite onto a relatively level, densely grassed area that is at least 50 feet from a waterway or wetland.

<u>Inspection & Maintenance</u>

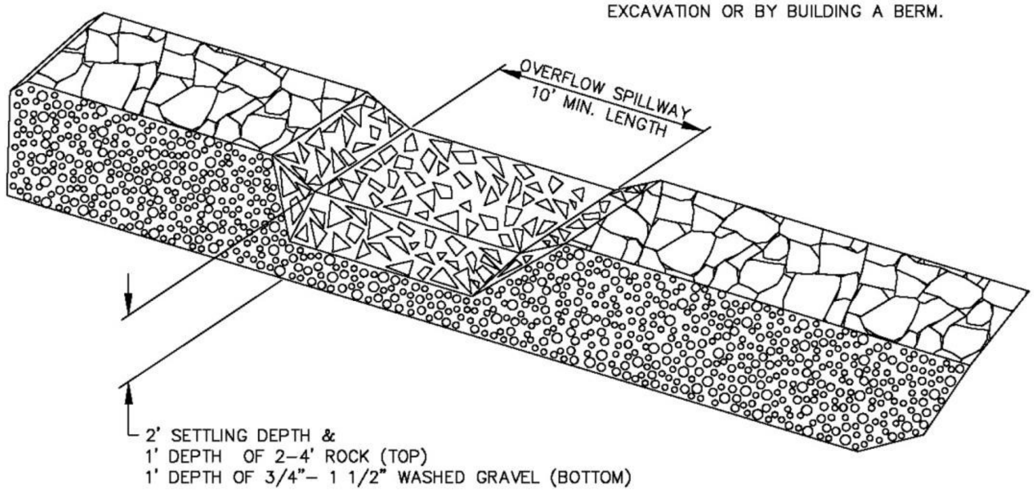
- Constant maintenance is essential for proper functioning.
- Remove sediment from the trap when it reaches one-third the storage capacity.
- Repair any damage to the trap, the embankments or the slopes.

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.



CROSS SECTION

NOTE: MAY BE CONSTRUCTED BY EXCAVATION OR BY BUILDING A BERM.



SEDIMENT TRAP OUTLET

NOT TO SCALE

NOTE:

1. ADDITIONAL BMPS MAY BE REQUIRED TO FILTER RUNOFF FROM THE SEDIMENT TRAP PRIOR TO DISCHARGE FROM THE CONSTRUCTION SITE.

SEDIMENT TRAP

DRAWING NO. 930

REVISED 10–31–19

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SIDEWALK SUB-GRADE GRAVEL BARRIER

4.3.12 Sidewalk Sub-grade Gravel Barrier

A sidewalk sub-grade gravel barrier is an application that provides storage and filtration from run-off on sites with mild slopes. It can be used on all types of projects but is generally used on single-family residential construction sites. Normal installation occurs when excavating for sidewalks at the same time as footing and foundation excavation.

<u>Advantages</u>

- Easy to install
- Very economical
- Can retain suspended soils

<u>Disadvantages</u>

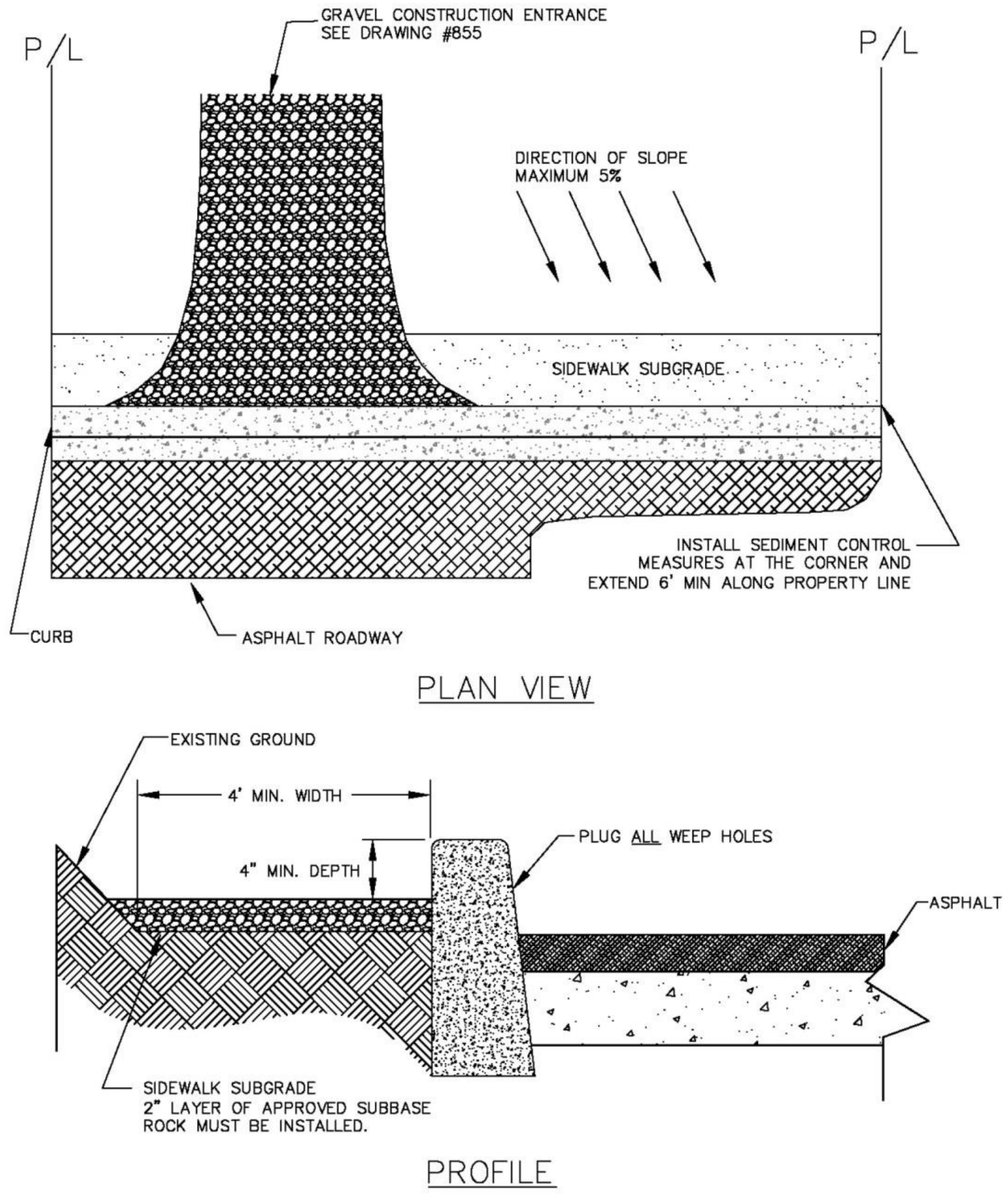
- May require installation of additional BMPs depending upon soil type and slope
- May need periodic maintenance for removal of suspended materials
- May not be acceptable by local jurisdiction for sub-base material when pouring sidewalk

<u>Design Criteria</u>

- Install where the site slopes to a street with curbs and slopes are 5% or less
- Plug all weep holes in curb
- Sidewalk sub-grade must have a minimum 4-inch depth and a 4-foot width.
- A 2 inch layer of approved sub-base material must be installed
- A gravel filter berm may be installed along the inside edge, or toe of slope to increase filtration
- Install sediment barrier on the downhill corner of property to intercept run-off
- On development sites, install sidewalk sub-grade as part of post construction
- On single-family residential construction sites, install at the time of the footing/foundation dig out
- If sidewalk concrete is to be poured prior to establishment of permanent site cover, approved sediment barriers must be installed prior to pouring sidewalk

Inspection & Maintenance

- Remove and replace gravel when filtering capacity is reduced byhalf, to maintain performance



NOTE:

1. SIDEWALK SUBGRADE CAN BE USED FOR ALL CONSTRUCTION ACTIVITIES.

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

SIDEWALK SUBGRADE

DRAWING NO. 895

REVISED 10–31–19

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TIRE WASH

Type 1

Type 2

4.2.13 Tire Wash Facility

Two types of tire wash facilities are available depending on the severity of sediment tracking and the size and duration of project. Type 1 can be retro-fitted in the field, using geotextile fabric and rock. Like a stabilized construction entrance, it is graded so that collected wash water is conveyed to a sediment trap, basin or other suitable treatment facility. Type 2 consists of a shallow concrete lined basin partially filled with water, through which exiting vehicles drive.

Advantages

- Reduces traffic hazards caused by debris on public roadways.
- Reduces sediment on roadways, which can wash into the storm sewer system.
- Type 1 is easy to construct and is relatively inexpensive.
- Type 2 is useful for high traffic volumes or large projects of long duration.

Disadvantages

- Only works if installed at every location where construction traffic leaves the site.
- Fills with sediment quickly and requires frequent maintenance.
- Requires a source of wash water.
- Requires a turnout or doublewide exit to avoid entering vehicles having to drive through wash area.
- Type 2 is costly to construct.
- Both facilities will generate large volumes of sediment-laden water, requiring treatment elsewhere on site.

Design Criteria

Type 1 (temporary)

- Minimum length: 40 ft.
- Minimum width: 10 ft.
- Minimum rock depth: 8 in.
- Average tire wash sump: 18 in.
- Install subgrade geotextile fabric as a liner
- Use 4-6 in. rock over geotextile fabric
- **Alternate:** 3 in. asphalt lift over a stable base coarse
- Grade the pad to drain to suitable collection and treatment facility.
- Install fencing as necessary to restrict exiting construction vehicle traffic to the tire wash.

Type 2 (permanent)

- Minimum length: 40 ft. with sloping ingress and egress
- Minimum width: 10 ft.
- Line bottom of basin with geotextile and 12 in. of a coarse rock base
- .
- Average tire wash sump: 18 in.
- Run out impervious area should be a minimum of 50 ft, graded back to facility.
- Construct basin out of 12 in. concrete with steel reinforcement.
- Provide water supply.
- Provide outlet for sediment-laden water discharge to treatment facility or provide pumps and tanks for water treatment.

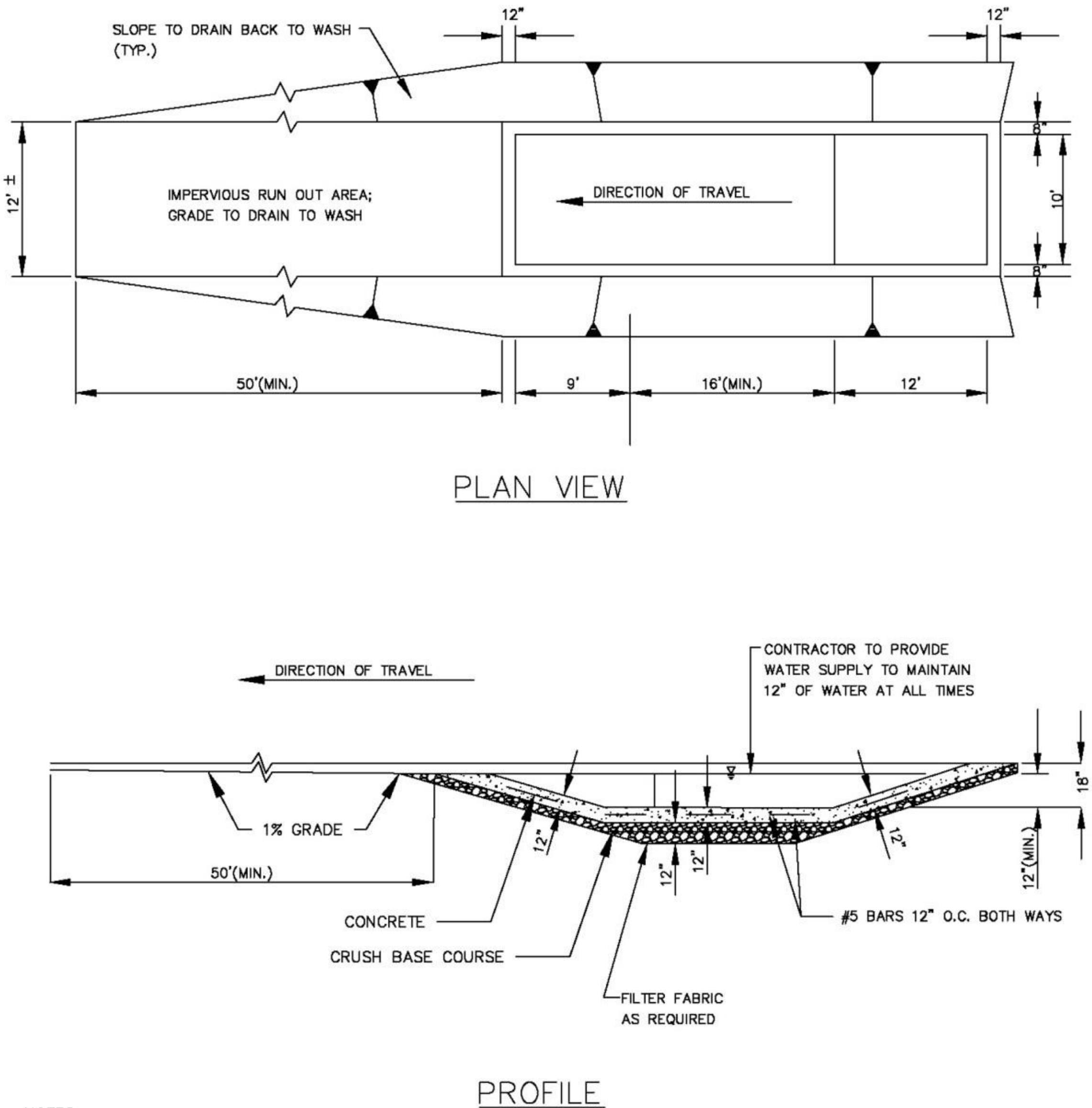
<u>Inspection & Maintenance</u>

Type 1- Inspect weekly at a minimum, or more depending upon use.

- Clean or replace rock clogged with sediment.
- Re-grade rock as needed.
- Maintain tire wash sump depth.
- Maintain a clean run-out pad.
- Immediately remove any rock that gets carried from the pad to the roadway.
- Ensure that wash water drainage, collection and treatment system is functioning.

Type 2 - Inspect weekly at a minimum, or more depending on use.

- Remove/discharge wash water once the condition of the water makes the tire wash no longer effective..
- Remove accumulated sediment from tire wash facility in order to maintain tire wash sump.
- Ensure that wash water collection and treatment system is functioning.



NOTES:

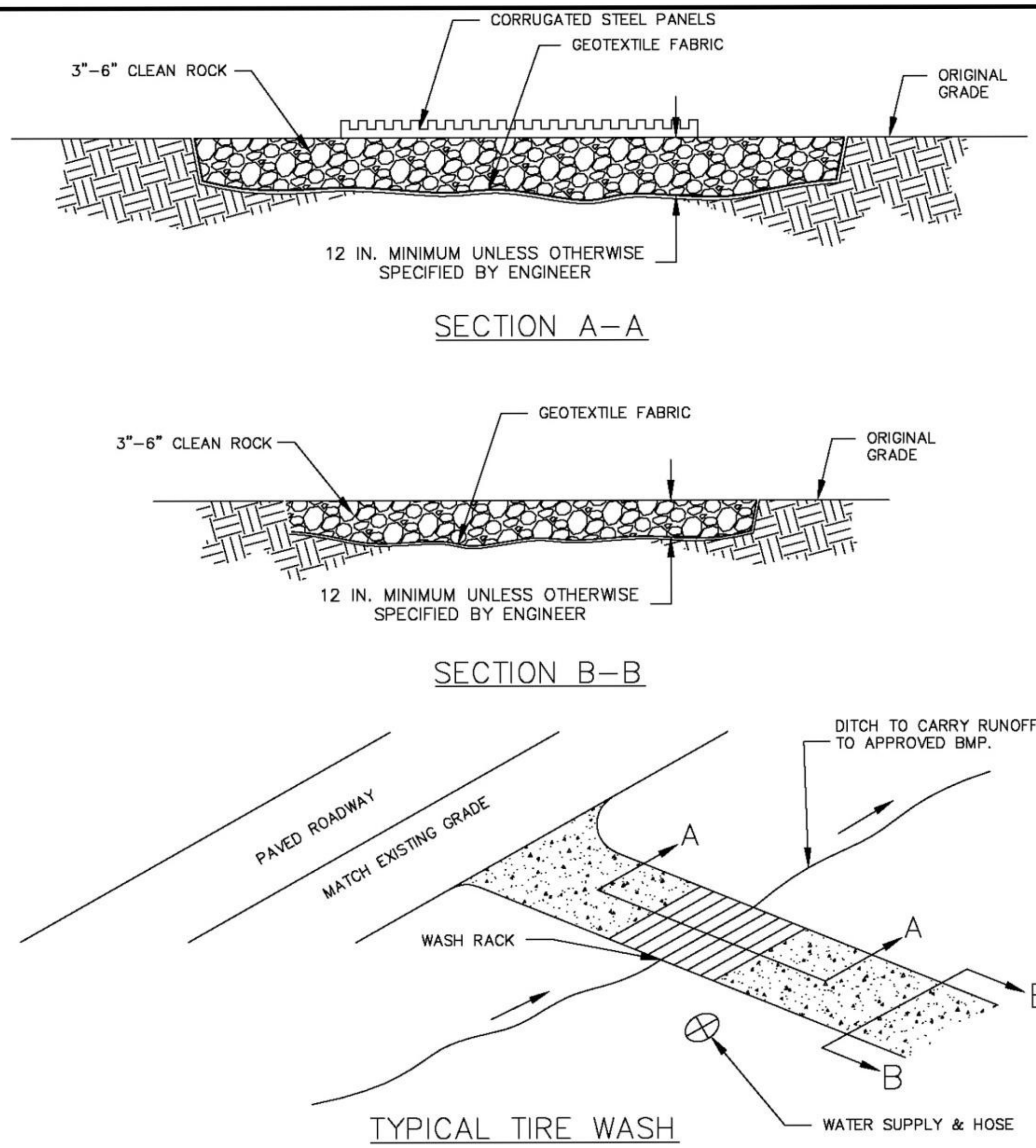
1. CONTRACTOR TO REMOVE ACCUMULATED SEDIMENT AS NEEDED TO PREVENT TRACKING FROM TIRE WASH; SEDIMENT LADEN WATER MAY BE PIPED TO AN APPROVED BMP.
2. USE GEOTEXTILE FABRIC WITH AGGREGATE FOR A TEMPORARY TIRE WASH.

FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

TIRE WASH–(DRIVE–THROUGH)

DRAWING NO. 870

REVISED 10–31–19



FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.

NOTE:

1. MANY DESIGNS CAN BE FIELD FABRICATED OR PRE-FABRICATED UNITS MAY BE USED

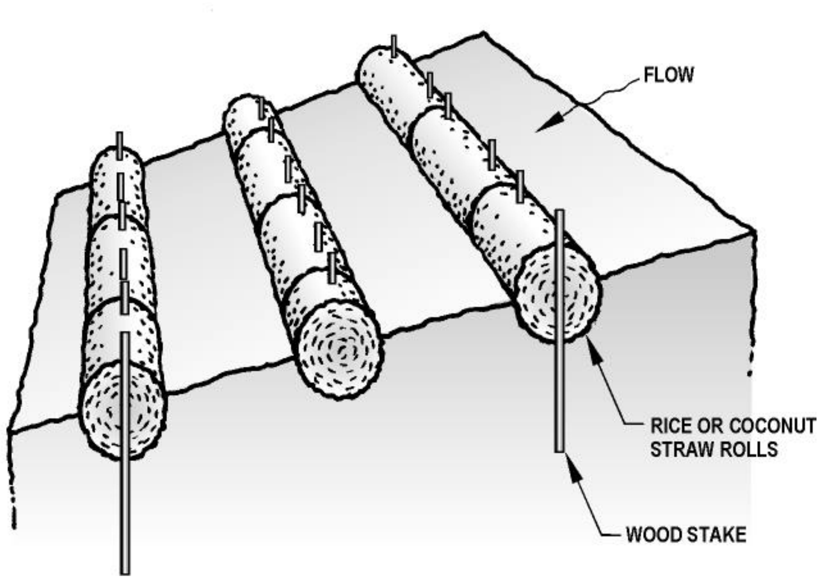
TIRE WASH
(MANUAL HOSE WASH)

DRAWING NO. 865

REVISED 10–31–19

WATTLES

4.3.14 Wattles



Wattles are manufactured from straw, coconut, or other material that is wrapped in tubular plastic netting. They are approximately 8-9 in. diameter by 7-25 ft. long. Wattles are placed in shallow trenches and staked along the contour of newly constructed or disturbed slopes.

<u>Advantages</u>

- They can often replace sediment fences on steep slopes.
- Wattles are short-term solution to help establish native vegetation.
- Wattles store moisture for vegetation planted immediately upslope.
- May be left in place to biodegrade and/or photodegrade.
- Straw becomes incorporated into the soil with time, adding organic material to the soil and retaining moisture for vegetation.
- Reduces runoff velocity.
- Light-weight and easy to install.

<u>Disadvantages</u>

- Wattles only function for one or two seasons.
- If not installed properly with sufficient trench, wattles may fail during the first rain event.
- Wattles may require maintenance to ensure that the stakes are holding and the wattles are still in contact with the soil. This is especially true on steep slopes in sandy soil.
- Low sediment retaining capacity may require frequent maintenance.

Design Criteria

- Wattles can be made from straw, coconut, or other approved material.
- Slope requires minor preparation prior to installation.
- Rills and shallow gullies should be smoothed as work progresses.
- Wattles should be installed on contours and placed with joints staggered. Trench should be deep enough to accommodate 1/3 to 1/2 the thickness of the wattle.
- Wattles should be installed from the bottom of the slope up.
- Spacing for slope installations should be determined by site conditions. Slope gradient and soil type are the main factors. Refer to table 4-11 for spacing guidelines.
- Wattle must be tight against the soil in trench. Make sure no gaps exist between the soil and the wattle.
- If live willow stakes are installed, use a straight bar to drive holes through wattles.
- Stakes must be driven a minimum of 12 in. into undisturbed material.
- Install stakes every 4 ft. Additional stakes may be driven on the downslope side of the trenches on highly erosive or very steep slopes.
- For flat ground installation along sidewalks or curbs, it may not be necessary to stake the wattles, however trenches must be dug. If sidewalks or curbs have not been backfilled, place wattles against it and backfill behind the wattle.

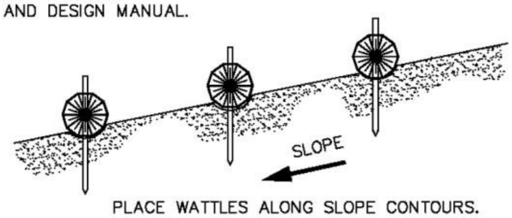
Table 4-12 Barrier Spacing For General Applications

INSTALL PARALLEL ALONG CONTOURS AS FOLLOWS		
% Slope	Slope	Maximum Spacing on Slope
10 % Flatter	10:1 or Flatter	300 ft
10 > % < 15	10:1 > x < 7.5:1	150 ft
15 > % < 20	7.5:1 > x < 5:1	100 ft
20 > % < 30	5:1 > x < 3.5:1	50 ft
30 > % < 50	3.5:1 > x < 2:1	25 ft

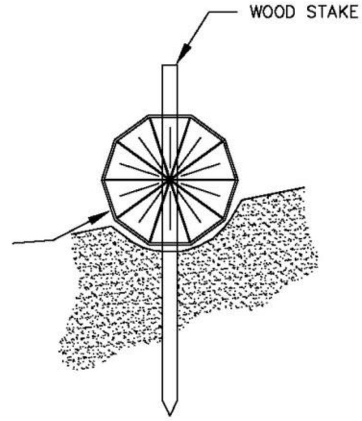
Inspection & Maintenance

- Make sure the wattles are in contact with the soil within the trench and stakes are not broken or dislodged.
- Re-seed, replant vegetation, or install matting if necessary to stabilize slope.

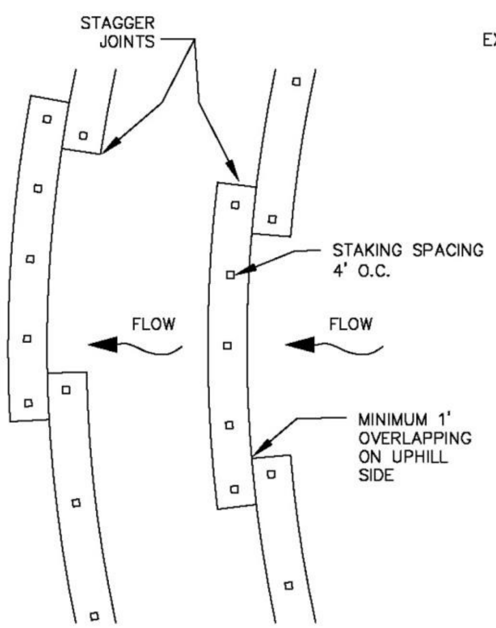
FOR FURTHER INFORMATION ON DESIGN CRITERIA SEE CHAPTER 4 OF CLEAN WATER SERVICES EROSION PREVENTION AND SEDIMENT CONTROL PLANNING AND DESIGN MANUAL.



PROFILE



SECTION



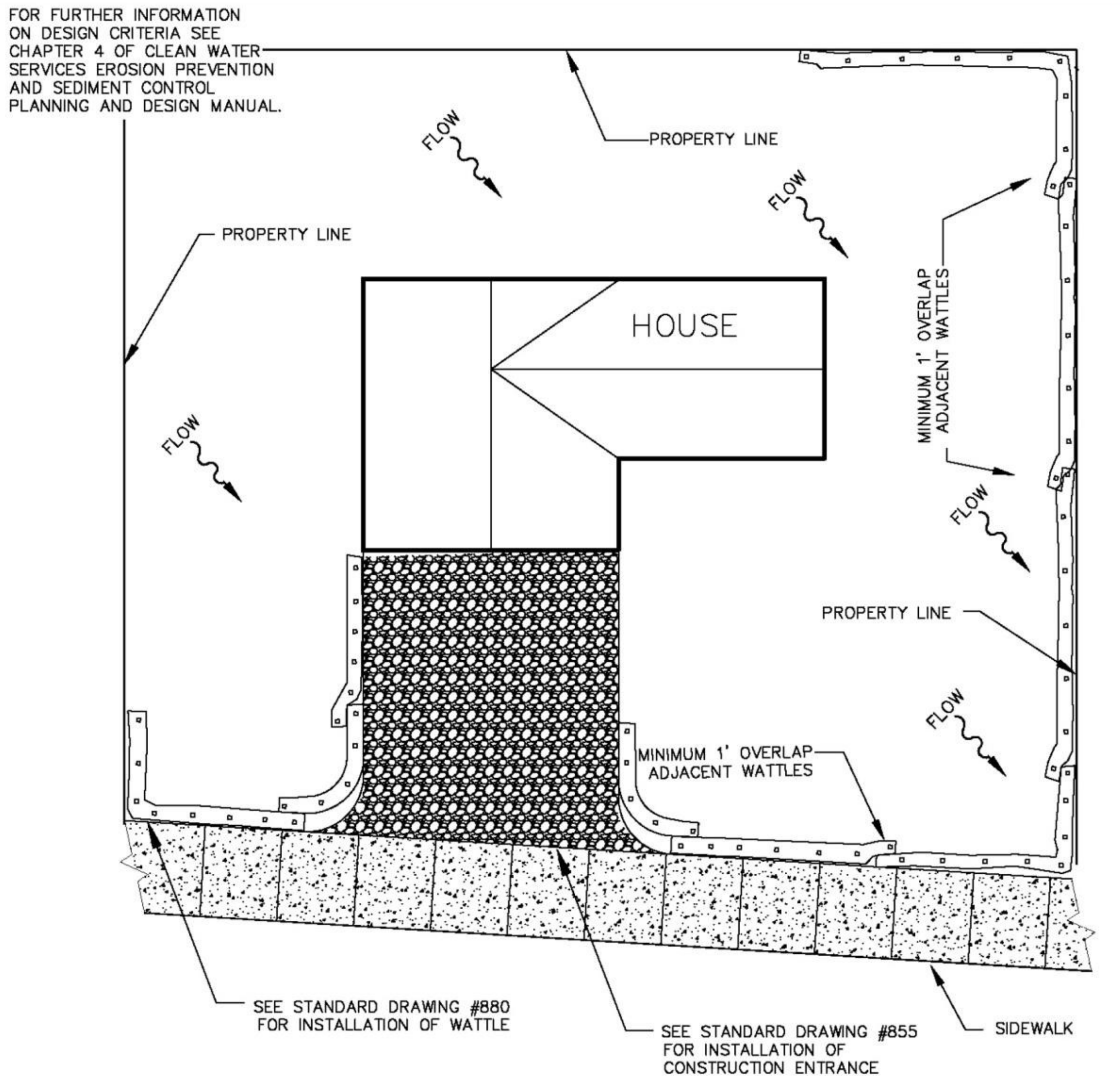
PLAN VIEW

NOTES:

1. STAKING SPECIFICATIONS:
   a. 1"X2" WOODEN STAKES
   b. ADDITIONAL STAKES MAY BE INSTALLED ON DOWNHILL SIDE OF WATTLES, ON STEEP SLOPE OR HIGHLY EROSIVE SOILS.
2. SPACING IN ACCORDANCE WITH DETAIL 940.
3. REMOVE ALL ROCKS, CLODS, VEGETATION OR OTHER OBSTRUCTIONS SO THAT THE INSTALLED WATTLES WILL HAVE DIRECT CONTACT WITH THE SOIL.
4. INSTALL THE WATTLES IN A 2" DEEP TRENCH, INSURING THAT NO GAPS EXIST BETWEEN THE SOIL AND THE BOTTOM OF THE WATTLE. THE ENDS OF ADJACENT WATTLES SHALL BE OVERLAPPED 1 FT. MINIMUM TO PREVENT SEDIMENT PASSING THROUGH THE FIELD JOINT.

WATTLES

DRAWING NO. 880 REVISED 10-31-19



PLAN VIEW

NOTES:

1. SEE STANDARD DRAWING #880 FOR INSTALLATION OF WATTLES..
2. ALTERNATE MATERIALS MAY BE USED AS APPROVED BY DISTRICT OR CITY.
3. PERIMETER MEASURES INSTALLED AS NEEDED.

WATTLES
SINGLE FAMILY APPLICATION

DRAWING NO. 885 REVISED 10-31-19

CHAPTER 5
POLLUTION CONTROL MEASURES AND BMPs

5.1 Management of Other Construction Site Pollutants

There are numerous potential pollutants, other than erosion and sediment, associated with construction activities. Potential pollutants include pollutants associated with the use of concrete and other cement-related mortars and the handling, application, and disposal of construction products and chemicals such as paints, adhesives, and solvents. The improper use and handling of construction materials can result in wash water, spills or wastes being left on the ground. These chemicals can infiltrate into soils causing groundwater contamination or wash-off to surface waters during subsequent storms.

Although this manual is not intended to address all aspects of construction site pollution control, some issues overlap with erosion and sediment control and must be taken into account in the overall planning process. At a minimum the contractor should provide pollution prevention for:

1) Off-site tracking of soils;
2) Material management;
3) Waste management;
4) Vehicle and equipment management;
5) Site history.

Each construction project is unique, and understanding the pollution risks for each construction activity is essential to successfully selecting and implementing pollution control BMPs. Defining these risks requires careful review of the site characteristics and the nature of the construction project.

Once these pollution risks are defined, BMP objectives can be developed and pollution control BMPs selected. In general the pollution control BMP objectives for construction projects are as follows:

- **Practice Good Housekeeping –** Perform activities in a manner, which keeps potential pollutants from either draining or being transported off-site by managing pollutant sources and modifying construction activities.
- **Contain Waste –** Dispose of all construction waste in designated areas and keep storm water from flowing on or off these areas.

Table 5-1 represents disposal and management options for typical potential pollutants associated with construction activities.

Table 5-1 Quick reference for Pollution Control Measures and BMPs

DISCHARGE/ACTIVITY	BMP DETAIL #	BMP/POLLUTION CONTROL
Painting & Paint Removal		
Excess paint	3, 4, 7	Oil Based – 1. Recycle/reuse. 2. Dispose as hazardous waste. Water Based – 1. Recycle/reuse. 2. Dry residue in cans, dispose as trash. 3. If volume is too much to dry, dispose as hazardous waste.
Paint cleanup	3, 8	Wipe paint out of brushes, then: For oil based paints – 1. Filter & reuse thinners, solvents. 2. Dispose as hazardous waste. For water based paints – 1. Rinse to sanitary sewer.
Paint stripping (with solvent)	3	1. Dispose as hazardous waste.
Non-hazardous paint scraping/sand blasting	3	1. Dry sweep, dispose as trash.
HAZARDOUS paint scraping/sand blasting (e.g. marine paints or paints containing lead or tributyltin)	3, 8	1. Dry sweep, dispose as hazardous waste.

Table 5-1 (cont.) Quick reference for Pollution Control Measures and BMPs

DISCHARGE/ACTIVITY	BMP DETAIL #	BMP/POLLUTION CONTROL
General Construction		
Soil from excavations during wet weather periods	9	1. Should not be placed in street, on paved areas or near waterways. 2. Remove soil from site or backfill by end of day. 3. Cover with tarpaulin or surround with sediment barrier, or use other runoff control measures (see chapter 4) 4. Place inlet protection at storm drain inlets. 5. Clean street, or paved areas to remove dirt that has fallen on roadway surface.
Soil from excavations placed on paved surfaces during dry season	9	1. Keep materials out of storm conveyance systems and off roadways. Remove dirt that has fallen on roadway via sweeping. 2. Cover to prevent wind erosion.
Cleaning streets in construction areas	7	1. Dry sweep. 2. Use silt ponds, inlet protection and/or similar sediment control techniques when flushing pavement.
Soil erosion, sediments	(see chapter 4)	1. Cover disturbed soils, use erosion controls, block entry to storm drain. 2. Seed or plant as soon as possible.
Fresh cement, grout, mortar	10	1. Use/reuse excess. 2. Dispose of in trash. Ensure trash container is leak proof. 3. Do not allow into surface water and/or collection systems.
Washwater from concrete/mortar (etc.) cleanup	10	1. Direct all wash water into a pit or leak-proof container. The pit does not need to be lined or leak proof, but the pit or container must be designed so that no overflows can occur due to inadequate sizing or precipitation. 2. Concrete wash water must not adversely affect groundwater. A wash water container should be lined if soil in the area have high infiltration rates. Check with local jurisdiction. 3. Pump and remove to appropriate disposal facility. 4. Locate washout area at least 50 feet from storm drains, open ditches, or water bodies

Table 5-1 (cont.) Quick reference for Pollution Control Measures and BMPs

DISCHARGE/ACTIVITY	BMP DETAIL #	BMP/POLLUTION CONTROL
General Construction		
Rinsewater from concrete mixing trucks	10	1. Return truck to yard for rinsing into settling pond or lined washout. Wash concrete trucks and equipment off site (in an appropriately protected area) or in a designated concrete washout areas only. 2. At construction site, wash into lined settling pond or dirt area and spade in, never allow into storm sewer or waterways.
Runoff from Foundation Forms & Form Treatment	4, 6	1. Store forms on a pervious surface 2. Place a tarpaulin over the forms when not in use to prevent contact with precipitation. 3. Store form treatment fluids in secondary containment at a designated area.
Non-hazardous construction and demolition debris	7	1. Recycle/reuse (concrete, wood, etc.) 2. Dispose as trash.
Hazardous demolition and construction debris (e.g. asbestos).	8	1. Dispose as hazardous waste.
Concrete saw-cut slurry. (Wet sawing)	10	1. Use dry cutting technique and sweep up residue. 2. Place a berm on down-slope side of project to collect slurry before it flows off site. 3. Vacuum slurry and dispose off-site. 4. Shovel out gutters; dispose residue to dirt area, construction yard or landfill. 5. Block all storm drains or curb inlets
Construction dewatering (Nonturbid, uncontaminated groundwater)	1	1. Recycle/reuse. 2. Discharge to storm drain upon local agency approval. 3. Settle, pump water to sanitary sewer or vegetated area at least 50 feet from surface water. Discharge to the sanitary sewer may require a permit from the POTW.
Construction dewatering (Other than nonturbid, uncontaminated groundwater)	1	1. Recycle/reuse. 2. Discharge to sanitary sewer, may need permit from the POTW. 3. As appropriate, treat prior to discharge to storm drain, requires NPDES permit.

Table 5-1 (cont.) Quick reference for Pollution Control Measures and BMPs

DISCHARGE/ACTIVITY	BMP DETAIL #	BMP/POLLUTION CONTROL
General Construction		
Leaks from garbage dumpsters	6	1. Store dumpster on site and ensure nearby catchbasins are protected. 2. Collect, contain leaking material. Eliminate leak, keep covered, return to leasing company for immediate repair. 3. If dumpster is used for liquid waste, use plastic liner.
Leaks from construction debris bins	6, 4	1. Insure bins are used for dry nonhazardous materials only. (Suggestion: Fencing, covering help prevent misuse).
Dumpster cleaning water	6	1. Clean at dumpster owner's facility and discharge waste through grease interceptor to sanitary sewer. 2. Clean on site and discharge through grease interceptor to sanitary sewer.
Cleaning spills from driveways, paved areas	6	1. Sweep and dispose as trash (Dry cleaning only). 2. For vehicle leaks, follow this 3-step process: a. Clean up leaks with rags or absorbents. b. Sweep, using granular absorbent material (cat litter). c. Mop and dispose of mop water to sanitary sewer.
Paving Operations	2	1. Avoid paving during wet weather 2. Protect drainage systems by diverting runoff or trap/ filter system. 3. Place drip pans or absorbent materials under paving equipment when not in use.
Power washing sidewalks, driveways, plazas	6	Follow this 3-step process: a. Collect all water and properly dispose of, do not allow runoff to enter storm sewer. b. Clean oil leaks with rags or absorbents. c. Sweep (Use dry absorbent as needed).
Aggregate wash from driveway/patio construction	6	1. Wash onto dirt area, spade in. 2. Pour driveway approach last. 3. Collect and remove to appropriate disposal facility. 4. Settle, pump water to vegetated area at least 50 feet from surface water.

Table 5-1 (cont.) Quick reference for Pollution Control Measures and BMPs

DISCHARGE/ACTIVITY	BMP DETAIL #	BMP/POLLUTION CONTROL
Landscape/Garden Maintenance		
Pesticides	5, 8, 14	1. Use all material in container. Rinse containers and then use rinsewater as product. Dispose rinsed empty containers as trash. 2. Dispose unused pesticide as hazardous waste.
Fertilizer Applications	5, 8, 14	1. Sweep any "over spray" material from streets, sidewalks and driveways.
Yard & Garden clippings	7	1. Compost. 2. Take to landfill.
Tree trimming	7	1. Chip if necessary, before composting or recycling.
Vehicle / Equipment Wastes		
Used motor oil & oil filters	14, 6, 4, 8	1. Use secondary containment while storing, send to recycler.
Antifreeze	14, 6, 4, 8	1. Use secondary containment while storing, send to recycler.
Other vehicle fluids and solvents	14, 6, 4, 8	1. Dispose as hazardous waste.
Automobile batteries	14, 4, 8	1. Use secondary containment while storing. 2. Send to auto battery recycler. 3. Take to Recycling Center.
Vehicle Washing	11, 14	1. Wash on pervious surface and use cold water only. 2. Never allow runoff to directly discharge to storm drainage systems.
Mobile Vehicle Washing	11	1. Collect wash water and discharge to sanitary sewer w/ agency approval; never allow wash water to discharge to storm drainage systems.
Rinsewater from dust removal at new car fleets	11	1. If rinsing dust from exterior surfaces for appearance purposes, do not use soap (cold water only).

Table 5-1 (cont.) Quick reference for Pollution Control Measures and BMPs

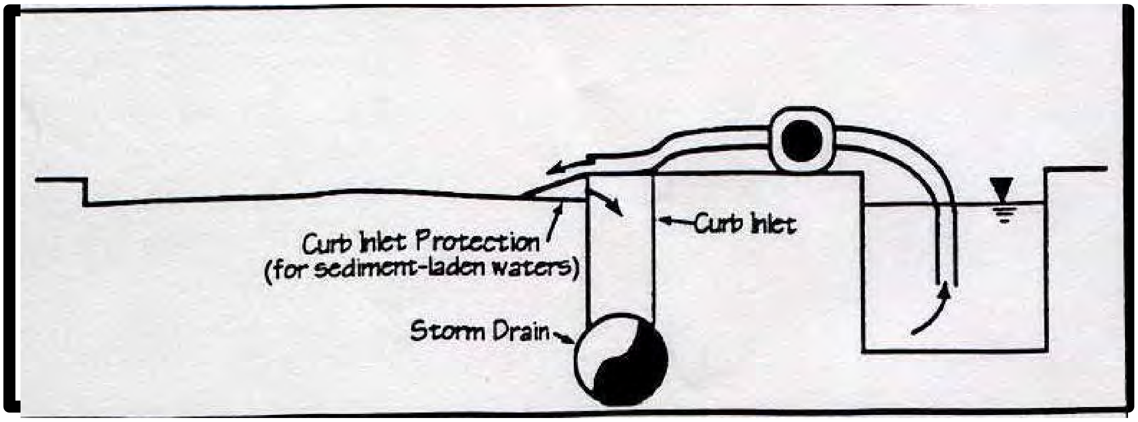
DISCHARGE/ACTIVITY	BMP DETAIL #	BMP/POLLUTION CONTROL
Vehicle leaks & equipment fueling	6, 13, 14	1. Clean up leaks with rags or absorbents. 2. Sweep, using granular absorbent material (cat litter). 3. Fuel only in designated area and place a spill kit in the fueling area.
Other Wastes		
Roof drains		1. If roof is contaminated with industrial waste products, discharge to sanitary sewer with approval from local sanitary authority (may need a discharge permit). 2. If no contamination is present, discharge to pervious surface.
Cooling water Air conditioning condensate		1. Recycle/reuse. 2. Discharge permit may be required, contact local sanitary authority.
Pumped groundwater, infiltration/foundation drainage (contaminated)		1. Recycle/reuse (landscaping, etc.). 2. Discharge permit may be required, contact local sanitary authority
Fire fighting flows		Under emergency conditions, Fire Department will determine the appropriate procedures to use. If contamination is present, and life and safety are not at issue, Fire Department will attempt to prevent flow to stream or storm drainage system.
Clean-up wastewater from sewer back-up		1. Follow this procedure: a. Block storm drain, contain, collect and return spilled material to the sanitary sewer. b. Block storm drain; rinse remaining material to collection point and pump to sanitary sewer. (No rinsewater may flow to storm drain.) c. Report to local jurisdiction

5.2 Pollution Control Measures and BMPs

This section describes specific BMPs for common construction activities that may pollute storm water. The following fact sheets were adapted from the Construction Methods Handbook developed in 1993 by California's Storm Water Quality Task Force and are suitable for inclusion in many ESCPs or PCPs for typical contractor activities. The BMPs listed are not an exhaustive list, nor will every BMP be appropriate for every situation. Therefore, suggested BMPs that are inappropriate may be deleted and additional BMPs for specific site conditions should be added to the ESCP or PCP. In addition, the selection and implementation of BMPs should be reviewed on a regular basis to match the changing conditions at construction sites.

The following fact sheets have been included.

- BMP 1 Dewatering Operations
- BMP 2 Paving Operations
- BMP 3 Structure Construction and Painting
- BMP 4 Material Delivery and Storage
- BMP 5 Material Use
- BMP 6 Spill Prevention and Control
- BMP 7 Solid Waste Management
- BMP 8 Hazardous Waste Management
- BMP 9 Contaminated Soil Management
- BMP 10 Concrete Waste Management
- BMP 11 Vehicle and Equipment Cleaning
- BMP 12 Vehicle and Equipment Fueling
- BMP 13 Vehicle and Equipment Maintenance
- BMP 14 Employee/Subcontractor Training



BMP 1: DEWATERING OPERATIONS

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from dewatering operations by using sediment controls and by testing the groundwater for pollution.

APPROACH

There are two general classes of pollutants that may result from dewatering operations, including sediments, and toxics and petroleum products. High sediment content in dewatering discharges is common because of the nature of the operation. On the other hand, toxics and petroleum products are not commonly found in dewatering discharges unless the site or surrounding area has been used for light or heavy industrial activities, or the area has a history of groundwater contamination. The following steps will help reduce storm water pollution from dewatering discharges:

<u>Sediment</u>

- Use sediment controls to remove sediment from water generated by dewatering. Refer to Chapter 4, page 4-83 for dewatering BMPs.
- Use filtration to remove sediment from a sediment trap or basin. Filtration can be achieved with:
  - Sump pit and a perforated or slit standpipe with holes and wrapped in filter fabric. The standpipe is surrounded by stones, which filter the water as it collects in the pit before being pumped out. Wrapping the standpipe in filter fabric may require an increased suction inlet area to avoid clogging and unacceptable pump operation.
  - Floating suction hose that allows cleaner surface water to be pumped out of trap or basin.

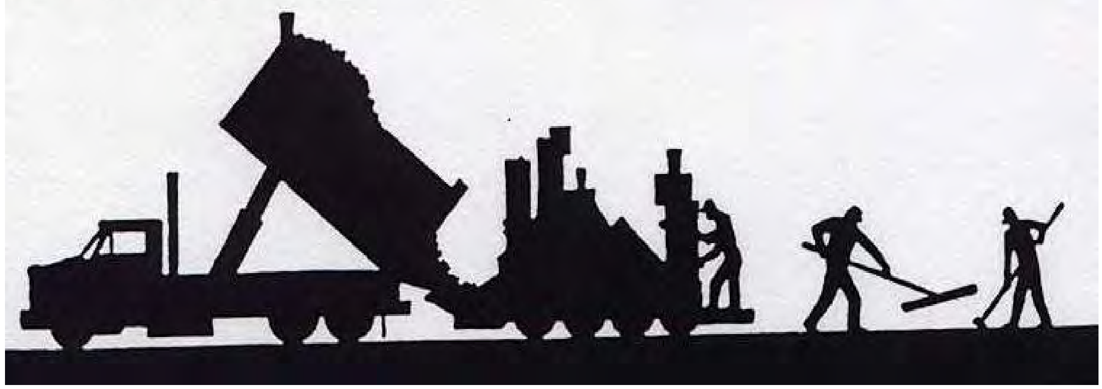
<u>Toxics and Petroleum Products</u>

- In areas suspected of having groundwater pollution, sample the groundwater near the excavation site and have the water tested for known or suspected pollutants at a certified laboratory. Check with the Department of Environmental Quality (DEQ) and the local wastewater treatment plant for their requirements for dewatering, additional water quality tests, and disposal options.
- With a permit, you may be able to recycle/reuse pumped groundwater for landscape irrigation, or discharge to the storm sewer. With a permit from the DEQ or a local agency, you may be able to treat pumped groundwater and discharge it to the municipal wastewater treatment plant via the sanitary sewer.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1, Quick Reference – Disposal Alternatives.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

● Sediment	○ Nutrients	◒ Toxic Materials
○ Oil & Grease	○ Floatable Materials	○ Other Construction Waste



Graphic: North Central Texas COG, 1993

BMP 2: PAVING OPERATIONS

DESCRIPTION

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent run-on and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

APPROACH

- Avoid paving during wet weather.
- Store materials away from drainage courses to prevent storm water run-on (see BMP 4, Material Delivery and Storage).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or trap/filter sediment.
- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drop pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials rather than burying. See BMP 13 (Vehicle and Equipment Maintenance) and BMP 6 (Spill Prevention and Control) in this chapter.
- Cover catch basins and manhole when applying seal coat, track coat, slurry seal, fog seal, etc.
- Shovel or vacuum saw cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- If paving involves Portland cement concrete, see BMP 10 (Concrete Waste Management).
- If paving involves asphaltic concrete, the following precautions may help prevent pollutant from entering storm water:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks by sweeping. Properly dispose of this waste by referring to BMP 7 (Solid Waste Management) in this chapter.
  - Old asphalt must be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.
  - If paving involves on-site mixing plant, follow the storm water permitting requirements for industrial activities.
- Train employees and subcontractors.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

◒ Sediment	○ Nutrients	◒ Toxic Materials
◒ Oil & Grease	○ Floatable Materials	○ Other Construction Waste

BMP 3: PAINTING

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from painting and associated construction activities by enclosing or covering or berming building material storage areas, using good housekeeping practices, using safer alternative products and training employees and subcontractors.

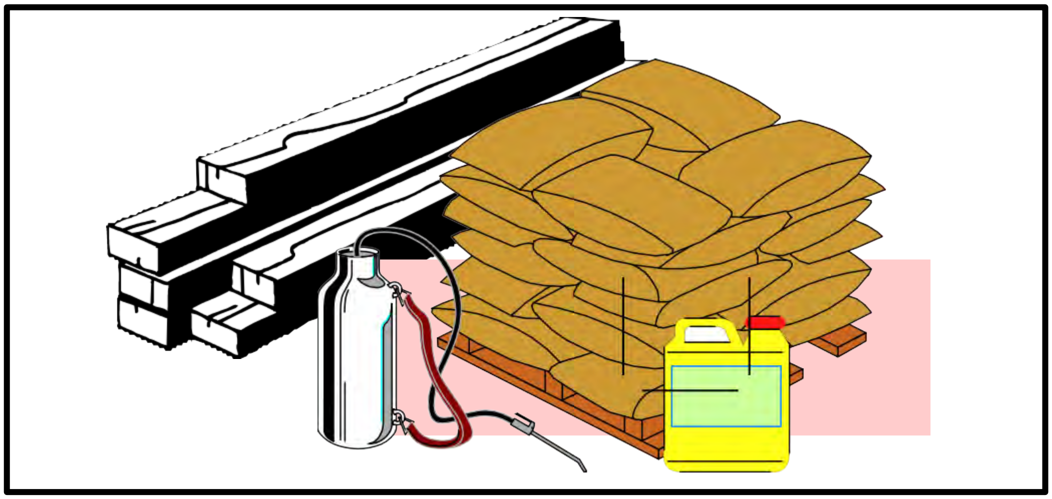
APPROACH

- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area.
- Use soil erosion control techniques if bare ground is exposed.
- Buy recycled or less hazardous products to the maximum extent practicable.
- Conduct painting operations consistent with local air quality and OSHA regulations.
- Properly store paints and solvents. See BMP 4 (Material Delivery and Storage) in this chapter.
- Properly store and dispose waste materials generated from the activity. See the waste management BMPs (BMP 7 to BMP 10) in this chapter.
- Recycle residual paints, solvents, lumber and other materials to the maximum extent practicable.
- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.
- Clean the storm drain in the immediate construction area after construction is completed.
- Educate employees who are doing the work.
- Inform subcontractors of company policy on these matters and include appropriate provisions in their contract to make certain proper housekeeping and disposal practices are implemented.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

○ Sediment	○ Nutrients	◒ Toxic Materials
○ Oil & Grease	● Floatable Materials	● Other Construction Waste



BMP 4: MATERIAL DELIVERY AND STORAGE

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from material delivery and storage by minimizing the storage of hazardous materials on-site, storing materials in a designated area, installing secondary containment, conducting regular inspection, and training employees and subcontractors.

The best management practice covers only material delivery and storage. For other information on materials, see BMP 5 (Material Use), or BMP 6 (Spill Prevention and Control). For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following materials are commonly stored on construction sites:
- Soil
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster or other products
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds

Storage of these materials on-site can pose the following risks:
- Storm water pollution
- Injury to workers or visitors
- Groundwater pollution
- Soil contamination

The following steps should be taken to minimize risk of discharge of pollution:
- Designate areas of the construction site for material delivery and storage.
  - Place near the construction entrances, away from waterways
  - Gravel haul roads
  - Avoid transport near drainage paths or waterways
  - Surround with earth berms
  - Place in an area which will be paved
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes in your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1, Quick Reference – Disposal Alternatives.

- Keep an accurate, up-to-date inventory of materials delivered and stored on-site.
- Keep your inventory down.
- Minimize hazardous materials on-site storage.
- Handle hazardous materials as infrequently as possible.
- During the rainy season, consider storing materials in a covered area.
- Store materials in secondary containment such as an earthen dike, horse trough, or even a child's wading pool for non-reactive materials such as containers of detergents, oil, grease, and paints. Small amounts of material may be secondarily contained in "bus boy" trays or concrete mixing trays.
- Do not store chemicals, drums, or bagged materials directly on the ground. Place these items on a pallet and, when possible, in appropriate secondary containment.
- If drums must be kept uncovered, store them at a slight angle to reduce ponding of rainwater on the lids and to reduce corrosion.
- Try to keep chemicals in their original containers, and keep them well labeled.
- Train employees and subcontractors on proper handling and management of waste material.
- Employees trained in emergency spill cleanup procedures should be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove materials and any contaminated soil (See BMP 9). If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

◒ Sediment	◒ Nutrients	◒ Toxic Materials
◒ Oil & Grease	◒ Floatable Materials	○ Other Construction Waste

BMP 5: MATERIAL USE

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water by using alternative products, minimizing hazardous material use on-site, and training employees and subcontractors.

APPROACH

The following materials are commonly used on construction sites:
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster or other products
- Petroleum products such as fuel, oil, and grease, and
- Other hazardous chemicals such as acids, lime, glues, paints, solvents, and curing compounds.

Use of these materials on-site can pose the following risks:
- Storm water pollution
- Injury to workers or visitors
- Groundwater pollution
- Soil contamination

The following steps should be taken to minimize the risk:
- Use less hazardous, alternative materials as much as possible.
- Minimize use of hazardous materials on-site.
- Use materials only where and when needed to complete the construction activity.
- Followmanufacturer's instructions regarding uses, storage, protective equipment, ventilation, flammability, and mixing of chemicals.
- Personnel who use pesticides should be trained in their use.
- Do not over-apply fertilizers, herbicides, and pesticide. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydroseeding. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains.
- Train employees and subcontractors in proper material use.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

○ Sediment	○ Nutrients	◒ Toxic Materials
◒ Oil & Grease	◒ Floatable Materials	○ Other Construction Waste

BMP 6: SPILL PREVENTION AND CONTROL

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

The best management practice (BMP) 6 covers only spill prevention and control. BMP 4 (Material Delivery and Storage) and BMP 5 (Material Use), also contain useful information, including on spill prevention. For information on wastes, see the waste management BMPs in this chapter.

APPROACH

The following steps will help reduce the storm water impacts of leaks and spills:

Define “Significant Spill”

- Different materials pollute in different amounts. Make sure that each employee knows what a “significant spill” is for each material they use, and what is the appropriate response for “significant” and “insignificant” spills.

General Measures

- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals.

Cleanup

- Clean up leaks and spills immediately.
- On paved surfaces, clean up spills with as little water as possible. Use a rag for small spills, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this chapter for specific information.

Reporting

- Report significant spills to local agencies, such as the Fire Department. They can assist in clean up.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hour).
- Oregon Emergency Response System (OERS) at 1-800-452-0311

Use the following protective measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur on-site, use a designated area and /or a secondary containment, located away from drainage courses, to prevent the run-on of storm water and the runoff of spills.
- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Do not leave full drip pans or other open containers lying around.
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute storm water. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask your oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

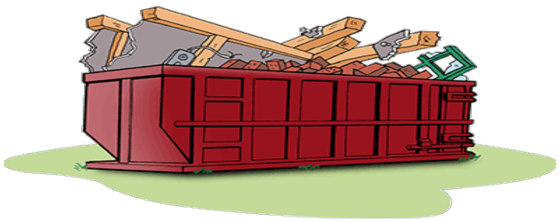
Vehicle and Equipment Fueling

- If fueling must occur on-site, use designated areas, located away from drainage courses, to prevent the run-on of storm water and the runoff of spills.
- Discourage “topping-off” of fuel tanks; an increase in temperature can cause fuel to expand and overflow.
- Always use secondary containment such as a drain pan to catch when fuel spills/leaks.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

○ Sediment	○ Nutrients	◒ Toxic Materials
◒ Oil & Grease	○ Floatable Materials	○ Other Construction Waste



BMP 7: SOLID WASTE MANAGEMENT

DESCRIPTION
Prevent or reduce the discharge or pollutants to storm water from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

APPROACH

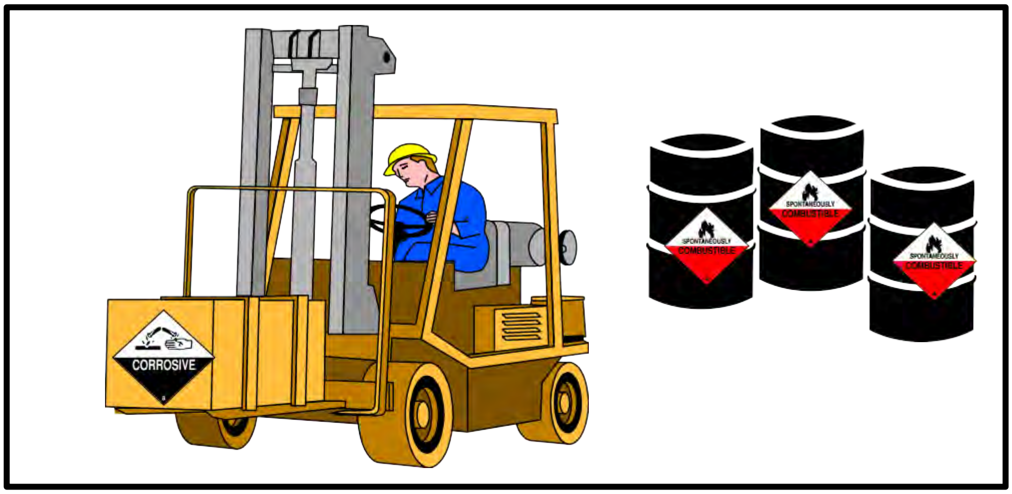
Solid waste is one of the major pollutants resulting from construction. Construction debris includes:
- Solid waste generated from trees and shrubs removed during land clearing, demolition or existing structures (rubble), and building construction;
- Packaging materials including wood, paper and plastic;
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products; and
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, plastic wrappers, and cigarettes.

The following steps will help keep a clean site and reduce storm water pollution:
- Select designated waste collection areas on-site.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for on-site use. Inspect dumpsters for leaks and repair any dumpster that is not watertight.
- Locate containers in a covered area and/or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes. Ensure lids are secure during windy conditions.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during raining and windy conditions.
- Erosion and sediment control devices tend to collect litter. Remove this solid waste promptly.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Salvage or recycle any useful material. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- If a container does spill, clean up immediately.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.
- Cover loads of material that are hauled off site.
- Train employees and subcontractors in proper solid waste management.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

◒ Sediment	○ Nutrients	○ Toxic Materials
○ Oil & Grease	● Floatable Materials	● Other Construction Waste



BMP 8: HAZARDOUS WASTE MANAGEMENT

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from hazardous waste through proper material use, waste disposal, storage and training of employees and subcontractors.

APPROACH

Many of the chemicals used on-site can be hazardous materials that become hazardous waste upon disposal. These wastes may include:
- Paints and solvents
- Petroleum products such as oils, fuels, and grease
- Herbicides and pesticides
- Acids for cleaning masonry
- Concrete curing compounds

In addition, sites with existing structures may contain wastes that must be disposed of in accordance with Federal, State, and local regulation. These wastes include:
- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints;
- Asbestos; and
- PCB's (particularly in older transformers).

The following steps will help reduce storm water pollution from hazardous wastes:

<u>Material Use</u>
- Use the entire product before disposing of the container.
- Do not remove the original product label as it contains important safety and disposal information.
- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instruction. Over-application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried off-site by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with Federal and State regulation.
- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and re-use thinners and solvents. Dispose of excess oil-based paint and sludge as hazardous waste.

<u>Waste Recycling/Disposal</u>
- Select designated hazardous waste collection areas on-site.

- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes. This can cause chemical reactions, make recycling impossible, and complicate disposal.
- Recycle material such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g. excess oil-based paint and sludge) is collected, removed, and disposed of onlyat an authorized disposal area.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1.

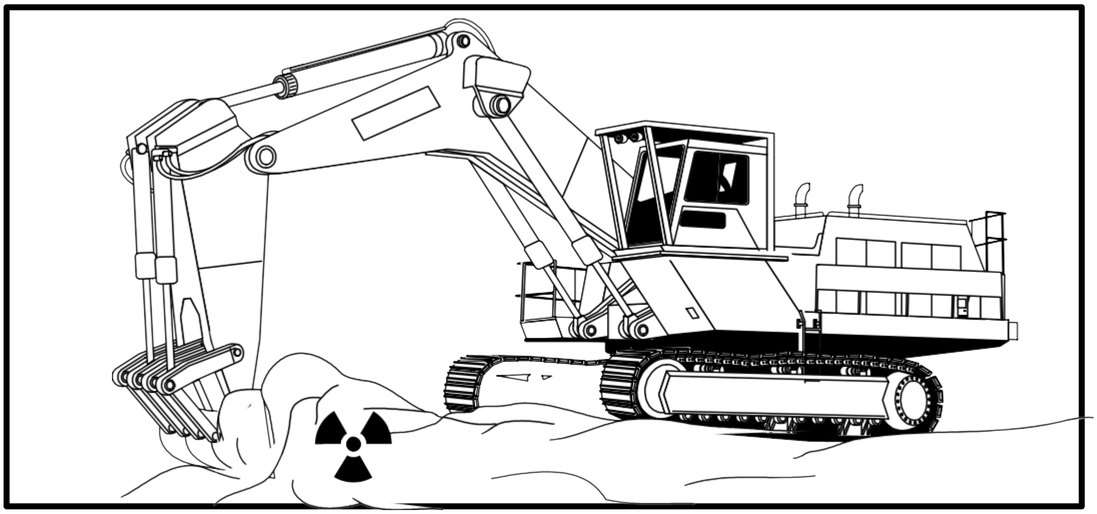
Training

- Train employees and subcontractors in proper hazardous waste management.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

○ Sediment	○ Nutrients	◒ Toxic Materials
○ Oil & Grease	○ Floatable Materials	○ Other Construction Waste



BMP 9: CONTAMINATED SOIL MANAGEMENT

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

APPROACH

Contaminated soils may occur on your site for several reasons including:
- Past site uses and activities;
- Detected or undetected spills and leaks; and
- Acid alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements.

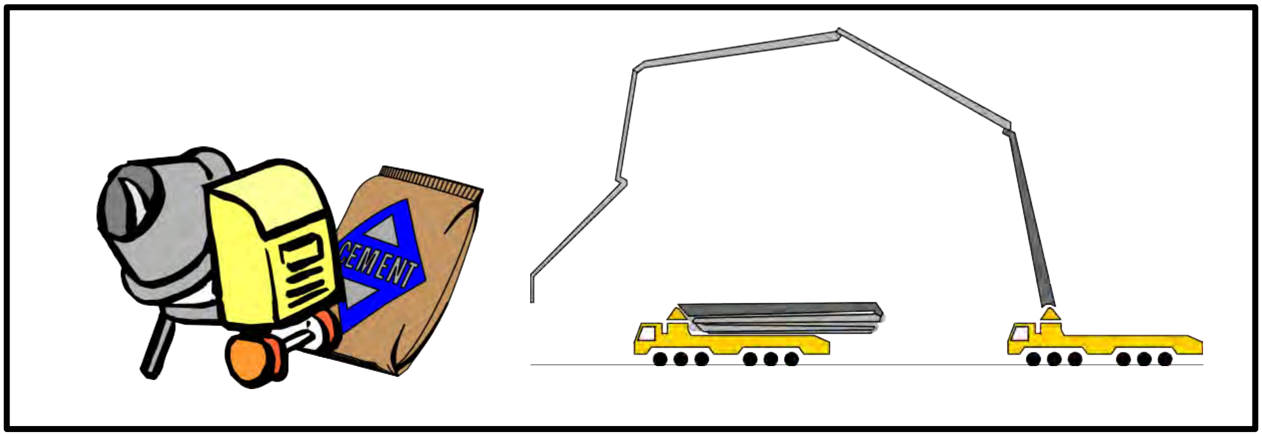
Most developers conduct pre-construction environmental assessments as a matter of routine. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm that a site assessment is complete before earth moving begins.

The following steps will help reduce storm water pollution for contaminated soil:
- Conduct thorough site planning including pre-construction research and geologic surveys.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills to the maximum extent practicable. Contaminated soil can be expensive to treat and/or dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- Test suspected soils at a certified laboratory.
- If the soil is contaminated, work with the local regulatory agencies to develop options for treatment and/or disposal.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

◒ Sediment	○ Nutrients	● Toxic Materials
○ Oil & Grease	○ Floatable Materials	○ Other Construction Waste



BMP 10: CONCRETE WASTE MANAGEMENT

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from concrete waste by conducting washout off-site, performing on-site washout in a designated area, and training employees and subcontractors.

APPROACH

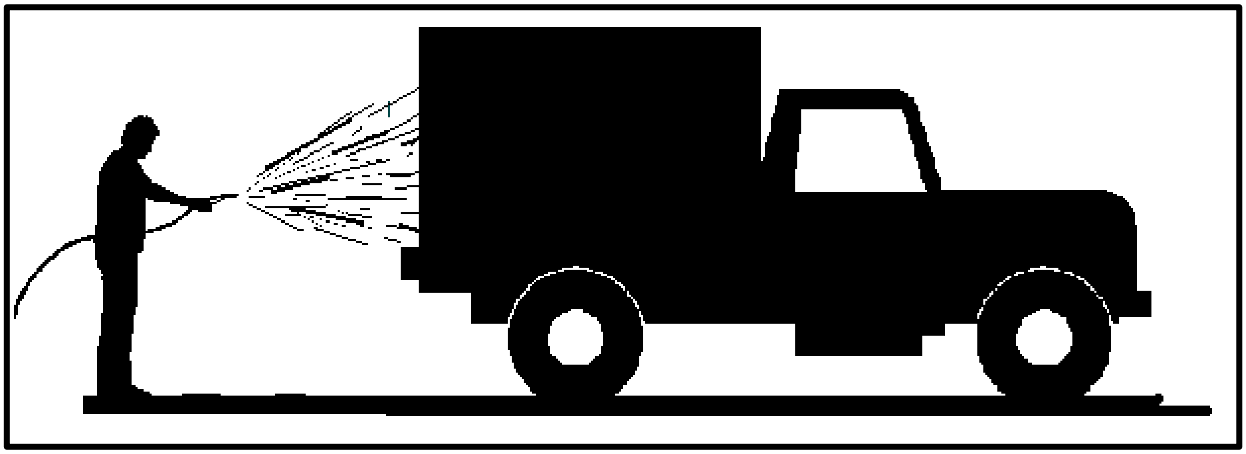
The following steps will help reduce storm water pollution from concrete wastes:

- Store dry and wet materials under cover, away from drainage areas.
- Avoid mixing excess amount of fresh concrete or cement on-site.
- Perform washout of concrete trucks off-site or in designated areas only.
- Do not wash out concrete trucks into storm drains, open ditches, streets, or streams.
- Do not allow excess concrete to be dumped on-site, except in designated areas.
- For on-site washout:
  - Locate washout area at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for the amount of liquid and solid waste that will be generated;
  - Wash out wastes into the temporary pit where the concrete can be set, be broken up, and then disposed of properly.
- When washing concrete to remove fine particles and expose the aggregate, avoid creating runoff by draining the water to a bermed or level area.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile, or dispose in the trash.
- Train employees and subcontractors in proper concrete waste management.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

◒ Sediment	○ Nutrients	Toxic Materials
○ Oil & Grease	○ Floatable Materials	◒ Other Construction Waste



BMP 11: VEHICLE AND EQUIPMENT CLEANING

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicles and equipment by using off-site facilities, washing in designated contained areas only, eliminating discharges to the storm drain by infiltrating or recycling the wash water, and training employees and subcontractors.

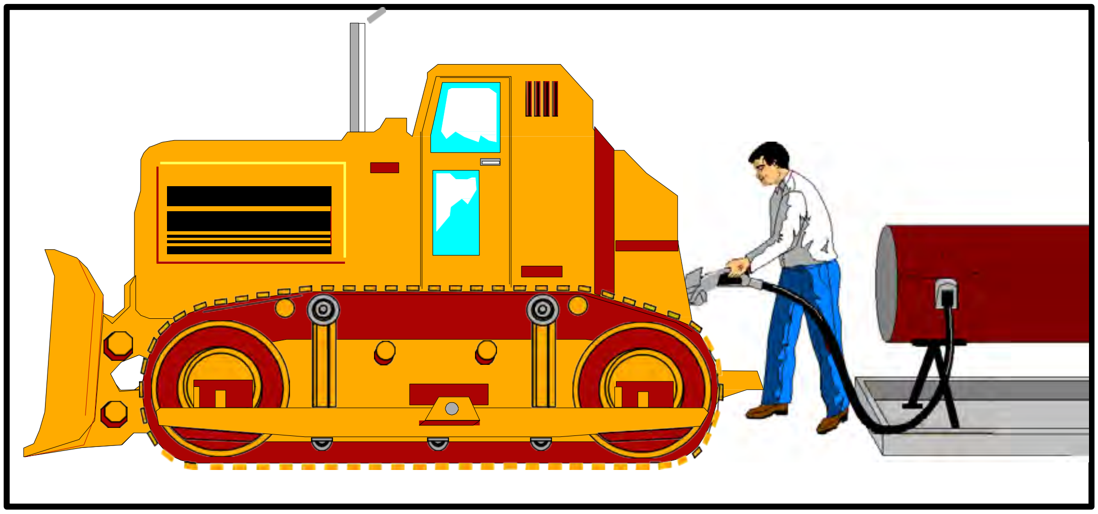
APPROACH

- Use off-site commercial washing business as much as possible. Washing vehicles and equipment outdoors or in areas where wash water flows onto paved surfaces or into drainage pathways can discharge pollutants. If you wash a large number of vehicles or pieces of equipment, consider conducting this work at an off-site commercial business. These businesses are better equipped to handle and dispose of the wash waters properly. Performing this work off-site can also be economical by eliminating the need for a separate washing operation at your site.
- If washing must occur on-site, use designated bermed wash areas to prevent wash water contact with storm water, creeks, rivers, and other water bodies. The wash area can be sloped for wash water collection and subsequent infiltration into the ground.
- Use as little water as possible to avoid having to install erosion and sediment control for the wash area.
- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning on-site. Steam cleaning can generate significant pollutant concentrations.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

◒ Sediment	○ Nutrients	◒ Toxic Materials
◒ Oil & Grease	○ Floatable Materials	○ Other Construction Waste



BMP 12: VEHICLE AND EQUIPMENT FUELING

DESCRIPTION

Prevent fuel spills and leaks, and reduce their impacts to storm water by using off-site facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors.

APPROACH

- Use off-site fueling stations as much as possible. Fueling vehicles and equipment outdoors or in areas where fuel may spill/leak onto paved surfaces or into drainage path ways can discharge pollutants. If you fuel a large number of vehicles or pieces of equipment, consider using an off-site fueling station. These businesses are better equipped to handle fuel and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate fueling area at your site.
- If fueling must occur on-site, use designated areas, located away from drainage ways.
- Discourage “topping-off” of fuel tanks.
- Always use secondary containment, such as a drain pan or drop cloth, when fueling to catch spills/leaks.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Carry out all Federal and State requirements regarding stationary above ground storage tanks.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and perhaps forklifts, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

○ Sediment	○ Nutrients	◒ Toxic Materials
◒ Oil & Grease	○ Floatable Materials	○ Other Construction Waste

BMP 13: VEHICLE AND EQUIPMENT MAINTENANCE

DESCRIPTION

Prevent or reduce the discharge of pollutants to storm water from vehicle and equipment maintenance by running a “dry site”. This involves using off-site facilities, performing work in designated areas only, providing cover for materials stored outside, checking for leaks and spills, containing and cleaning up spills immediately, and training employees and subcontractors.

APPROACH

- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Use off-site repair shops as much as possible. Maintaining vehicles and equipment outdoors or in areas where vehicles or equipment fluids may spill or leak into the ground can pollute storm water. If you maintain a large number of vehicles or pieces of equipment, consider using an off-site repair shop. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work off-site can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur on-site, use designated areas, located away from drainage courses, to prevent the run-on of storm water and the runoff of spills.
- Always use secondary containment, such as a drain pan or drop cloth, to catch sills or leaks when removing or changing fluids.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Use adsorbent materials on small spills rather than hosing down or burying the spill. Remove the adsorbent materials promptly and dispose of properly.
- Regularly inspect on-site vehicles and equipment for leaks, and repair immediately.
- Check incoming vehicles and equipment (including delivery trucks and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment on-site.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic, and transmissions fluids.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- For a quick reference on disposal alternatives for specific wastes, see Table 5-1.

TARGET POLLUTANTS

● Likely to have significant impact ○ Probable Low or Unknown impact

○ Sediment	○ Nutrients	◒ Toxic Materials
◒ Oil & Grease	○ Floatable Materials	○ Other Construction Waste

BMP 14: EMPLOYEE/SUBCONTRACTOR TRAINING

DESCRIPTION

Employee/subcontractor training is not so much, a best management practice, as it is a method by which to implement BMPs. This fact sheet highlights the importance of training and of integrating the elements of employee/subcontractor training from the individual source controls into a comprehensive training program as part of the Erosion and Sediment Control Plan (ESCP).

The specific employee/subcontractor training aspects of each of the source controls are highlighted in the individual fact sheets. The focus of this fact sheet is more general, and includes the overall objectives and approach for assuring employee/subcontractor training in storm water pollution prevention. Accordingly, the organization of this fact sheet differs from the other fact sheets in the chapter.

OBJECTIVES

Employee/subcontractor training should be based on four objectives:
- Promote a clear identification and understanding of the problem, including activities with the potential to pollute storm water;
- Identify solutions (BMPs);
- Promote employee/subcontractor ownership of the problems and the solutions; and
- Integrate employee/subcontractor feedback into training and BMP implementation.

APPROACH
- Integrate training regarding storm water quality management with existing training programs that may be required by other regulations, the Hazardous Waste Operations and Emergency Response standard (29CFT 1910.120), the Spill Prevention Control and Countermeasure Plan (40CFR 112).
- Train employees/subcontractors in standard operating procedures and spill cleanup techniques described in the Pollution Control Plan. Employee/subcontractors trained in spill containment and cleanup should be present during the loading/unloading and handling of materials.
- Personnel who use pesticides should be trained in their use.
- Educating off-site contractors and subcontractors supports the efforts of well-trained employees.
- Consider posting the quick reference table around the job site or in the on-site office trailer to reinforce training.
- Train employees/subcontractors in standard operating procedures and spill cleanup techniques described in the fact sheets. Employees/subcontractors trained in spill containment and cleanup should be present during the loading/unloading and handling of materials.
- Personnel who use pesticides should be trained in their use. The Oregon Department of Pesticide Regulation and county agricultural commissioner's license pesticide dealers, certify pesticide applicators, and conduct on-site inspections.
- Proper education of off-site contractors is often overlooked. The conscientious efforts of well-trained employee/subcontractors can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do on-site.

REFERENCES

Blueprint for a Clean Bay-Construction-Related Industries: Best Management Practices for Storm Water Pollution Prevention; Santa Clara Valley Nonpoint Source Pollution Control Program, 1992

Storm Water management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Hot-mix Asphalt Paving Handbook, U.S. Army Corps of Engineers, Ac 150/5370-14, Appendix July 1991

Best Management Practices and Erosion Control Manual for Construction Sites; Flood Control District of Maricopa County, AZ. September 1992

Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992

Processes, Procedures, and Methods to Control Pollution Resulting from all Construction Activity; USEPA, 430/0-73-007,1973.

Swisher, R.D., 1987. Surfactants Biodegradation, Marcel Decker Corporation

CHAPTER 6
INSPECTION AND MAINTENANCE

Erosion and sediment control (ESC) measures are required and are used for the purpose of protecting sensitive areas such as, streams, rivers, lakes, wetlands and the MS4 system. Inspection and maintenance of ESC measures throughout the life of the project is imperative to ensure their performance. Unless the measures are properly installed and maintained, there is a strong chance of failure during the construction period.

6.1 Permittee Site Inspector

The owner of the site shall designate a competent person as the Permittee Site Inspector (PSI). Inspections must be conducted by a person knowledgeable in the principles and practice of erosion and sediment controls and possess the skills to assess conditions at the construction site that could affect stormwater quality. The inspector should be knowledgeable in the correct installation of the erosion and sediment controls, and is able to assess the effectiveness of any sediment and erosion control measures selected to control the quality of stormwater discharges from the construction activity.

The PSI shall be responsible for assuring the implementation of the ESCP and have the authority to immediately mobilize the necessary personnel and equipment to correct and modify erosion prevention and sediment controls when necessary. Check with local jurisdiction for specific requirements, permits and inspection requirements.

Duties of the PSI include:

- Provide name and 24-hour contact information of PSI
- Manage and insure proper implementation of the ESCP.
- Accompany the Agency in a field review of the ESCP prior to the beginning of work.
- Conduct inspections. Check local and/or state regulations for inspection frequency and requirements.
- Mobilize crews to make immediate repairs to the controls or install controls during working and non-working hours.
- Complete erosion control monitoring forms after each inspection.
- Maintain up-to-date ESCP throughout the life of the project, available for review upon request.
- Prepare a contingency plan in preparation for emergencies and wet weather conditions.
- Accompany the Agency on inspections and, if requested, on inspection made by other regulating Agencies.
- In the case of ineffective controls, the PSI shall record measures to clean up significant amounts of sediment. Should a control measure not function effectively, one or more of the following tasks should be performed.
    - Immediately repair the control.
    - Replace the control.
    - Provide additional controls.

6.2 Pre-Construction Meeting

Larger more complex construction sites such as, subdivisions, commercial, and highway projects require ongoing, very detailed inspection and maintenance for longer periods. For that very reason alone, pre-construction meetings are vital and should be scheduled prior to any clearing, grading, or utility activities. Equally important is who should attend. Along with the inspector and engineer, the contractors grading and utility superintendent should be present. The PSI, contractor and regulatory inspector should carefully review the ESCP prior to the pre-construction meeting to understand what is required. Implementing the ESCP and assuring its performance may involve significant expense if done incorrectly. The following pre-construction activities should be required.

- Prior to the pre-construction meeting, review and comment on the ESCP.
- During the pre-construction meeting, review all comments and concerns.
- Prohibit clearing and grading operations prior to ESCP approval and implementation.
- Tentatively locate construction accesses.
- Delineate clearing limits, drainage courses, easements, setbacks, wetlands, and other sensitive areas and their buffers.

The pre-construction meeting provides an opportunity for the contractor to discuss the plan with the inspector and learn which elements of the ESCP deserve the most attention. Adjustments to improve performance or make installation easier and maintenance more reliable may also be discussed.

The pre-construction meeting is also an opportunity to discuss the inspection schedule and procedures. Key points to consider in the pre-construction meeting are:

- Pollution Control Plan for contractor operations.
- Discuss the responsibilities and qualifications of the individuals that are designated as the PSI. Method to be used to document the updates to the ESCP.
- Adjacent areas that need special protection from sedimentation, particularly environmentally sensitive areas such as wetlands, stream crossings, channel, and water disposal outlets.
- Discuss drainage aspects of the site (both pre and post construction).
- Location of erosion and sediment control practices and their implementation.
- Sequence of construction activities to limit areas of exposed soils.
- Sequence of installation with respect to the construction schedule.
- Surface stabilization plans, temporary and permanent seeding.
- Construction schedule and any anticipated shutdown periods.
- Maintenance plans and the contractor’s procedure for monitoring performance.
- Location of all borrow and disposal areas.
- Emergency or contingency plans.
- Any special requirements identified in permits, reports or environmental assessments.
- Monitoring form used and availability.

6.2.1 Modified ESCP

All projects will include an ESCP prepared prior to the start of any construction or other land disturbing activities. This plan may require a registered engineer's approval. This plan is only a guide and is unlikely to have addressed all erosion problems for the project adequately. The ESCP included in the plan set should not be followed blindly. It is the owner or PSI's responsibility to make modifications to the plan as necessary to prevent erosion and sediment from leaving the site. The ESCP is a living document that should be updated with the changing conditions of the site and document the BMPs installed at any one time. As modifications to the ESCP take place, it is extremely important to secure the interest of all parties. Communications between the contractor, designated person and inspector is vital.

Depending upon the level of modification, the design engineer is responsible for submitting changes to the ESCP to the local jurisdiction. Check with DEQ, the DEQ Local Agent or local jurisdiction for specific requirements.

6.2.2 Construction Schedule Review

The construction schedule, in general, should include the following:

- Timing of activities to limit seasonal and weather impacts.
- Timing of wet weather work and temporary work shut down.
- Time of activities to meet "in-water" work restrictions.
- Erosion prevention and sediment controls shown on the plans should be installed before ground-disturbing activities begin.
- Permanent facilities, such as sediment traps and basins, which will be used during construction as temporary measures should be installed.
- Retention of temporary perimeter controls until all upstream areas are finally stabilized.
- Timing of soil stabilization such as seeding, planting, etc.

6.3 Installation of BMPs

It must be understood that installation is equally important to the value and success of the materials. If installed incorrectly, even the best materials will fail causing more damage and additional expense to the project. For this reason alone, installation procedures should be followed very closely.

Installation of all base measures shall be inspected by Permittee Site Inspector (PSI) and any deficiencies corrected prior to the start of land disturbing activities. Subsequent inspections of any additional installations should also be made throughout the life of the project as needed. Base measures need to also be inspected by the local jurisdiction with erosion control authority.

The agency inspector, contractor or PSI should be familiar with installations details for each BMP used on the project. Details for the installation of all specified BMPs should be provided in the ESCP. Installation details for BMPs are also provided in Chapter 4 of this manual.

6.4 Inspection Requirements

The owner or designated person (PSI) shall be required to provide ongoing inspection of erosion and sediment control measures throughout the life of the project. All development site inspections should be recorded on an approved monitoring form and readily available. The effectiveness of each BMP at every location on site should be documented on the monitoring form, and general observations on site conditions should be recorded. Information provided on the form is useful for tracking repairs and demonstrating permit compliance. It is noteworthy that in the event of permit violations or subsequent enforcement actions, the information recorded on the form, along with photographs and videos may be used to evaluate the responsibility of involved parties.

Minimum inspection requirements including frequency will vary, therefore the owner or PSI will need to refer to local or state regulations for required inspection frequency.

6.4.1 Inspection Checklist

The sample Inspection Checklist included in Appendix B may be used by Agency representatives when inspecting erosion and sediment controls on a project site. The checklist is intended to summarize the key elements of a successful erosion and sediment control program. Topics on the checklist include:

- Schedule Review
- Erosion and Sediment Control Plan
- Erosion and Pollution Control Manager
- Sensitive Areas
- Contingency Plans
- Materials On-Hand
- Maintenance
- Monitoring Forms
- Slope Protection and Stabilization
- Plan Revisions and Modifications
- BMP Evaluation
- Additional Items

6.4.2 Inspection of Work Restriction Areas

All construction projects are required to restrict certain types of work, which may contribute to sediment-laden water leaving the project boundaries or entering waterways. The following work restrictions need to be inspected prior to the start of work and throughout the life of the project.

1) **Flag Clearing Limits:** Construction site clearing limits will be clearly flagged in accordance with the approved plans. No ground disturbance is permitted beyond the flagged boundary. Flagging should be maintained for the duration of construction.
2) **Perimeter Controls before Grubbing:** all appropriate perimeter controls should be installed prior to any major site grubbing operation. Perimeter controls include interceptor ditches, berms infill areas, and sediment fences. Perimeter controls are especially important when protecting existing streams, wetlands and natural areas.

3) **Wet Weather Plan and Schedule:** Prior to wet weather construction work and before temporary work suspension for winter, the contractor, or designated person should meet with the Agency to review and update the ESCP and to develop a schedule to assure that appropriate controls are implemented and maintained during wet weather and suspended work periods.
4) **Limit Disturbed Areas:** If soil erosion and sediment resulting from construction activities is not effectively controlled, the Agency will limit the amount of disturbed areas that can be effectively controlled.
5) **Install BMPs Early:** Erosion and sediment control features should be incorporated into the projects at the earliest practicable time. All erosion and sediment control measures should be installed according to the approved implementation schedule.
6) **Stop Work:** Failure to control erosion and or pollution shall be cause for the Agency to stop all construction work until measures have been taken to bring all construction into compliance.

6.5 Stabilization Requirements

All soils that are exposed and disturbed by construction-related activities should be stabilized according to the following time frames.

- All seeding applications must be completed and established prior to wet weather season
- Wet weather season – October 1st through May 31st
- Soils exposed during wet weather season as a result of construction must be covered at the end of each day

6.6 Erosion Control Contingency Items

It is a requirement that all construction sites have materials on hand as a contingency in the event of a failure or when required to shore up BMPs installed as part of the ESCP.
The contingency items may also be used at the discretion of the project inspector to strengthen the erosion control measures as needed during construction.

The following are examples of materials to be kept on the project site for use in emergencies.

- 100 ft. of sediment fence
- 260 sq. ft. or plastic sheeting
- 1,000 ft. of rope
- 50 empty sand bags (to be filled as needed)
- 10 bales of straw (used for ground cover)
- 10 bio-filter bags with stakes

6.7 Maintenance

Erosion and sediment controls must be maintained in good working order at all times in order to function as intended. These controls must be maintained in place until the Agency issues notification of acceptance of permanent stabilization.

Typical maintenance activities, guidelines and failure modes for BMPs are discussed in Chapter 4 of this manual. The inspector should be familiar with maintenance requirements for each BMP used on the project. It is noteworthy that maintenance activities and frequencies vary among the different BMPs and will depend largely on weather and other site conditions. In general, the more effective erosion prevention measures are, the less maintenance will be required for sediment controls.

6.7.1 Sediment Removal

Sediment shall be removed and the controls upgraded or repaired as outlined in Chapter 4 BMP maintenance, or as directed. In the event of continuous rainfall over a 24-hour period, or other circumstances that preclude equipment operation in that area, additional sediment controls may need to be hand-carried, and installed in accordance with best management practices and as approved by the Agency. Sediment will need to be removed from controls such as sediment fences, sediment barriers, check dams, inlet protection, and sediment traps when the sediment buildup has reached 1/3 the exposed height of the control or storage depth. Rock filters and filter berm material shall be replaced with new rock material when sediment reduces the filtering capacity by 50 percent. Rock or other material specified shall be added or removed as needed to maintain proper function of the entrance areas. All paved areas shall be kept clean (by mechanical means) for the duration of the project.

6.7.2 Sediment Disposal

Removed sediment shall be placed in a non-erodible area within the construction site, or removed and disposed of off-site in accordance with all federal, state, and local laws and ordinances. Sediment-laden water shall not be flushed into the storm water or sanitary system.

6.8 Winterization

The wet weather season is October 1 through May 31. Prior to working during the wet weather season, and before consideration of work suspension for winter, the contractor should meet with the Agency to review and update the ESCP and to develop a schedule to assure that appropriate controls are implemented and maintained during wet weather season and during any possible work suspension periods. Winter preparations should begin several weeks prior to the wet weather season. Refer to Chapter 4 for information on common best management practices.

6.9 Designer/Inspector Tool Box

Several worksheets are provided in Appendix C to aid designers and inspectors in determining and verifying the quality and quantity of various erosion control BMPs. These are especially useful when verifying the application rates of various mulch and hydraulically applied products. Appendix C includes the following:

- Slope Inclination Conversions
- Metric Conversions Table
- Straw Mulch Application Worksheet
- Hydraulic Application Equations

- Wood Fiber Mulch Hydraulic Application Worksheet
- Seed / Fertilizer Hydraulic Application Worksheet
- Hydraulic Application Example Problems

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APPENDICES

Appendix A

Grading & Erosion Control Information

Erosion Control Notes

Erosion and Sediment Control Plan Symbols

GRADING & EROSION CONTROL INFORMATION

GENERAL CONTRACTOR Name:____________________ Address:____________________ ____________________ Phone #: ____________	**CONSTRUCTION ACTIVITY** Project #: __________ Project Name:____________________
EXCAVATION CONTRACTOR Name:____________________ Address:____________________ ____________________ Phone #: ____________	**SITE ADDRESS** Nearest Cross Streets: ____________________ ____________________
OWNER/APPLICANT Name:____________________ Address:____________________ ____________________ Phone #: ____________	**DRAINAGE / WATERWAY** Name of nearest stream, creek, river: ____________________
24-HOUR EMERGENCY CONTACT Name:____________________ Address:____________________ ____________________ Phone #: ____________	**SOIL DISPOSAL** Exporting Soil? Y N Address of Site:____________________ ____________________

I agree to comply with the "Erosion Prevention and Sediment Control Planning and Design Manual" and will construct and maintain ESC measures to contain Sediment on the construction site.

____________________________ ________________

Owner/Applicant Signature **Date**

STANDARD EROSION AND SEDIMENT CONTROL PLAN DRAWING NOTES;

1. WHEN RAINFALL AND RUNOFF OCCURS DAILY INSPECTIONS OF THE EROSION AND SEDIMENT CONTROLS AND DISCHARGE OUTFALLS MUST BE PROVIDED BY SOME ONE KNOWLEDGEABLE AND EXPERIENCED IN THE PRINCIPLES, PRACTICES, INSTALLATION, AND MAINTENANCE OF EROSION AND SEDIMENT CONTROLS WHO WORKS FOR THE PERMITTEE.

2. CONSTRUCTION ACTIVITIES MUST AVOID OR MINIMIZE EXCAVATION AND CREATION OF BARE GROUND FROM OCTOBER 1 THROUGH MAY 31 EACH YEAR.

3. DURING WET WEATHER PERIOD, TEMPORARY STABILIZATION OF THE SITE MUST OCCUR AT THE END OF EACH WORK DAY.

4. SEDIMENT CONTROLS MUST BE INSTALLED AND MAINTAINED ON ALL DOWN GRADIENT SIDES OF THE CONSTRUCTION SITE AT ALL TIMES DURING CONSTRUCTION. THEY MUST REMAIN IN PLACE UNTIL PERMANENT VEGETATION OR OTHER PERMANENT COVERING OF EXPOSED SOIL IS ESTABLISHED.

5. ALL ACTIVE INLETS MUST HAVE SEDIMENT CONTROLS INSTALLED AND MAINTAINED AT ALL TIMES DURING CONSTRUCTION. UNLESS OTHERWISE APPROVED, A SURFACE MOUNTED AND ATTACHABLE, U-SHAPED FILTER BAG IS REQUIRED FOR ALL CURB INLET CATCH BASINS.

6. SIGNIFICANT AMOUNTS OF SEDIMENT WHICH LEAVES THE SITE MUST BE CLEANED UP WITHIN 24 HOURS AND PLACED BACK ON THE SITE AND STABILIZED OR PROPERLY DISPOSED. THE CAUSE OF THE SEDIMENT RELEASE MUST BE FOUND AND PREVENTED FROM CAUSING A RECURRENCE OF THE DISCHARGE WITHIN THE SAME 24 HOURS. ANY IN-STREAM CLEAN UP OF SEDIMENT SHALL BE PREFORMED ACCORDING TO THE OREGON DEPARTMENT OF STATE LANDS REQUIRED TIME FRAME.

7. SEDIMENT MUST NOT BE INTENTIONALLY WASHED INTO STORM SEWERS, DRAINAGE WAYS, OR WATER BODIES.

8. SEDIMENT MUST BE REMOVED FROM BEHIND ALL SEDIMENT CONTROL MEASURES WHEN IT HAS REACHED A HEIGHT OF 1/3RD THE BARRIER HEIGHT, AND PRIOR TO THE CONTROL MEASURES REMOVAL.

9. CLEANING OF ALL STRUCTURES WITH SUMPS MUST OCCUR WHEN THE SEDIMENT RETENTION CAPACITY HAS BEEN REDUCED BY 50% AND AT COMPLETION OF PROJECT.

10. ANY USE OF TOXIC OR OTHER HAZARDOUS MATERIALS MUST INCLUDE PROPER STORAGE, APPLICATION, AND DISPOSAL.

11. THE PERMITTEE MUST PROPERLY MANAGE HAZARDOUS WASTES, USED OILS, CONTAMINATED SOILS, CONCRETE WASTE, SANITARY WASTE, LIQUID WASTE, OR OTHER TOXIC SUBSTANCES DISCOVERED OR GENERATED DURING CONSTRUCTION.

12. THE APPLICATION RATE OF FERTILIZERS USED TO REESTABLISH VEGETATION MUST FOLLOW MANUFACTURER'S RECOMMENDATIONS. NUTRIENT RELEASES FROM FERTILIZERS TO SURFACE WATERS MUST BE MINIMIZED. TIME RELEASE FERTILIZERS SHOULD BE USED AND CARE SHOULD BE MADE IN APPLICATION OF FERTILIZERS WITHIN ANY WATER WAY RIPARIAN ZONE.

13. OWNER OR DESIGNATED PERSON SHALL BE RESPONSIBLE FOR PROPER INSTALLATION AND MAINTENANCE OF ALL EROSION AND SEDIMENT CONTROL MEASURES, IN ACCORDANCE WITH CURRENT CLEAN WATER SERVICES STANDARDS AND STATE, AND FEDERAL REGULATIONS.

14. PRIOR TO ANY LAND DISTURBING ACTIVITIES, THE BOUNDARIES OF THE CLEARING LIMITS, VEGETATED BUFFERS, AND ANY SENSITIVE AREAS SHOWN ON THIS PLAN SHALL BE CLEARLY DELINEATED IN THE FIELD. UNLESS OTHERWISE APPROVED, NO DISTURBANCE IS PERMITTED BEYOND THE CLEARING LIMITS. THE OWNER/PERMITTEE MUST MAINTAIN THE DELINEATION FOR THE DURATION OF THE PROJECT.
NOTE: VEGETATED CORRIDORS TO BE DELINEATED WITH ORANGE CONSTRUCTION FENCE OR APPROVED EQUAL.

15. PRIOR TO ANY LAND DISTURBING ACTIVITIES, THE BMPS THAT MUST BE INSTALLED ARE GRAVEL CONSTRUCTION ENTRANCE, PERIMETER SEDIMENT CONTROL, AND INLET PROTECTION. THESE BMPS MUST BE MAINTAINED FOR THE DURATION OF THE PROJECT.

16. IF VEGETATIVE SEED MIXES ARE SPECIFIED, SEEDING MUST TAKE PLACE NO LATER THAN SEPTEMBER 1ST; THE TYPE AND PERCENTAGES OF SEED IN THE MIX ARE AS IDENTIFIED ON THE PLANS OR AS SPECIFIED BY THE DESIGN ENGINEER.

17. WATER-TIGHT TRUCKS MUST BE USED TO TRANSPORT SATURATED SOILS FROM THE CONSTRUCTION SITE. AN APPROVED EQUIVALENT IS TO DRAIN THE SOIL ON SITE AT A DESIGNATED LOCATION USING APPROPRIATE BMPS; SOIL MUST BE DRAINED SUFFICIENTLY FOR MINIMAL SPILLAGE.

18. ALL PUMPING OF SEDIMENT LADEN WATER MUST BE DISCHARGED OVER AN UNDISTURBED, PREFERABLY VEGETATED AREA, AND THROUGH A SEDIMENT CONTROL BMP (I.E. FILTER BAG).

19. THE ESC PLAN MUST BE KEPT ONSITE. ALL MEASURES SHOWN ON THE PLAN MUST BE INSTALLED PROPERLY TO ENSURE THAT SEDIMENT LADEN WATER DOES NOT ENTER A SURFACE WATER SYSTEM, ROADWAY, OR OTHER PROPERTIES.

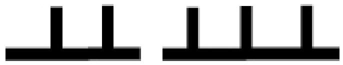
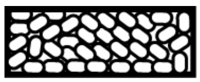
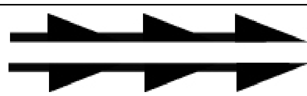
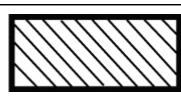
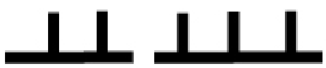
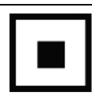
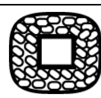
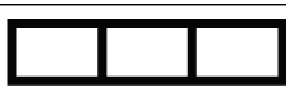
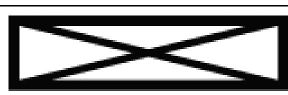
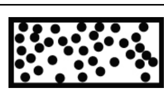
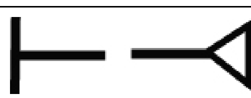
20. THE ESC MEASURES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE MEASURES SHALL BE UPGRADED AS NEEDED TO MAINTAIN COMPLIANCE WITH ALL REGULATIONS.

21. WRITTEN ESC LOGS ARE SUGGESTED TO BE MAINTAINED ONSITE AND AVAILABLE TO DISTRICT INSPECTORS UPON REQUEST.

22. IN AREAS SUBJECT TO WIND EROSION, APPROPRIATE BMPS MUST BE USED WHICH MAY INCLUDE THE APPLICATION OF FINE WATER SPRAYING, PLASTIC SHEETING, MULCHING, OR OTHER APPROVED MEASURES.

23. ALL EXPOSED SOILS MUST BE COVERED DURING WET WEATHER PERIOD.

Erosion Prevention and Sediment Control Symbols

	**Brush Barrier**
	**Check Dam**
	**Compost Blanket**
	**Construction Entrance**
	**Diversion Dike**
	**Diversion Swale**
	**Diversion Dike/Swale**
	**Erosion Control Matting**
	**Filter Berm**
	**Inlet Protection**
	**Outlet Protection**
	**Sediment Barrier**
	**Sediment Fence**
	**Sediment Mat**
	**Sediment Trap**
	**Seeding & Mulching**
	**Temporary Slope Drains**

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Appendix B

Erosion Control Inspection Log

Inspector Checklist For Erosion Control

Erosion Control Inspection Log

Project Name: ____

Date:_________________Time:_______________Weather:____Rainfall In the Last 24 Hours: Yes_______No ______

Site Active: Yes______No______ Days Since Last Inspection: ______

Inspection Type: Initial Inspection______Regular Inspection______Final_______Active Storm Water Runoff______Other___________________________________

Observations: ____

____

____

____(More Space on Back)

Corrective Actions Taken/Needed: ____

____

____

____(More Space on Back)

Have Any Changes Been Made to the ESCP: Yes_____No______

If Yes, What Changes Have Been Made: ____

____

Have The Changes Been Documented: Red Lines: Yes______No______Action Plan: Yes______No_______

Inspected By: Print Name:____Title:____

Signature:____

Additional Comment Space on Back

Observations: (Continued)

Corrective Actions Taken/Needed: (Continued)

INSPECTION CHECKLIST
FOR
EROSION CONTROL

- ❑ **SCHEDULE**

  Have you looked at the Contractors Schedule and determined any conflicts?
  - ✓ Install necessary Best Management Practices (BMPs) prior to any earthwork beginning.
  - ✓ Are earthwork operations being performed in wet weather season with soils that are highly erosive?
  - ✓ Grubbing of areas that will be worked on much later should be delayed
  - ✓ Staging of project may require staging of erosion control measures
  - ✓ Is seeding scheduled before the end of the seed dates?
  - ✓ Are there “In-Stream work areas that may alter contractor’s schedule?
  - ✓ When will the contractor remove BMPs?

- ❑ **EROSION AND SEDIMENT CONTROL PLAN (ESCP)**
  - ✓ Walk project during preliminary or advanced plan review and look for potential erosion problems
  - ✓ Have you reviewed the Contractor’s Erosion Control Plan to determine if it is adequate or makes sense? The ESCP included in the bid package may need modifications to address site conditions or staging
  - ✓ Walk project with PSI prior to any earthwork looking for needed modifications of ESCP
  - ✓ Is the ESCP being kept up-to-date?
  - ✓ Is the ESCP kept on-site? Where?
  - ✓ What is contractor’s erosion control plan for offsite borrow sources and waste areas?

- ❑ **EROSION AND SEDIMENT CONTROL MANAGER (PSI)**

  Have you met and talked with the person identified as the PSI?
  - ✓ Do you believe this person has adequate knowledge to perform this work?
  - ✓ Does this person understand all the required duties of the PSI?
  - ✓ Does this person have the authority to direct resources and make changes in an emergency situation?

- ❑ **SENSITIVE AREAS**

  Are there sensitive areas, which require “extra” attention?
  - ✓ Have they been adequately addressed on the ESCP?
  - ✓ Will these sensitive areas require more monitoring?

- ❑ **CONTINGENCY PLAN**
  - ✓ Is there a contingency plan for unexpected events?
  - ✓ What is the plan for stabilization of earthwork performed after seeding dates?

- ❑ **MATERIALS ON-HAND**

  It may be difficult to get Erosion Control materials in the middle of the wet season. It is easier to deal with erosion before it happens rather than after.
  - ✓ Does the Contractor have adequate materials on hand to cover each phase of work they plan on performing?

- **MAINTENANCE**
  - ✓ Consider access for maintenance of BMPs. Place where they are easy to maintain if you have a choice
  - ✓ Are installed erosion and sediment controls in good working order?
  - ✓ Are catch basins cleaned out when more than 6 inches of sediment depth accumulates?
  - ✓ At sediment fences, barriers, check dams, inlet protection cleaned out when sediment reaches 1/3 of the storage depth?
  - ✓ Are construction entrances maintained with fresh rock to prevent tracking of sediment onto pavement?

- **MONITORING FORMS**
  - ✓ Are you getting Erosion Control Weekly reports as often as they should be filed from the PSI?
  - ✓ Are the forms complete and adequately represent site conditions and work performed?
  - ✓ Are forms on-site with the “Up-to-Date Plan”?

- **SLOPE PROTECTION & STABILIZATION**
  - ✓ All highly sensitive areas
  - ✓ Permanently finish slopes from top down and seed as you go!
  - ✓ Track walk slopes to provide loosened soil and hold seed
  - ✓ Temporarily stabilize unfinished earthwork scheduled for re-disturbance at a later date (i.e. straw mulch, chemical soil stabilizers, plastic sheeting, matting, etc.)

- **PLANS ARE ONLY A GUIDE**
  What’s best for your project is what works on your project. No designer can sit in an office and determine what works on your project. It may require trial and error. The plans are a toolbox with available tools. You may have to create and modify these tools to satisfy the conditions

- **IT’S NOT WORKING!!!**
  Are the BMPs working? If not, are the facilities attempting to prevent erosion before it starts?

- **ADDITIONAL ITEMS**
  - ✓ Go back to newly installed BMPs to check their performance
  - ✓ How will contractor handle dust control or wind erosion?
  - ✓ Will snow melt change runoff and drainage patterns?

Appendix C

Metric Conversion Table

Slope Conversion Table

Seed or Fertilizer Hydraulic Application Table A-1

Wood Fiber Mulch Hydraulic Application Table C-1, C-2

Hydraulic Application Worksheet

Example Mulch/Seed Worksheet

Metric Conversion Tables

Measurement in:	**From English Units:**	**To Metric Units:**	**Multiply By**
Length	inch (in)	millimeter (mm)	25.40
	foot (ft)	meter (mm)	0.3048
	yard (yd)	meter (mm)	0.9144
	mile (mi)	kilometer (km)	1.609
Area	in^2	mm^2	645.2
	ft^2	m^2	0.0929
	yd^2	m^2	0.8361
	mi^2	km^2	2.590
	acre	hectare (ha)	0.4047
	acre	m^2	4047

Quantity	**From SI Units**	**To English Units**	**Divide By**
Length	km	mile	1.609
	m	yard	0.9144*
	m	foot	0.3048*
	mm	inch	25.4*
Area	km^2	square mile	2.59
	m^2	acre	4047
	hectare	acre	0.404
	m^2	square yard	0.836
	m^2	square foot	0.092
	mm^2	square inch	645.2

Abbreviations

L	liter
ha	hectares
kg	Kilogram=1x103 grams
m	meter
km	kilometer=1x103 meters

SLOPE CONVERSION TABLE

Rise:Run	% Grade	Angle Degree
1:00	1.0	0.6
1:90	1.1	0.6
1:80	1.3	0.7
1:70	1.4	0.8
1:60	1.7	1.0
1:50	2.0	1.1
1:40	2.5	1.4
1:35	2.9	1.6
1:30	3.3	1.9
1:25	4.0	2.3
1:20	5.0	2.9
1:19	5.3	3.0
1:18	5.6	3.2
1:17	5.9	3.4
1:16	6.3	3.6
1:15	6.7	3.8
1:14	7.1	4.1
1:13	7.7	4.4
1:12	8.3	4.8
1:11	9.1	5.2
1:10	10.0	5.7
1:9	11.1	6.3
1:8	12.5	7.1
1:7	14.3	8.1
1:6	16.7	9.5
1:5	20.0	11.3
1:4	25.0	14.0
1:3	33.3	18.4
1:2	50.0	26.6
1:1	100.0	45.0

How to calculate Slope: $\frac{\text{Rise or (v) vertical change elevation (feet)}}{\text{Run or (h) horizontal distance (feet)}}$

Example: Divide rise by run to get your calculated slope %

$\frac{15v}{50h}$ *** Divide 15v by 50h to get .30 or 30%**

TableA-1

Seed or Fertilizer Hydraulic Application

Application Load (Wst)	Area of Coveraae (A) Application Rates of Pure Live Seed (Rs)													
	20 lb/acre		40 lb/acre		60 lb/acre		80 lb/acre		100 lb/acre		200 lb/acre		400 lb/acre	
Pounds	acre	ft.ʟ	acre	ft.'	acre	ft_ʟ	acre	ft ʟ	acre	ft_ʟ	acre	ft_ʟ	acre	ft_ʟ
10	0.50	21,780	0.25	10,890	0.17	7,260	0.13	5,445	0.10	4 356	0.05	2 178	0.03	1,089
20	1.00	43,560	0.50	21,780	0.33	14,520	0.25	10,890	0.20	8,712	0.10	4,356	0.05	2,178
30	1.50	65,340	0.75	32,670	0.50	21,780	0.38	16,335	0.30	13,068	0.15	6,534	0.08	3,267
40	2.00	87,120	1.00	43,560	0.67	29,040	0.50	21,780	0.40	17,424	0.20	8,712	0.10	4,356
50	2.50	108,900	1.25	54,450	0.83	36,300	0.63	27,225	0.50	21,780	0.25	10,890	0.13	5,445
60	3.00	130,680	1.50	65,340	1.00	43,560	0.75	32,670	0.60	26,136	0.30	13,068	0.15	6,534
70	3.50	152,460	1.75	76,230	1.17	50,820	0.88	38,115	0.70	30,492	0.35	15,246	0.18	7,623
80	4.00	174,240	2.00	87,120	1.33	58,080	1.00	43,560	0.80	34,848	0.40	17,424	0.20	8,712
90	4.50	196,020	2.25	98,010	1.50	65,340	1.13	49,005	0.90	39,204	0.45	19,602	0.23	9,801
100	5.00	217 800	2.50	108 900	1.67	72,600	1.25	54,450	1.00	43 560	0.50	21,780	0.25	10,890
120	6.00	261,360	3.00	130,680	2.00	87,120	1.50	65,340	1.20	52,272	0.60	26,136	0.30	13,068
140	7.00	304,920	3.50	152,460	2.33	101,640	1.75	76,230	1.40	609,984	0.70	30,492	0.35	15,246
160	8.00	348 480	4.00	174,240	2.67	116,160	2.00	87,120	1.60	69,696	0.80	34,848	0.40	17,424
180	9.00	392,040	4.50	196,020	3.00	130,680	2.25	98,010	1.80	78,408	0.90	39,204	0.45	19,602
200	1000	435,600	5.00	217,800	3.33	145,200	2.50	108,900	2.00	87,120	1.00	43,560	0.50	21,780
220	11.00	479,160	5.50	239,580	3.67	159,720	2.75	119,790	2.20	95,832	1.10	47,916	0.55	23,958
240	12.00	522,720	6.00	261,360	400	174,240	3.00	130,680	2.40	104,544	1.20	52,272	0.60	26,136
260	1300	566,280	6.50	283,140	433	188,760	3.25	141,570	2.60	113,256	1.30	56,628	0.65	28,314
280	14.00	609,840	7.00	304,920	467	203,280	3.50	152,460	2.80	121,968	1.40	60,984	0.70	30,492
300	15.00	653,400	7.50	326,700	5.00	217,800	3.75	163,350	3.00	130,680	1.50	65,360	0.75	32,670

"Application Load" is in Pure Live Seed.

Gross weight of seed can be converted by the Pure Live Seed (PLS) Rate [%Purityx % Germination = %PLS; Wsf = Gross Weight x %PLS]

To evaluate mulch tracer material, use Table C-1.

Wood Fiber Mulch Hydraulic Application

Table C-1 — **2,000lb/acre Application Rate (Rwr)**

Wood Fiber	**Water Required for Application**		**Area of Coverage (A)**	
(Ww1)	Average (Vwa)	Maximum (Vwml		
	40 lbs mulch/ 100aal water	50lbs mulch/ 100aal water		
Pounds	*Gallons	*Gallons	fr	Acres
500	1,250	1,000	10,890	0.25
600	1,500	1,200	13,068	0.30
700	1,750	1,400	15,246	0.35
800	2,000	1,600	17,424	04 0
900	2,250	1,800	19,602	045
1,000	2,500	2,000	21,780	0.50
1,100	2,750	2,200	23,958	0.55
1,200	3 000	2 400	26 136	0.60
1,300	---	2,6 00	28,314	0.65
1,400	---	2,8 00	30,492	0.70
1,500	---	3 000	32,670	0.75

Table C-2 — **2,500lb/acre Application Rate (Rwr)**

Wood Fiber	**Water Required for ADDlication**		**Area of Coveraae (A)**	
(Ww1)	Average (Vwa)	Maximum (Vwm)		
	40 lbs mulch / 1OOaal water	50lbs mulch / 1OOaal water		
Pounds	*Gallons	*Gallons	tr	Acres
500	1,250	1,000	8,712	0.20
600	1,500	1,200	10,454	0.24
700	1 750	1 400	12,197	0.28
800	2,000	1,600	13,939	0.32
900	2,250	1,800	15,682	0.36
1,000	2,500	2 000	17,424	04 0
1,100	2,750	2,200	19,166	04 4
1,200	3,000	2,400	20,909	04 8
1,300	---	2,600	22,651	0.52
1,400	---	2,800	24,394	0.56
1,500	---	3,000	26,136	0.60

* Largest Typical Hydro seeding equipment has a 3,000 gallon working volume.

HYDRAULIC APPLICATION

Wood Fiber Mulch Hydraulic Application

Average Water Required for Application

V_{wa} (gal) = (W_{wf}) / (40lbs mulch / 100gal water)

Maximum Water Required for Application

V_{wm} (gal) = (W_{wf}) / (50lbs mulch / 100gal water)

Area of Coverage

A (acre) = (W_{wf} / R_{wf})

A (ft^2) = (W_{wf} / R_{wf}) * (43,560 ft^2/acre)

Wood Fiber Application Rate (lb/acre)	R_{wf}
Weight or Mass of Wood Fiber (lbs)	W_{wf}
Average Water Requirement (gal)	V_{wa}
Maximum Water Requirement (gal)	V_{wm}
Area of Coverage (ft^2) & (acres)	A

Seed or Fertilizer Hydraulic Application

Area of Coverage

A (acre) = (W_{sf} / R_{sf})

A (ft^2) = (W_{sf} / R_{sf}) * (43,560 ft^2/acre)

Seed or Fertilizer Application Rates (lb/acre)	R_{sf}
Weight or Mass of Seed or Fertilizer (lbs)	W_{sf}
Area of Coverage (ft^2) & (acres)	A

<u>Example #1</u> (Mulch - Area of Coverage)

Given: Required mulch application rate 2,000 lb/acre.
Hydro Seeder with 1,800 gal working capacity.
900 lbs of Wood Fiber to be applied over seeded area.

Find: Range of Area of Coverage.

Answer: Find the 2,000 lb/acre Application Rate Chart, Table C-3.

<u>Using a 50 lbs / 100 gal mulch/water ratio</u>:
Find 1,800 gal in the Maximum Water Required for Application column.
Follow this row over to the area columns.
One tank can cover **0.45 acre (19,602 ft^2).**

<u>Using a 40 lbs / 100 gal mulch/water ratio</u>:
Find 1,800 gal in the Average Water Required for Application column.
There isn't an 1,800 gal row, so interpolate between 1,750 gal and 2,000 gal.
Follow the 1,750 gal and 2,000 gal row over to the area columns.
At 1,750 gal, one tank can cover 0.35 acre (15,246 ft^2).
At 2,000 gal, one tank can cover 0.40 acre (17,424 ft^2).
One tank can cover 1,800 lb * ((0.40 acre - 0.35 acre)/(2,000 gal - 1,750 gal))
0.36 acre (15,682 ft^2).

<u>Example #2</u> (Mulch - Materials Used)

Given: 0.60 acre (26,136 ft^2) area to be seeded.
Required mulch application rate 1,200 lb/acre.
Hydro Seeder with 2,500 gal working capacity.

Find: A) Amount of Mulch Required in lbs.
B) Range of Water Required in gal.
C) Number of Trips Required.

Answer: Find the 2,000 lb/acre Application Rate Chart, Table C-3.

A) Find 0.60 acre under the Area of Coverage column.
Follow the row over to the Wood Fiber column.
The wood fiber required by the area is **1,200 lb.**

B) Find 0.60 acre under the Area of Coverage column.
Follow the row to the Required Water for Application column.
<u>Using a 50 lbs / 100 gal mulch/water ratio</u>:
The water required for the area is **2,400 gal.**
<u>Using a 40 lbs / 100 gal mulch/water ratio</u>:
The water required for the area is **3,000 gal.**

C) <u>Using a 50 lbs / 100 gal mulch/water ratio</u>:
(2,400 gal / (2,500 gal/trip)) = **1 trip.**
<u>Using a 40 lbs / 100 gal mulch/water ratio</u>:
(3,000 gal / (2,500 gal/trip)) = 1.2 trips, so use **2 trips.**

Example #3 (Seed - Area of Coverage)

Given: Seed Application Rate 40 lb/acre.
200 lb of Seed is to be Applied.

Find: Area of Coverage.

Answer: Use the Seed or Fertilizer Hydraulic Application Chart, Table A-1.
Find the 40 lb/acre application rate column.
Find the 200 lb seed row.
Determine where the column and the row intersect and record the area.
For 40 lb/acre, the area of coverage is **5 acre (217,800 ft^2).**

Or

Use the Formula on the Hydraulic Application Equations Sheet.
Find the area of coverage equation under the title Seed or Fertilizer Hydraulic Application.
The area equation is A (acre) = W_{sf} / R_{sf}
Area (acre) = (200 lb) / (40 lb/acre) = **5 acre.**
Area (ft^2) = [(200 lb) / (40 lb/acre)] * (43,560 ft^2/acre) = **217,800 ft^2.**

Example #4 (Seed - Materials Needed)

Given: Required Area of Coverage .13 acre (5,662.8 ft^2).
Seed Application Rate 200 lb/acre.

Find: Amount of Seed Required in lbs.

Answer: Use the Seed or Fertilizer Hydraulic Application Chart, Table A-1.
Find the 200 lb/acre application rate column.
Move down the list of areas to 0.13 acre.
0.13 acre is not in this column, so interpolate.
Find the area above and below 0.13 acre.
Follow the row from the area to the Amount of Seed column.
For 0.10 acre (4,356 ft^2), the amount of seed is **20 lbs.**
For 0.15 acre (6,534 ft^2), the amount of seed is **30 lbs.**

At 0.13 acre (5,662.8 ft^2), the amount of seed is
0.13 acre * ((30 lb - 20 lb)/(0.15 acre - 0.10 acre)) = **26 lbs.**

Or

Use the Formula on the Hydraulic Application Equations Sheet.
Find the area of coverage equation under the title Seed or Fertilizer Hydraulic Application.
The area equation is A (acre) = W_{sf} / R_{sf}
Rearrange the equation so W_{sf} (lb) = (A) * (R_{sf})
Wsf (lb) = (0.13 acre) * (200 lb/acre) = **26 lbs.**

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Appendix D

Acronyms

Glossary of Terms

References

ACRONYMS

USACOE	U.S. Army Corps of Engineers
AOS	Apparent Opening Size
ASTM	American Standards for Testing Materials
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
CWA	Clean Water Act
CWS	Clean Water Services
CZARA	Coastal Zone Act Reauthorization Amendments of 1990
CZMA	Coastal Zone Management Act of 1972
DEQ	Department of Environmental Quality
DOGAMI	Department of Geology and Mineral Industries
DSL	Department of State Lands
DOF	Department of Forestry
ECRM	Erosion Control and Revegetation Mats
EPA	Environmental Protection Agency
EPCM	Erosion and Pollution Control Manager
ESCP	Erosion Sediment Control Plan
EQC	Environmental Quality Commission
ESA	Endangered Species Act
ESCP	Erosion and Sediment Control Plan
HDPP	High Density Polyethylene Pipe
IECA	International Erosion Control Association
ISO	International Standards Organization
NMFS	National Marine Fisheries Service

ACRONYMS (continued)

NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
OAR	Oregon Administrative Rules
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
ORS	Oregon Revised Statutes
PCP	Pollution Control Plan
RUSLE	Revised Universal Soil Loss Equation
SWCD	Soil and Water Conservation District
TRM	Turf Reinforcement Mats
TSS	Total Suspended Solids
TMDL	Total Maximum Daily Load
WES	Water Environment Service

GLOSSARY OF TERMS

Adsorption	The adhesion of a substance to the substance to the surface of a solid or liquid. Heavy metals such as zinc and lead often adsorb onto particles.
Alluvial Soils	Soils developed from transported and relatively recently deposited material (alluvium) characterized by a weak modification (or none) of the original material by soil-forming processes.
Annual Storm	The highest peak storm discharge that is expected in any given year.
Apron	A pad of non-erosive material designed to prevent scour holes developing at the outlet ends of culverts, outlet pipes, grade stabilization structures, and other water control devices.
Aquifer	An underground porous, water-bearing geological formation. The term is generally restricted to materials capable of yielding an appreciable supply of water.
Base Flow	Stream discharge derived from groundwater sources as differentiated from surface runoff. Sometimes considered to include flows from regulated lakes or reservoirs.
Bedrock	The more or less solid rock in place either on or beneath the surface of the earth. It may be soft, medium or hard and have a smooth or irregular surface.
Berm	A constructed barrier of compacted earth.
Best Management Practices (BMPs)	Physical, structural and/or managerial practices employed to avoid or mitigate damage or potential damage from the contamination or pollution of surface waters or wetlands. Structural BMPs are actual physical installations rather than procedural/managerial BMPs, such as good housekeeping and employee training.
Catch Basin	A grated inlet, curb opening or combination inlet with or without a sump, which admits storm water to a sewer or sub-drain.
Channel	A natural stream or excavated ditch that conveys water.
Channel Stabilization	Protecting the sides and bed of a channel from erosion by controlling flow velocities and flow directions using jetties, drops or other structures and/or by lining the channel with a suitable liner such as vegetation, riprap, concrete or other similar material.

Check Dam	A small dam constructed in a gully or other small watercourse to decrease flow velocity, minimize channel scour and promote sediment deposition.
Clay	(1) Soil fraction consisting of particles less than 0.002 mm in diameter. (2) A soil texture class, which is dominated by clay or at least has a larger proportion of clay than either silt or sand.
Cohesion	The capacity of a soil to resist shearing stress, exclusive of functional resistance.
Cohesive Soil	A soil that, when unconfined, has considerable strength when air-dried and significant strength when saturated.
Coir	Fiber made from coconut husks.
Compost	Organic residue or a mixture of organic residues and soil that has undergone biological decomposition until it has become relatively stable humus.
Conventional Pollutants	Contaminants (other than nutrients) such as sediment, oil, and vehicle fluids.
Contour	An imaginary line on the surface of the earth connecting points of the same elevation.
Cut	Portion of land surface or area from which earth has been removed or will be removed by excavating the depth below the original ground surface to the excavated surface.
Cut-and-Fill	Process of earth grading by excavating part of a higher area and using the excavated material for fill to raise the surface of an adjacent lower area.
Cutoff Trench	A long, narrow excavation (keyway) constructed along the center line of a dam, dike, levee or embankment and filled with relatively impervious material intended to reduce seepage of water through porous strata.
Design Highwater	The elevation of the water surface at peak flow conditions of the design flood.
Design Storm	Selected storm of a given frequency used for designing a design storm system. Hypothetical storm derived from intensity-duration-frequency curves. A prescribed hyetograph and total precipitation amount (for a specific duration recurrence frequency) used to estimate runoff in order to analyze existing drainage, design new drainage facilities or assess impacts of a proposed project on surface water flow.

Detention	Storage and subsequent release of excess storm water runoff.
Detention Facility	An above or below ground facility, such as a pond or tank, which temporarily stores storm water runoff and releases it at a controlled rate. There is little or no infiltration of the stored storm water.
Detention Time	The theoretical time required to displace the contents of a tank or unit at a given rate of discharge (volume divided by rate of discharge).
Dewatering	The removal of water temporarily impounded in a holding basin.
Dike	An embankment to confine or control water, often built along the banks of a river o prevent overflow of lowlands; a levee.
Discharge	Usually the rate of water flow; a volume of fluid passing a point per unit time commonly expressed as cubic feet per second, cubic meters per second, gallons per minute, or millions of gallons per day.
Dispersion, Soil	The breaking down of fine soil aggregates into individual particles, resulting in single-grain structure. Ease of dispersion influences the erodibility of soils. Generally speaking, the more easily dispersed the soil, the more erodible it is.
Diversion	A channel with a supporting ridge on the lower side constructed at the top, across, or at the bottom of a slop for the purpose of controlling surface runoff.
Diversion Dike	A barrier built to divert surface runoff.
Drain	A buried slotted or perforated pipe or other conduit (subsurface drain) or a ditch (open drain) for carrying off surplus groundwater or surface water.
Drainage	The removal of excess surface water or groundwater from land by means of ditches or subsurface drains.
Drainageway	A natural or artificial depression that carries surface water to a larger watercourse or outlet such as a river, lake, or bay.
Drop Inlet	Overall structure in which the water drops through a vertical riser connected a discharge conduit or storm sewer.
Earth Dam	Dam constructed of compacted suitable soil materials.
Elongation	The increase in length produced in the gage length produced by a tensile load.
Embankment	A man-made deposit of soil, rock, or other material often used to form an impoundment.

Emergency Spillway	Usually a vegetated earth channel used to safely convey flood discharges around an impoundment structure.
Energy Dissipater	A device used to reduce the energy of flowing water to prevent erosion.
Environment	The sum total of all the external conditions that may act upon a living organism or community to influence its development or existence.
Erodibility	Susceptibility to erosion.
Erosion	The wearing away of the land surface by water, wind, ice, gravity, or other geological agents. The following terms are used to describe different types of water erosion: • Accelerated erosion – Erosion much more rapid than normal or geological erosion, primarily as a result of the activities of man. • Channel erosion – The erosion process whereby the volume and velocity of flow wears away the bed and/or banks of a well-defined channel. • Gully erosion – The erosion process whereby runoff water accumulates in narrow channels and, over relatively short periods, removes the soil to considerable depths, ranging from 1 to 2 feet to as much as 75 to 100 feet. • Rill erosion – An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently disturbed and exposed soils. See Rill. • Splash erosion – The spattering of small soil particles caused by the impact of raindrops on wet soils. The loosened and spattered particles may or may not be subsequently removed by surface runoff. • Sheet erosion – The gradual removal of a fairly uniform layer of soil from the land surface by runoff water.
Erosion and Sediment Control	Any temporary or permanent measures taken to reduce erosion, control siltation and sedimentation, and ensure that sediment-laden water does not leave a site.
Erosion and Sediment Control Plan (ESCP)	Plans, specification and BMP details intended to prevent and control erosion and sediment related to the project construction activities.
Evapotranspiration	The combined loss of water from an area by evaporation from the soil surface and by transpiration of plants.
Filter Fabric	A woven or non-woven, water permeable material generally made of synthetic products such as polypropylene and used in erosion and sediment control applications to trap sediment or prevent the movement of fine soil particles. Often used instead of a filter blanket.
Flood Peak	The highest stage or greatest discharge attained by a flood event. Thus, peak states or peak discharge.

Floodplain	The lowland that borders a stream and is subject to flooding when the stream overflows its banks.
Flood Stage	The stage at which overflow of the natural banks of a stream begins.
Floodway	A channel, either natural, excavated, or bounded by dikes and levees, used to carry flood flows.
Freeboard	Vertical clearance between the normal operating level and the top side of an open conduit or channel. Vertical distance between the design water surface elevation and the elevation of the barrier retaining the water.
Frequency of Storm (Design storm frequency)	The anticipated period in years that will elapse before another storm of equal intensity and/or total volume will recur: a 10-year storm can be expected to occur on the average once very 10 years.
Gabion	A wire mesh cage, usually rectangular, filled with rock and used to protect channel banks and other sloping areas from erosion.
Gauge	Device for measuring precipitation, water level, discharge, velocity, pressure, temperature, etc., e.g., a rain gauge. A measure of the thickness of metal, e.g., diameter of wire or wall thickness of steel pipe.
Geotextile	Any permeable textile used with foundation, rock, earth or any other geotechnical engineering-related material as an integral part of a human-made project, structure or system.
Grade	(1) the slope of a road, a channel, or natural ground. (2) The finished surface of canal bed, roadbed, top of embankment, or bottom of excavation; any surface prepared to a design elevation for the support of construction such as paving or the laying of a conduit. (3) To finish the surface of a canal bed, roadbed, top of embankment, or bottom of excavation, or other land area to a smooth, even condition.
Grade Stabilization Structure	A structure for the purpose of stabilizing the grade of a gully or other watercourse, thereby preventing further head-cutting or lowering of the channel bottom.
Gradient	Change of elevation, velocity, pressure, or other characteristics per unit length; slope.
Grading	The cutting and/or filling of the land surface to a desired slope or elevation.
Grass	A member of the botanical family Gramineae, characterized by blade-like leaves that originate as a sheath wrapped around the stem.
Grassed Waterway	A natural or constructed waterway, usually broad and shallow, covered with erosion-resistant grasses and used to safely conduct surface water from an area.

Ground Cover	(Horticulture) Low-growing, spreading plans useful for low maintenance landscape areas.
Habitat	The environment in which the life needs of a plan or animal are supplied.
Harmful Pollutant	A substance which has adverse effects on an organism. Adverse effects include immediate death, chronic poisoning, impaired reproduction and other conditions.
Head Loss	Energy loss due to friction, eddies, changes in velocity, elevation or direction of flow.
Headwater	The source of a stream. The water upstream from a structure or point a stream.
Heavy Metals	Metals having a high specific gravity, present in municipal and industrial wastes, and pose long-term environmental hazards. Such metals include cadmium, chromium, cobalt, copper, lead, mercury, nickel and zinc.
Hydrologic Cycle	The circuit of water movement from the atmosphere to the earth and back to the atmosphere through various stages or processes such as precipitation, interception, runoff, infiltration, percolation, storage, evaporation, and transpiration.
Hydrology	The science of the behavior of water in the atmosphere, on the surface of the earth, and underground.
Impervious	A surface, which water, can not easily penetrate. Can include graveled surface as well as paved surfaces.
Infiltration	The downward movement of water from the surface to the subsoil.
Invert	The inside bottom of a culvert or other conduit.
Land Capability	The suitability of land for use. Land capability classification involves consideration of: 1) the risks of land damage from erosion and other causes and 2) the difficulties in land use owing to physical land characteristics, including climate.
Land Use Controls	Methods for regulating the uses to which a given land area may be put, including such things as zoning, subdivision regulation, and floodplain regulation.
Loam	A soil textural classification in which the proportions of sand, silt and clay are well balanced. Loams have the best properties for cultivation of plants.
Mean Velocity	The average velocity of a stream flowing in a channel or conduit at a given cross-section or in a given reach. It is equal to the discharge divided by the cross-section area of the reach.

Mitigation	Means, in the following order or importance: 1. Avoiding the impact altogether by not taking a certain action or part of an action. 2. Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts. 3. Rectifying the impact by repairing, rehabilitating or restoring the affected environment. 4. Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action and 5. Compensation for the impact by replacing, enhancing, or providing substitute resources or environments.
Mulch	A natural or artificial layer of plant residue or other materials covering the land surface which conserves moisture, holds soil in place, aids in establishing plant cover, and minimizes temperature fluctuations.
National Pollutant Discharge Elimination System (NPDES)	The part of the Federal Clean Water Act, which requires permits (NPDES permits) for point and nonpoint source discharges.
Natural Drainage	The flow patterns of storm water runoff over the land in its pre-development state.
Nonpoint Source Pollution	Pollution that enters a water body from diffuse origins on the watershed and does not result from discernible, confined, or discrete conveyances.
Normal Depth	Depth of flow in an open conduit during uniform flow for the given conditions.
Nutrients	Essential chemicals for plant and animal growth. Excessive amounts can lead to water quality degradation and algae blooms. Some nutrients are toxic at high concentrations.
Open Drain	Natural watercourse or constructed open channel that conveys drainage water.
Outfall	The point, location, or structure where wastewater or drainage discharge from a sewer to a receiving body of water.
Outlet	Point of water disposal from a stream, river, lake tidewater, or artificial drain.
Outlet Channel	A waterway constructed or altered primarily to carry water from man made structures, such as smaller channels, tiles, lines, and diversions.
Peak Discharge	The maximum, instantaneous flow rate during a storm, usually in reference to a specific design storm event.

Permeability	A generic term for the ability of a material to conduct a fluid.
Permeable Soils	Soil materials with filtration rate of 10 minutes per inch or better. Such soils allow infiltration and reduce or eliminate surface and storm water runoff. Classified as SCS (Soil Conservation Services) Type A.
Permeability Rate	The rate at which water will move through a saturated soil. Permeability rates are classified as follows: • Very slow – Less than 0.06 inches per hour. • Slow – 0.06 to 0.20 inches per hour. • Moderately slow – 0.20 to 0.63 inches per hour. • Moderate – 0.63 to 2.0 inches per hour. • Rapid – 6.3 to 20.0 inches per hour. • Very rapid – More than 20.0 inches per hour.
Permittivity	For a geotextile, the volumetric flow rate if water per unit cross-section area, per unit head, under laminar flow conditions, in the normal direction through the fabric.
Point Source	Any discernible, confined and discrete conveyance, including but not limited to, any pipe ditch, channel, tunnel, conduit, well, discrete fissure, container, roller stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.
Point Source Pollutants	Pollution, which enters a water, body resulting from discernible confined or discrete conveyances.
Pollution Control Plan	Consists of Pollution Control Plan form, narrative, site map and details describing measures to prevent pollution related to contractor activities. Special Provision 00170.30 © spells out the Contractor's responsibilities related to Pollution Control.
Pervious	Allowing movement of water.
Porosity	The volume of pore space in soil or rock.
pH	A numerical measure of hydrogen ion activity. The neutral point is pH 7.0. All pH values below 7.0 are acid and all above 7.0 are alkaline.
Rainfall Intensity	The rate at which rain is falling at any given instant, usually expressed in inches per hour.
Rational Method	A means of computing storm drainage flow rates, Q, by use of the formula Q=CIA, where C is coefficient describing the physical drainage area, I is the rainfall intensity and A is the area.
Receiving Stream	The body of water into which runoff or effluent is discharged.

Retention	The process of collecting and holding surface and storm water runoff with no surface overflow.
Retention/Detention Facility	A type of drainage facility designed either to hold water for a considerable length of time and then release it by evaporation, plant transpiration, and/or infiltration into the ground, or to hold surface and storm water runoff for a short period of time and then release it to the surface and storm water management system.
Retention Structure	A natural or artificial basin that functions similar to a detention structure except that it maintains a permanent water supply.
Riparian	Pertaining to banks of streams, wetlands, lakes or tide waters.
Riser	The inlet portions of a drop inlet spillway that extends vertically from the pipe conduit barrel to the water surface.
Runoff	That portion of precipitation that flows from drainage area on the land surface, in open channels or in storm water conveyance systems.
Salmonid	A member of the fish family *salmonidae*. Includes Chinook, coho, chum, sockeye and pink salmon, cutthroat, steelhead, rainbow, Dolly varden, brook, kokanee and whitefish.
Sand	(1) Soil particles between 0.05 and 2.0 mm in diameter. (2) a soil textural class inclusive of all soils which are at least 70% sand and 15% or less clay.
Saturation	In soils, the point at which a soil or an aquifer will no longer absorb any amount of water without losing an equal amount.
Scour	The clearing and digging action of flowing water, especially the downward erosion caused by stream water in sweeping away mud and silt from the streambed and outside bank of a curved channel.
Sediment	Fragmented material originated from weathering and erosion of rocks and unconsolidated deposits. The material is transported by, suspended in, or deposited by water.
Sedimentation	Deposition or formation of sediment.
Sediment Delivery Ratio	The fraction of the soil eroded from upland sources that actually reaches a stream channel or storage reservoir.
Sediment Discharge	The quality of sediment, measured in dry weight or by volume, transported through a stream cross-section in a given time. Sediment discharge consists of both suspended load and bedload.
Seedbed	The soil prepared by natural or artificial means to promote the germination of seed and the growth of seedlings.
Seedling	A young plant grown from seed.

Sheet Erosion	Relatively uniform removal of soil from an area without the development of conspicuous water channels.
Sheet Flow	Relatively uniform flow over a plan surface without concentration of water into conspicuous channels.
Shoot	The above-ground portion of a plant.
Silt	(1) Soil fraction consisting of particles between 0.002 and 0.05 mm in diameter. (2) A soil textural class indicating more than 80% silt.
Siltation	Process by which a river, lake or other water body becomes clogged with sediment. Siltation can clog gravel beds and prevent successful salmon spawning.
Slope	Degree of deviation of a surface from the horizontal; measured as a numerical ration or percent. Expressed as a ratio, the first number is the horizontal distance (run) and the second is the vertical distance (rise), e.g., 2:1. Slope can also be expressed as the rise over the run. For instance, a 2:1 slope is a 50 percent slope.
Soil	The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.
Soil Horizon	A horizontal layer of soil that, through processes of soil formation, has developed characteristics distinct from the layers above and below.
Soil Profile	A vertical section of the soil from the surface through all horizons.
Soil Stabilization	Use of rock-lining, vegetation or other methods to prevent soil movement when loads are applied to the soil.
Soil Structure	The relation of particles or groups of particles which impart to the whole soil a characteristic manner of breaking; some types are crumb structure, block structure, platy structure, and columnar structure.
Soil Texture	The physical structure or character of soil determined by the relative proportions of the soil separates (sand, silt and clay) of which it is composed.
Spillway	A passage such as a paved apron or channel for surplus water over or around or through a dam or similar structure. An open or closed channel, or both, sued to convey excess water from a reservoir. It may contain gates, whether manually or automatically controlled, to regulate the discharge of excess water.
Storm Frequency	The statistical time interval between major storms of predetermined intensity and runoff volumes for which storm sewers and other structures are designed and constructed to handle hydraulically without surcharge or back-flood.

Storm Sewer	A sewer that carries storm water, surface drainage, street wash and other wash waters, but excludes sewage and industrial wastes. Also called a storm drain.
Storm Water	That portion of precipitation that does not percolate into the ground or evaporate, but flows via overland flow, interflow, channels or pipes into a defined surface water channel, or a constructed infiltration facility.
Storm Water Facility	A constructed component of a storm water drainage system, designed or constructed to perform particular function, or multiple functions. Storm water facilities include pipes, swales, ditches, culverts, street gutters, detention basins, retention basins, constructed wetlands and other.
Streambanks	The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream.
Subsoil	The B horizons of soils with distinct profiles. In soils with weak profile development, the subsoil can be defined as the soil below which roots do not normally grow.
Subsurface Drain	A pervious backfilled trench usually containing stone and perforated pipe for intercepting groundwater or seepage.
Surface Runoff	Precipitation that falls onto the surfaces of roofs, streets, the ground, etc., and is not absorbed or retained by that surface, but collects and runs off.
Suspended Solids	Organic or inorganic particles suspended in and carried by water, sand, mud, clay as well as solids.
Swale	An elongated depression in the land surface that is a least seasonally wet, is usually heavily vegetated, and is normally without flowing water. Swales conduct storm water into primary drainage channels and may provide some groundwater recharge.
Time of Concentration	The time period necessary for surface water runoff to reach the outlet of a sub-basin from the hydraulically most remote point in the tributary drainage area.
Toe of Slope	The base or bottom of a slope at the point where the ground surface abruptly changes to a significantly flatter grade.
Topography	General term to include characteristics of the ground surface such as plains, hills, mountains, degree of relief, steepness of slopes, and other physiographic features.
Topsoil	The dark-colored surface layer of A horizon of a soil. When present it ranges in depth from a fraction of an inch to 2 or 3 feet; equivalent to the plow layer of cultivated soils. Commonly used to refer to the surface soil layer(s), enriched in organic matter and having textural and structural characteristics favorable for plant growth.

Total Suspended Solids (TSS)	The entire amount of organic and inorganic particles dispersed in water. TSS are the larger particles in the water which are more easily removed by sedimentation than smaller particles which cause turbidity.
Toxicity	The characteristics of being poisonous or harmful to plant animal life; the relative degree or severity of the characteristic.
Trash Rack	A structural device used to prevent debris from entering a pipe spillway or other hydraulic structure.
Turbidity	Is caused by silt and clay particles, particles smaller than 0.02 mm, suspended in water. Measurement of turbidity can be done by turbidimeter which measures light-beam scatter caused by small suspended particles and converts it to NTU (national turbidity units).
Turf	Surface soil supporting a dense growth of grass and associated root mat.
Vegetative Stabilization	Protection of erodible or sediment-producing areas with: • Permanent seeding, producing long-term vegetative cover, • Short-term seeding, producing temporary vegetative cover, or • Sodding, producing areas covered with a turf of perennial sod-forming grass.
Watercourse	A definite channel with bed and banks within which concentrated water flows, either continuously or intermittently.
Water Quality	A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water Resources	The supply of groundwater and surface water in a given area.
Watershed Area	All land and water within the confines of a drainage divide.
Water Table	The free surface of the groundwater. That surface subject to atmospheric pressure under the ground, generally rising and falling with the season, or from other conditions such as water withdrawal.
Weir	Device for measure or regulating the flow of water.
Wet Pond	A facility treating storm water by utilizing a permanent pool of water to remove conventional pollutants from runoff. Treatment mechanisms include sedimentation, biological uptake and plant filtration.
Wet Season	October to May.

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Appendix G: Manning's Roughness Coefficients for Open Channels

Manning's n for Channels (Chow, 1959).

Type of Channel and Description	Minimum	Normal	Maximum
Natural streams - minor streams (top width at floodstage < 100 ft)			
1. Main Channels			
a. clean, straight, full stage, no rifts or deep pools	0.025	0.030	0.033
b. same as above, but more stones and weeds	0.030	0.035	0.040
c. clean, winding, some pools and shoals	0.033	0.040	0.045
d. same as above, but some weeds and stones	0.035	0.045	0.050
e. same as above, lower stages, more ineffective slopes and sections	0.040	0.048	0.055
f. same as "d" with more stones	0.045	0.050	0.060
g. sluggish reaches, weedy, deep pools	0.050	0.070	0.080
h. very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.100	0.150
2. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
a. bottom: gravels, cobbles, and few boulders	0.030	0.040	0.050
b. bottom: cobbles with large boulders	0.040	0.050	0.070
3. Floodplains			
a. Pasture, no brush			
1.short grass	0.025	0.030	0.035
2. high grass	0.030	0.035	0.050
b. Cultivated areas			
1. no crop	0.020	0.030	0.040
2. mature row crops	0.025	0.035	0.045
3. mature field crops	0.030	0.040	0.050
c. Brush			
1. scattered brush, heavy weeds	0.035	0.050	0.070
2. light brush and trees, in winter	0.035	0.050	0.060
3. light brush and trees, in summer	0.040	0.060	0.080
4. medium to dense brush, in winter	0.045	0.070	0.110
5. medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. dense willows, summer, straight	0.110	0.150	0.200
2. cleared land with tree stumps, no sprouts	0.030	0.040	0.050

3. same as above, but with heavy growth of sprouts	0.050	0.060	0.080
4. heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.080	0.100	0.120
5. same as 4. with flood stage reaching branches	0.100	0.120	0.160
4. Excavated or Dredged Channels			
a. Earth, straight, and uniform			
1. clean, recently completed	0.016	0.018	0.020
2. clean, after weathering	0.018	0.022	0.025
3. gravel, uniform section, clean	0.022	0.025	0.030
4. with short grass, few weeds	0.022	0.027	0.033
b. Earth winding and sluggish			
1. no vegetation	0.023	0.025	0.030
2. grass, some weeds	0.025	0.030	0.033
3. dense weeds or aquatic plants in deep channels	0.030	0.035	0.040
4. earth bottom and rubble sides	0.028	0.030	0.035
5. stony bottom and weedy banks	0.025	0.035	0.040
6. cobble bottom and clean sides	0.030	0.040	0.050
c. Dragline-excavated or dredged			
1. no vegetation	0.025	0.028	0.033
2. light brush on banks	0.035	0.050	0.060
d. Rock cuts			
1. smooth and uniform	0.025	0.035	0.040
2. jagged and irregular	0.035	0.040	0.050
e. Channels not maintained, weeds and brush uncut			
1. dense weeds, high as flow depth	0.050	0.080	0.120
2. clean bottom, brush on sides	0.040	0.050	0.080
3. same as above, highest stage of flow	0.045	0.070	0.110
4. dense brush, high stage	0.080	0.100	0.140
5. Lined or Constructed Channels			
a. Cement			
1. neat surface	0.010	0.011	0.013
2. mortar	0.011	0.013	0.015
b. Wood			
1. planed, untreated	0.010	0.012	0.014
2. planed, creosoted	0.011	0.012	0.015
3. unplaned	0.011	0.013	0.015

4. plank with battens	0.012	0.015	0.018
5. lined with roofing paper	0.010	0.014	0.017
c. Concrete			
1. trowel finish	0.011	0.013	0.015
2. float finish	0.013	0.015	0.016
3. finished, with gravel on bottom	0.015	0.017	0.020
4. unfinished	0.014	0.017	0.020
5. gunite, good section	0.016	0.019	0.023
6. gunite, wavy section	0.018	0.022	0.025
7. on good excavated rock	0.017	0.020	
8. on irregular excavated rock	0.022	0.027	
d. Concrete bottom float finish with sides of:			
1. dressed stone in mortar	0.015	0.017	0.020
2. random stone in mortar	0.017	0.020	0.024
3. cement rubble masonry, plastered	0.016	0.020	0.024
4. cement rubble masonry	0.020	0.025	0.030
5. dry rubble or riprap	0.020	0.030	0.035
e. Gravel bottom with sides of:			
1. formed concrete	0.017	0.020	0.025
2. random stone mortar	0.020	0.023	0.026
3. dry rubble or riprap	0.023	0.033	0.036
f. Brick			
1. glazed	0.011	0.013	0.015
2. in cement mortar	0.012	0.015	0.018
g. Masonry			
1. cemented rubble	0.017	0.025	0.030
2. dry rubble	0.023	0.032	0.035
h. Dressed ashlar/stone paving	0.013	0.015	0.017
i. Asphalt			
1. smooth	0.013	0.013	
2. rough	0.016	0.016	
j. Vegetal lining	0.030		0.500

Appendix H: Landscape Requirements and Plant Lists for Stormwater Facilities

Refer to the current Clean Water Services or City of Salem Landscape Requirements and Plant Lists for Stormwater Facilities (or other agencies as approved).

Appendix I: Rational Method

Rational Method

The rational method for analyzing small drainage basins may be used with the following limitations:

- **The Rational Method shall not be used to size retention and treatment stormwater management facilities.** However, the Rational Method is allowed to size other types of drainage facilities per the 1990 Marion County Engineering Standards; therefore, the standards are included here.
- Only use for predicting a conservative peak flow rate to be used in determining the required capacity for conveyance elements.
- The Rational Method shall not be used for calculating runoff from a contributing drainage area exceeding 10 acres.
- The time of concentration shall be a minimum of five minutes.

Q = Cf*C*I*A

where

Q = Peak flow (cubic feet per second)

Cf = A runoff coefficient adjustment factor to account for reduction of infiltration and other losses during high intensity storms.

C = A runoff coefficient determined by ground cover. The engineer must document the methodology used in determining the value proposed.

I = Rainfall intensity in inches per hour for the storm duration. For the Rational Method, the basin time of concentration, T_c, is used as the storm duration. Intensities for given durations are shown in Figures 4-2 through 4-4 below. The time of concentration must first be calculated (see Section 4.3.5: Time of Concentration).

A = The basin area in acres.

Equation I-1. Rational Method

I.1 Runoff Coefficient "C"

The runoff coefficient can be difficult to estimate because it represents the interaction of many complex factors including surface ponding, infiltration, antecedent moisture, ground cover conditions, ground slopes, and soil type.

Table I-1 represents typical average values for different land uses and topography. The actual runoff coefficient for a given drainage basin can best be approximated by calculating a weighted average of all distinct surface types as follows:

$$Caf = (\Sigma Cx * Ax)/Atotal$$

where: Caf = the weighted average C-value for the drainage basin

Cx = individual C-values for distinct surface types within a subbasin

Ax = individual areas for distinct surface types within a subbasin

A total = total area of the drainage basin

Equation I-2. Runoff Coefficient "C"

Table I-1. Rational Method Runoff Coefficient "C"			
Land Use	Ground Slope, percent		
	0 to 2	2 to 10	Over 10
Developed Surface Types			
Impervious Surfaces (pavement and roofs)	0.9	0.9	0.9
Gravel surfacing (parking lots, storage areas, roads)	0.85	0.85	0.85
Pervious hardscapes (e.g., pervious pavement)	0.5	0.55	0.6
Landscape Areas (except lawns)	0.3	0.35	0.4
Lawns	0.17	0.22	0.35
Undeveloped Surface Types			
Meadow, pasture, or farm	0.25	0.3	0.25
Mixed	0.15	0.2	0.25
Woodland and Forest	0.1	0.15	0.2
Development Types			
Commercial Development	0.8	0.85	0.9
Industrial Development, Heavy	0.7	0.8	0.9
Dense Residential (over 6 units/acre)	0.7	0.75	0.8
Industrial Development, Light	0.6	0.7	0.8
Normal Residential (3 to 6 units/acre)	0.5	0.55	0.6
Light Residential (1 to 3 units/acre)	0.35	0.4	0.45
Parks	0.15	0.2	0.25

Runoff Coefficient Adjustment Factor

The coefficients in Table I-1 above are applicable for 10 years or less recurrence interval storms. Less frequent, higher intensity storms require adjusted runoff coefficients because infiltration and other losses have a proportionally smaller effect on runoff. Runoff coefficient adjustment factors (CF) for storms of different recurrence intervals are listed in Table I-2.

Table I-2. Runoff Coefficient Adjustment Factor	
Recurrence Interval	Runoff Adjustment Factor (C_F)
10 years or less[1]	1.0
25 years	1.1
50 years	1.2
100 years	1.25

1. *Includes the Water Quality Design Storm*

Rainfall Intensity "I"

The peak intensity shall be derived from ODOT's rainfall intensity-duration-recurrence (IDR) curves for a given zone. Rainfall zones for Marion County are shown in Figure I-1. The IDR curves for Zones 5, 7, and 8 are shown in Figure I-2 through Figure I-4 below. The design storm duration is typically based on the longest time of concentration for the drainage area.

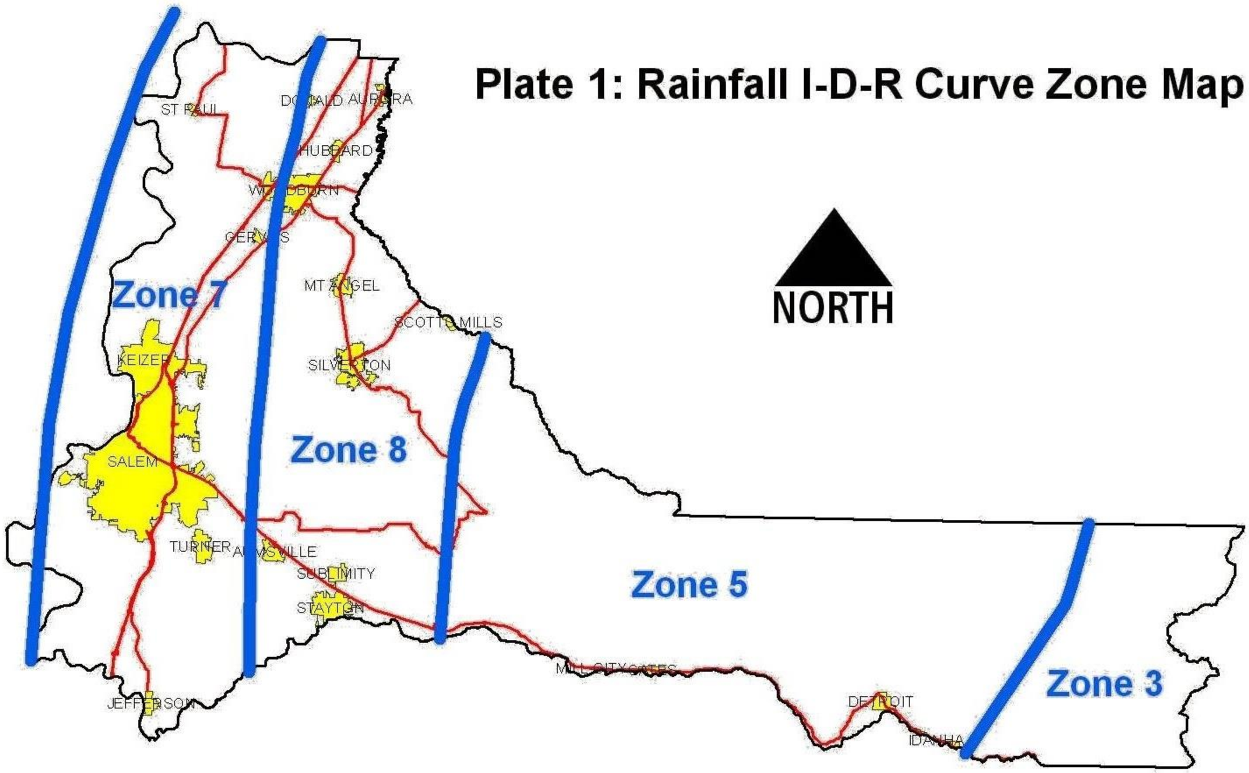

Figure I-1. Rainfall Zone Map for Marion County

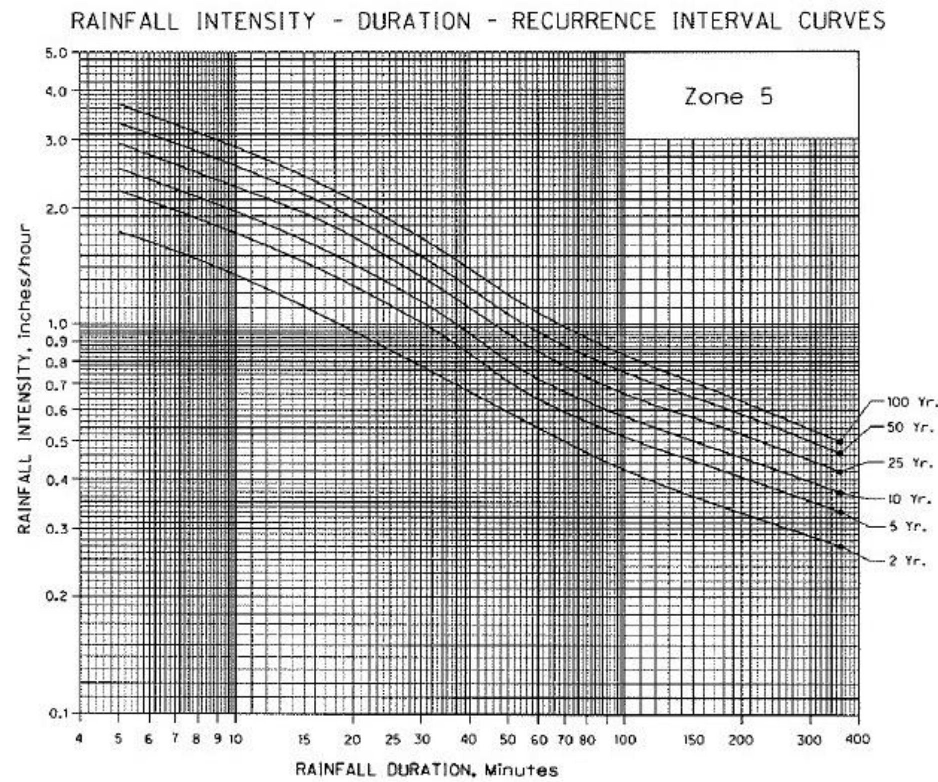

Figure I-2. Rainfall Intensity–Duration–Recurrence Curve for Zone 5

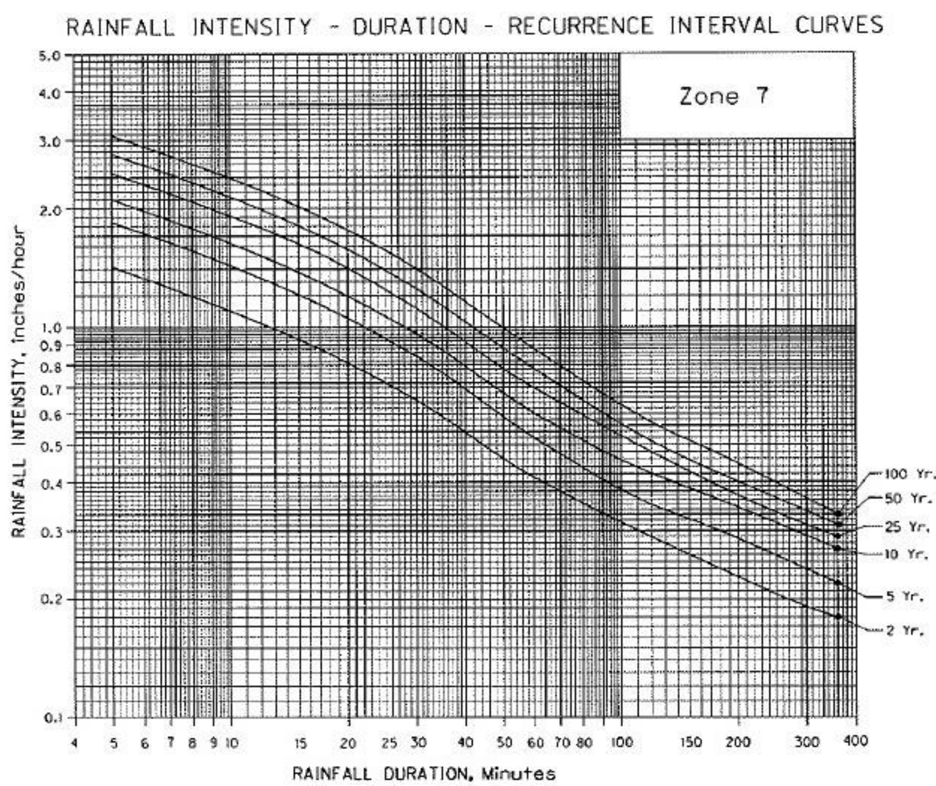

Figure I-3. Rainfall Intensity–Duration–Recurrence Curve for Zone 7

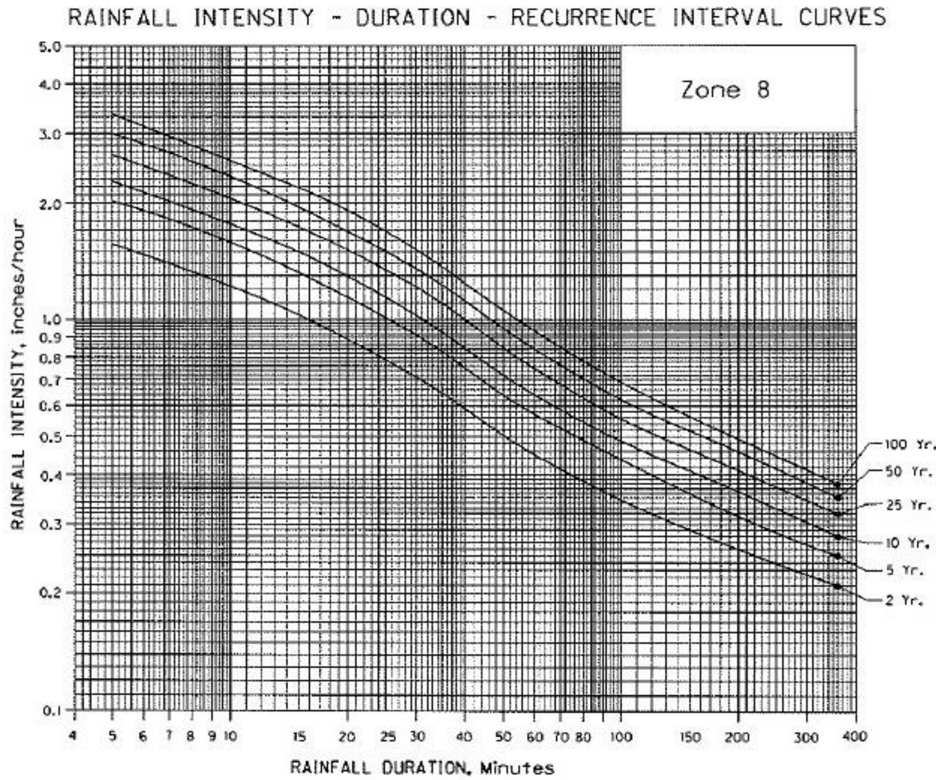

Figure I-4. Rainfall Intensity–Duration–Recurrence Curve for Zone 8