STORMWATER MANAGEMENT FACILITY OPERATION AND MAINTENANCE (O&M) MANUAL

For:

Forest Lakes Metropolitan District (FLMD)
Water Intake and Treatment Plant Project

Located at:

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Monument , CO 80132

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FOREST LAKES METROPOLITAN DISTRICT – WATER INTAKE AND TREATMENT PLANT

1.0 INTRODUCTION

This Stormwater Management Facility Operation and Maintenance (O&M) Manual has been developed for the Forest Lakes Metropolitan District (FLMD) water intake and treatment plant. The contents of this O&M Manual were taken directly from the O&M templates provided by the City of Colorado Springs and the Southeast Metro Stormwater Authority (SEMSWA). Adjustments have been made to the information provided where appropriate to tailor the manual to the stormwater management facility at the FLMD water intake and treatment plant.

2.0 COMPLIANCE WITH STORMWATER FACILITY MAINTENANCE REQUIREMENTS

All property owners are responsible for ensuring that stormwater facilities installed on their property are properly maintained and that they function as designed. In some cases, this maintenance responsibility may be assigned to others through special agreements. The maintenance responsibility for a stormwater facility may be designated on the subdivision plat, the site development plan, and/or within a maintenance agreement for the property. Property owners should be aware of their responsibilities regarding stormwater facility maintenance. Maintenance agreement(s) associated with this property are provided in Appendix D.

3.0 INSPECTION & MAINTENANCE – FREQUENCY AND DOCUMENTATION

Requirements for the inspection and maintenance of stormwater facilities, as well as reporting requirements are included in this Stormwater Management Facility Operation and Maintenance Manual. Inspection frequency details for the best management practices for this site development can be found in the Standard Operations Procedures and Maintenance (SOP) Document provided in Appendix A.

Verification that the stormwater best management practices (BMPs) have been properly inspected and maintained and submittal of the Inspection and Maintenance Forms (provided in Appendix B) shall be provided to the El Paso County upon request.

Copies of the Inspection and Maintenance Forms for each of the stormwater BMPs are located in Appendix B. Each form shall be reviewed and filed by the property owner or property manager and made available to El Paso County upon request.

4.0 PREVENTATIVE MEASURES TO REDUCE MAINTENANCE COSTS

The most effective way to maintain your Stormwater Management facility is to prevent the pollutants from entering the facility in the first place. Common pollutants include sediment,

trash & debris, chemicals, dog wastes, runoff from stored materials, illicit discharges into the storm drainage system and many others. A thoughtful maintenance program will include measures to address these potential contaminants, and will save money and time in the long run. Key points to consider in your maintenance program include:

- Educate property owners/residents to be aware of how their actions affect water quality, and how they can help reduce maintenance costs.
- Keep properties, streets and gutters, and parking lots free of trash, debris, and lawn clippings.
- Ensure the proper disposal of hazardous wastes and chemicals.
- Plan lawn care to minimize the use of chemicals and pesticides.
- Sweep paved surfaces and put the sweepings back on the lawn.
- Be aware of automobiles leaking fluids. Use absorbents such as cat litter to soak up drippings – dispose of properly.
- Re-vegetate disturbed and bare areas to maintain vegetative stabilization.
- Clean out the upstream components of the storm drainage system, including inlets, storm sewers and outfalls.
- Do not store materials outdoors (including landscaping materials) unless properly protected from runoff.

5.0 ACCESS AND EASEMENTS

All stormwater management facilities located on the site have both a designated access location as well as a maintenance easement. Refer to the Construction Drawings located in Appendix C for access and easement locations.

6.0 SAFETY

Keep safety considerations at the forefront of inspection procedures at all times. Likely hazards should be anticipated and avoided. Never enter a confined space (outlet structure, manhole, etc) without proper training or equipment. A confined space should never be entered without at least one additional person present.

If a toxic or flammable substance is discovered, leave the immediate area and contact the local Sheriff at 911.

Potentially dangerous (e.g., fuel, chemicals, hazardous materials) substances found in the areas must be referred to the local Sheriff's Office immediately for response by the Hazardous Materials Unit. The emergency contact number is 911.

Vertical drops may be encountered in areas located within and around the facility. Avoid walking on top of retaining walls or other structures that have a significant vertical drop. If a vertical drop is identified within the facility that is greater than 48" in height, make the appropriate note/comment on the maintenance inspection form.

If any hazard is found within the facility area that poses an immediate threat to public safety, contact the local Sheriff's Office immediately.

7.0 FIELD INSPECTION EQUIPMENT

It is imperative that the appropriate equipment is taken to the field with the inspector(s). This is to ensure the safety of the inspector and allow the inspections to be performed as efficiently as possible. Below is a list of the equipment that may be necessary to perform the inspections of all Stormwater Management Facilities:

- Protective clothing and boots.
- Safety equipment (vest, hard hat, confined space entry equipment).
- Communication equipment.
- Operation and Maintenance Manual for the site including stormwater management facility location maps.
- Clipboard.
- Stormwater Facility Maintenance Inspection Forms (see Appendix B).
- Manhole Lid Remover.
- Shovel.

Some of the items identified above need not be carried by the inspector (manhole lid remover, shovel, and confined space entry equipment). However, this equipment should be available in the vehicle driven to the site.

8.0 INSPECTING STORMWATER MANAGEMENT FACILITIES

The quality of stormwater entering the waters of the state relies heavily on the proper operation and maintenance of permanent best management practices. Stormwater management facilities must be periodically inspected to ensure that they function as designed. The inspection will determine the appropriate maintenance that is required for the facility.

8.1 Inspection Procedures

All stormwater management facilities are required to be inspected by a qualified individual at a minimum of once per year. Inspections should follow the inspection guidance found in the Standard Operations Procedures and Maintenance Document for the specific type of facility. (Appendix A of this manual).

8.2 Inspection Report

The person(s) conducting the inspection activities shall complete the appropriate inspection report for the specific facility. Inspection forms are located in Appendix B.

The following information explains how to fill out the Inspection Forms:

8.2.1 General Information

This section identifies the facility location, person conducting the inspection, the date and time the facility was inspected, and approximate days since the last rainfall. Property classification is identified as single-family residential, multi-family residential, commercial, or other.

The reason for the inspection is also identified on the form depending on the nature of the inspection. All facilities should be inspected on an annual basis at a minimum. In addition, all facilities should be inspected after a significant precipitation event to ensure the facility is draining appropriately and to identify any damage that occurred as a result of the increased runoff.

8.2.2 Inspection Scoring

For each inspection item, a score must be given to identify the urgency of required maintenance. The scoring is as follows:

Table 1. Facility Maintenance Inspection Scoring

Score	Description
0	No deficiencies identified.
1	**Monitor –** Although maintenance may not be required at this time, a potential problem exists that will most likely need to be addressed in the future. This can include items like minor erosion, concrete cracks/spalling, or minor sediment accumulation. This item should be revisited at the next inspection.
2	**Routine Maintenance Required –** Some inspection items can be addressed through the routine maintenance program (see SOP in Appendix A). This can include items like vegetation management or debris/trash removal.
3	**Immediate Repair Necessary –** This item needs immediate attention because failure is imminent or has already occurred. This could include items such as structural failure of a feature (outlet works, forebay, etc), significant erosion, or significant sediment accumulation. This score should be given to an item that can significantly affect the function of the facility.
N/A	**N/A –** This is checked by an item that may not exist in a facility. Not all facilities have all of the features identified on the form (forebay, micro-pool, etc.).

8.2.3 Inspection Summary/Additional Comments

Additional explanations to inspection items, and observations about the facility not covered by the form, are recorded in this section.

8.2.4 Overall Facility Rating

An overall rating must be given for each facility inspected. The overall facility rating should correspond with the highest score (0, 1, 2, 3) given to any feature on the inspection form.

8.3 Verification of Inspection and Form Submittal

The Stormwater Management Facility Inspection Form provides a record of inspection of the facility. Inspection Forms for each facility type are provided in Appendix B. Verification of the inspection of the stormwater facilities, the facility inspection form(s), and Inspector Qualifications shall be recorded on an annual basis. The verification and the inspection form(s) shall be reviewed and filed by the property owner or property manager.

9.0 MAINTAINING STORMWATER MANAGEMENT FACILITIES

Stormwater management facilities must be properly maintained to ensure that they operate correctly and provide the water quality treatment for which they were designed. Routine maintenance performed on a frequently scheduled basis, can help avoid more costly rehabilitative maintenance that results when facilities are not adequately maintained.

9.1 Maintenance Categories

Stormwater management facility maintenance programs are separated into three broad categories of work. These categories are based largely on the Urban Drainage and Flood Control District's Maintenance Program for regional drainage facilities. The categories are separated based upon the magnitude and type of the maintenance activities performed. A description of each category follows:

9.1.1 Routine Work

The majority of this work consists of scheduled mowing and trash and debris pickups for stormwater management facilities during the growing season. This includes items such as the removal of debris/material that may be clogging the outlet structure well screens and trash racks. It also includes activities such as weed control, mosquito treatment, and algae treatment. These activities normally will be performed numerous times during the year. These items can be completed without any prior correspondence with El Paso County; however, completed inspection and maintenance forms shall be made available to El Paso County upon request.

9.1.2 Restoration Work

This work consists of a variety of isolated or small-scale maintenance and work needed to address operational problems. Most of this work can be completed by a small crew, with minor tools, and small equipment. This type of work does not require approval or review by El Paso County.

9.1.3 Rehabilitation Work

This work consists of large-scale maintenance and major improvements needed to address failures within the stormwater management facilities. This work generally requires consultation with a licensed professional engineer and may require an engineering design with construction

plans to be prepared for review and approval. This work may also require more specialized maintenance equipment, surveying, construction permits or assistance through private contractors and consultants. These items may require prior correspondence with a licensed professional engineer.

9.2 Maintenance Personnel

Maintenance personnel must be qualified to properly maintain stormwater management facilities. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

9.3 Maintenance Forms

The Stormwater Management Facility Maintenance Form provides a record of maintenance activities. Maintenance Forms for each facility type are provided in Appendix B. Maintenance Forms shall be completed by the contractor completing the required maintenance items. The form shall then be reviewed by the property owner or an authorized agent of the property owner and filed. Forms shall be made available to El Paso County upon request.

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Appendix A

– APPENDIX A –
STANDARD OPERATION PROCEDURES FOR INSPECTION AND MAINTENANCE FOR BIORETENTION (RAIN GARDEN, POROUS LANDSCAPE DETENTION) AND FULL SPECTRUM DETENTION (FSD) OUTLET WORKS

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STANDARD OPERATION PROCEDURES FOR INSPECTION AND MAINTENANCE – BIORETENTION (RAIN GARDEN, POROUS LANDSCAPE DETENTION) AND FULL SPECTRUM DETENTION (FSD) OUTLET WORKS

1.0 BACKGROUND INFORMATION

Bioretention (also known as a rain garden or porous landscape detention) is a common type of Stormwater Best Management Practice (BMP) utilized within the Front Range of Colorado. Bioretention facilities consist of a low-lying vegetated area underlain by a sand and peat bed with an underdrain pipe. A shallow surcharge zone exists above the bioretention for temporary storage of the Water Quality Capture Volume (WQCV). During a storm, accumulated runoff ponds in the vegetated zone and gradually infiltrates into the underlying sand and peat bed, filling the void spaces of the sand. The underdrain gradually dewaters the sand and peat bed and discharges the runoff to a nearby channel, swale, or storm sewer. The bioretention provides an opportunity for filtering, adsorption, and biological uptake of constituents in stormwater. The popularity of bioretention areas has increased because they allow the WQCV to be provided on a site that has little open area available for stormwater management.

The Bioretention facility at this site also includes a Full Spectrum Detention (FSD) outlet structure. In addition to the water quality treatment provided by the Bioretention system, this FSD outlet structure has been designed to attenuate flow from storm events which generate runoff volumes greater than the WQCV. This structure has been designed to release runoff from storm events between the 5-year and 100-year storm return frequencies at specific discharge rates to mitigate the adverse impacts of increased flood flows to downstream receiving waters as a result of development.

1.1 General Site Description

The Forest Lakes Metropolitan District (FLMD) Water Intake and Treatment Plant is located at 2621 Forest Lakes Drive, Monument, CO 80132, at the southwest corner of the intersection of Forest Lakes Drive and Long Valley Drive. The water treatment plant is owned and operated by the FLMD.

The 3.5-acre site water treatment plant property consists of a 6,600 sq. ft. surface water treatment plant building and a 675 sq. ft. groundwater well treatment building, each of which houses various water treatment systems designed to provide the FLMD with a drinking water supply. The tributary drainage area to the bioretention and FSD facility is approximately 1.04 acres and is approximately 40% impervious.

1.2 General Stormwater Management Description

All stormwater water from the 1.04 acres of tributary area to the bioretention and FSD facility is conveyed via roof downspouts and/or surface runoff to a 10 foot wide and 1 foot deep riprap lined

swale which directs all stormwater into the facility designed to provide water quality treatment and flood control during the 100-year event. For storm events less than or equal to the 100-year event, water is directed into an outlet structure and discharged into an existing storm drainage system which eventually discharges into Pinion Lake located southeast of the facility. In the event of a storm event greater than the 100-year event, water overtops the facility, and is surface discharged onto Long Valley Drive via an emergency spillway. Long Valley Drive eventually discharges into Pinion Lake.

1.3 Stormwater Facilities Plan

Inspection or maintenance personnel may utilize the documents in ***Appendix C*** for locating the stormwater facilities associate with this site.

1.4 Onsite Stormwater Management Facilities

1.4.1 Volume Reduction Facilities

The site utilized Level 1 Minimizing Directly Connected Impervious Area (MDCIA) which attempts to route all surface water over grass or pervious surfaces. There is no curb and gutter located along the site driveway which allows all internal site and building roof area to surface drain to the 10 foot wide and 1 foot deep riprap lined channel. This channel directs all site runoff into the bioretention and FSD facility area.

1.4.2 Storage Facilities

There is one onsite bioretention combined with an FSD outlet structure storage facility for the water treatment plant located southwest of the site entrance off of Long Valley Drive.

1.4.3 Water Quality Facilities

There is one onsite bioretention combined with an FSD outlet structure used for providing the water quality capture volume for the water treatment plant site located southwest of the site entrance off of Long Valley Drive.

1.4.4 Source Control Best Management Practices

There are no non-structural BMPs associated with the water treatment plant site.

2.0 INSPECTING BIORETENTION AND FSD OUTLET WORKS

2.1 Access and Easements

Inspection or maintenance personnel may utilize the Construction Drawings located in ***Appendix C*** containing the locations of the access points and maintenance easements of the bioretention and FSD area within this site.

2.2 Stormwater Best Management Practice Locations

Inspection or maintenance personnel may utilize the figures located in ***Appendix C*** containing the locations of the access points and maintenance easements of the bioretention area and FSD outlet structure within this site.

2.3 Bioretention and FSD Facility Features

Bioretention and FSD facilities have a number of features that are designed to serve a particular function. Many times the proper function of one feature depends on another. It is important for maintenance personnel to understand the function of each of these features to prevent damage to any feature during maintenance operations. Below is a list and description of the most common features within a bioretention and the corresponding maintenance inspection items that can be anticipated:

Table 1. Typical Bioretention and FSD Inspection & Maintenance Requirements Matrix

Maintenance Location	Maintenance Activity						
	Sediment Removal	Mowing / Weed Control	Trash / Debris Removal	Erosion	Overgrown Vegetation Removal	Removal / Replacement	Structure Repair
Inflow Points	X		X	X			X
Landscaping	X	X	X	X	X		
Filter Media	X	X	X	X	X	X	
Underdrain System						X	
FSD Outlet Works	X		X				X
Emergency Overflow	X		X				X
Embankment		X	X	X	X		

2.3.1 Inflow Points

Inflow points or outfalls into the bioretention and FSD facility are the point of stormwater discharge into the facility. The primary inflow point into the facility is via the 10 foot wide and 1 foot deep riprap lined channel and associated riprap rundown into an impact basin. The impact basin is intended to protect the facility from erosion. A small amount of localized surface runoff will also enter the facility via sheet flow around the perimeter of the facility.

The typical maintenance items that are required at inflow points are as follows:

2.3.1.1 Riprap Displaced

Many times, because of the repeated impact/force of water, the riprap can shift and settle. If any portion of the riprap rundown or apron appears to have settled, soil is present between the riprap, or the riprap has shifted, maintenance may be required to ensure future erosion is prevented.

2.3.1.2 Erosion Present / Outfall Undercut

In some situations, the energy dissipater may not have been constructed, or maintained appropriately and erosion has occurred. Any erosion within the vicinity of the inflow point will require maintenance to prevent damage to the structure and sediment transport within the facility. It is imperative that material utilized to correct erosion problems within the filter media meets the requirements for filter media as shown on the approved construction drawings (see ***Appendix C***).

2.3.1.3 Sediment Accumulation

Because of the turbulence in the water created by the energy dissipater, sediment often deposits immediately downstream of the inflow point. To prevent a loss in performance of the infrastructure, sediment that accumulates in this area must be removed on a timely basis.

2.3.1.4 Structural Damage

Structural damage can occur at any time during the life of the facility. For this bioretention and FSD facility structural damage at the inlet may occur to the riprap rundown. Structural damage can lead to additional operating problems with the facility, including loss of hydraulic performance. Structural repairs to the inlet should be made as soon as possible upon their discovery.

2.3.2 Landscaping

The landscaped area consists of specific plant materials and associated landscaping mulch in the bottom of the bioretention facility. These plantings provide several functions for the bioretention. Planting not only provides an aesthetic value for the bioretention, but in many cases assists with biological uptake or removal of pollutants.

The plants are carefully selected for use in the bioretention. Plants utilized in bioretention areas must be able to grow in dry sandy soils but also be able to withstand frequent inundation by stormwater runoff. These plants also must be able to withstand a variety of pollutants commonly found in stormwater runoff. In addition, plants utilized in bioretention systems cannot have a deep extensive root system that may cause maintenance difficulty or damage to the facility. Table 2 provides a summary of the recommend seed mix for use in the bioretention area.

The typical maintenance activities that are required within the landscape areas are as follows:

2.3.2.1 Woody Growth/Weeds Present

Undesirable vegetation can grow in and around the landscaped area in the bioretention that can significantly affect the performance of the facility. This type of vegetation includes dense areas of shrubs (willows) and noxious weeds. If undesired vegetation is not routinely mowed/removed, the growth can cause debris/sediment to accumulate, resulting in blockage of the filter media. Also, shrub and weed roots can cause damage to the filter media and underdrain system. Routine management is essential to prevent more extensive and costly future maintenance.

2.3.2.2 General Landscape Care

The landscape elements of the bioretention are the same as any other landscape area and need to be provided with regular care. Landscape mulch will need to be removed and replaced to ensure the aesthetics of the bioretention.

Table 2. Native Seed Mix for Bioretention

Common Name	Scientific Name	Variety	PLS lbs per Acre	Ounces per Acre
Sand bluestem	*Andropogon hallii*	Garden	3.5	
Sideoats grama	*Bouteloua curtipendula*	Butte	3	
Prairie sandreed	*Calamovilfa longifolia*	Goshen	3	
Indian ricegrass	*Oryzopsis hymenoides*	Paloma	3	
Switchgrass	*Panicum virgatum*	Blackwell	4	
Western wheatgrass	*Pascopyrum smithii*	Ariba	3	
Little bluestem	*Schizachyrium scoparium*	Patura	3	
Alkali sacaton	*Sporobolus airoides*		3	
Sand dropseed	*Sporobolus cryptandrus*		3	
Pasture sage	*Artemisia frigida*			2
Blue aster	*Aster laevis*			4
Blanket flower	*Gaillardia aristata*			8
Prairie coneflower	*Ratibida columnifera*			4
Purple prairieclover	*Dalea (Petalostemum) purpurea*			4
		Sub-Totals:	27.5	22
		Total lbs per acre:	28.9	

2.3.3 Filter Media

The filter media is the main pollutant removal component of the bioretention. The filter media consists of 18-inches of a mixture of washed sand and peat. The filter media removes pollutants through several different processes, including sedimentation, filtration, absorption, infiltration and microbial uptake.

Sedimentation is accomplished by the slow release of stormwater runoff through the filter media. This slow release allows sediment particles to be deposited on the top layer of the filter media where they are easily removed through routine maintenance. Other pollutants are also removed through this process because many pollutants utilize sediment as a transport mechanism.

Filtration is the main pollutant removal mechanism of bioretention facilities. When the stormwater runoff migrates down through the filter media, many of the particulate pollutants are physically strained out as they pass through the filter bed of sand and are trapped on the surface or among the pores of the filter media.

Absorption results from the peat utilized in the filter media. Organic materials have a natural ability to attach to soluble nutrients, metals and organic pollutants. This attachment then prevents these pollutants from leaving the bioretention.

Bioretention facilities that are not lined with an impervious liner allow for infiltration into the native soils. This process also allows for additional pollutant removal.

Microbes that naturally occur in the filter media can assist with pollutant removal by breaking down organic pollutants.

The typical maintenance activities that are required within the filter media areas are as follows:

2.3.3.1 Infiltration Rate Check

The infiltration rate of the bioretention needs to be checked in order to ensure proper functioning of the filter media. Generally, a bioretention should drain completely within 12-hours of a storm event. If drain times exceed the 12-hour drain time then maintenance of the filter media shall be required.

2.3.3.2 Sediment Removal

Although bioretention facilities should not be utilized in areas where large concentrations of sediment may enter the bioretention, it is inevitable that some sediment will enter the bioretention. Excess sediment should be removed when it begins to impede the infiltration rate of the bioretention facility.

2.3.3.3 Filter Replacement

The top layers of the filter media are the most susceptible to pollutant loading and therefore may need to be removed and disposed of properly on a semi-regular basis when infiltration rates slow. If removal of accumulated sediment does not return the infiltration rate to a 12-hour drain time, then the top layer of the filter media will need to be removed and replaced. The filter media specification is provided on the design drawings in ***Appendix C***.

2.3.4 Underdrain System

The underdrain system consists of an underdrain aggregate area and perforated PVC pipes. There is also geotextile fabric below the aggregate to prevent the native soil from entering the underdrain system. The underdrain aggregate area allows for storage of treated stormwater runoff prior to the discharge of the runoff through the perforated PVC pipe.

The typical maintenance activities that are for the underdrain system are as follows:

2.3.4.1 Cleaning

With proper maintenance of the landscape areas and filter media, there should be a minimum amount of maintenance required on the underdrain system. Generally the only maintenance performed on the underdrain system is Jet-Vac cleaning. Cleanout locations for the underdrain systems are located on the Construction Drawings in ***Appendix C***.

2.3.5 FSD Outlet Works and Overflow

Generally, the initial runoff (or WQCV) during the storm event contains the majority of the pollutants. Bioretention facilities are designed to treat only the WQCV and any amount over the WQCV flows through the FSD outlet at a prescribed rate. The concrete structure has steel orifice plates anchored/embedded into it to control stormwater release rates. The larger openings (flood control) on the outlet structure has a trash track to prevent clogging. The FSD orifice plate (smaller diameter holes) has a well screen covering it to prevent smaller materials from clogging it. The outlet structure is the single most important feature in the FSD operation. Proper inspection and maintenance of the outlet works is essential in ensuring the long-term operation of the FSD facility.

The most typical maintenance items that are found with the FSD outlet works are as follows:

2.3.5.1 Trash Rack / Well Screen Clogged

Trash and debris can accumulate in the upper area after large events, or from illegal dumping. Over time, this material can clog the outlet works. Floatable material that enters the facility will most likely make its way to the outlet structure. This material is trapped against the trash racks and well screens on the outlet structure (which is why they are there). This material must be removed on a routine basis to ensure the outlet structure drains in the specified design period.

2.3.5.2 Structural Damage

The outlet structure is primarily constructed of concrete, which can crack, spall, and settle. The steel grate on the outlet structure overflow is also susceptible to damage.

2.3.5.3 Orifice Plate Missing / Not Secure

Many times residents, property owners, or maintenance personnel will remove or loosen orifice plates if they believe the pond is not draining properly. Any modification to the orifice plate(s) will significantly affect the designed discharge rates for water quality and/or flood control. Modification of the orifice plates is not allowed without approval from a Professional Engineer.

2.3.5.4 Woody Growth/Weeds Present

The presence of plant material not part of the original landscaping, such as wetland plants or other woody growth, can clog the overflow outlet works during a larger storm event, causing flooding to adjacent areas. This plant material may indicate a clogging of the filter media and may require additional investigation.

2.3.6 Emergency Overflow

An emergency spillway is typical of all stormwater detention facilities and designed to serve as the overflow in the event the volume of the facility is exceeded. The emergency spillway is armored with riprap (or other hard armor). The emergency spillway is a weir (notch) in the bioretention and FSD facility embankment. Proper function of the emergency spillway is essential to ensure flooding does not affect adjacent properties.

The most typical maintenance items that are found with the emergency overflow are as follows:

2.3.6.1 Riprap Displaced

As mentioned before, the emergency spillway is armored with riprap to provide erosion protection. Over the life of the facility, the riprap may shift or dislodge due to flow.

2.3.6.2 Erosion Present

Although the spillway is typically armored, stormwater flowing through the spillway can cause erosion damage. Erosion must be repaired to ensure the integrity of the facility embankment, and proper function of the spillway.

2.3.6.3 Woody Growth/Weeds Present

Management of woody vegetation is essential in the proper long-term function of the spillway. Larger trees or dense shrubs can capture larger debris entering the facility and reduce the capacity of the spillway.

2.3.6.4 Obstruction Debris

The spillway must be cleared of any obstruction (man-made or natural) to ensure the proper design capacity.

2.3.7 Embankments

The bioretention facility utilizes an embankment to store the WQCV. Regular inspections should be made for rill and surface erosion, and sparse vegetation on the embankment slopes.

The typical maintenance activities that are required with the embankments areas are as follows:

2.3.7.1 Sparse Vegetation

The embankments are one of the most visible parts of the bioretention, and therefore aesthetics is important. Adequate and properly maintained vegetation can greatly increase the overall appearance of the bioretention. Vegetation can reduce the potential for erosion and subsequent sediment transport to the filter media, thereby reducing the need for more costly maintenance.

2.3.7.2 Erosion

Inadequate vegetative cover may result in erosion of the embankments. Erosion that occurs on the embankments can cause clogging of the filter media and destabilize the integrity of the facility.

2.3.8 Miscellaneous

There are a variety of inspection/maintenance issues that may not be attributed to a single feature within the bioretention facility. This category on the inspection form is for maintenance items that are commonly found in the bioretention, but may not be attributed to an individual feature.

Typical miscellaneous maintenance activities that are required in bioretention and FSD facilities are as follows:

2.3.8.1 Access Maintenance

Access needs to be maintained so that regular inspections and maintenance activities can be performed.

2.3.8.2 Graffiti / Vandalism

Vandals can cause damage to the bioretention infrastructure. If criminal mischief is evident, the inspector should forward this information to the local emergency agency.

2.3.8.3 Public Hazards

Public hazards include items such as containers of unknown/suspicious substances, and exposed metal/jagged concrete on structures. If any hazard is found within the facility area that poses an immediate threat to public safety, contact the local emergency services at 911 immediately.

2.3.8.4 Other

Any miscellaneous inspection/maintenance items not contained on the form should be entered here.

2.4 Inspection Forms

Bioretention with an FSD outlet structure Inspection forms are located in ***Appendix B***. Inspection forms shall be completed by the person(s) conducting the inspection activities. Each form shall be reviewed and filed by the property owner or property manager per the requirements of the Inspection and Maintenance Plan. These inspection forms shall be kept a minimum of 5 years and made available to El Paso County upon request.

3.0 MAINTAINING BIORETENTION FACILITY AND FSD OUTLET WORKS

3.1 Maintenance Personnel

Maintenance personnel should be experienced to properly maintain bioretention and FSD facilities. Inadequately trained personnel can cause additional problems resulting in additional maintenance costs.

3.2 Equipment

It is imperative that the appropriate equipment and tools are taken to the field with the operations crew. The types of equipment/tools will vary depending on the task at hand. Below is a list of tools, equipment, and material(s) that may be necessary to perform maintenance on a bioretention and FSD facility:

1. Mowing Tractors
2. Trimmers (extra string)
3. Shovels
4. Rakes
5. All Surface Vehicle (ASVs)
6. Skid Steer

7. Back Hoe
8. Track Hoe/Long Reach Excavator
9. Dump or pickup truck (depending on volume of material needed to be hauled)
10. Jet-Vac Machine
11. Engineers Level (laser)
12. Riprap (Minimum - Type M)
13. Geotextile Fabric (see Construction Drawings in ***Appendix C*** for specifications)
14. Erosion Control Blanket(s)
15. Sod
16. Illicit Discharge Cleanup Kits
17. Trash Bags
18. Tools (wrenches, screw drivers, hammers, etc)
19. Confined Space Entry Equipment
20. Approved Inspection and Maintenance Plan
21. Underdrain aggregate (see Construction Drawings in ***Appendix C*** for specifications)
22. Bioretention Filter Media (see Construction Drawings in ***Appendix C*** for specifications)
23. Wood Landscaping Mulch (see Construction Drawings in ***Appendix C*** for specifications)

Some of the items identified above may not be needed for every maintenance operation. However, this equipment should be available to the maintenance operations crews should the need arise.

3.3 Safety

Vertical drops may be encountered in areas located within and around the facility. Avoid walking on top of retaining walls or other structures that have a significant vertical drop. If a vertical drop is identified within the facility that is greater than 48" in height, make the appropriate note/comment on the maintenance inspection form.

3.4 Bioretention Maintenance Forms

The bioretention and FSD Maintenance Form provides a record of each maintenance operation performed by maintenance contractors. The Maintenance Form shall be filled out in the field after the completion of the maintenance operation. Each form shall be reviewed and filed by the property owner or property manager. The bioretention and FSD outlet works Maintenance Form is located in ***Appendix B***.

3.5 Bioretention Maintenance Categories and Activities

A typical bioretention and FSD Maintenance Program will consist of three broad categories of work: Routine, Restoration (minor), and Rehabilitation (major). Within each category of work, a variety of maintenance activities can be performed on the facility. A maintenance activity can be specific to each feature within the bioretention, the FSD outlet works, or general to the overall facility. This section of the Standard Operations Procedures explains each of the categories and

briefly describes the typical maintenance activities for a bioretention facility with and FSD outlet structure.

A variety of maintenance activities is typical of bioretention and FSD facilities. The maintenance activities range in magnitude from routine trash pickup to the reconstruction of the bioretention filter media, underdrain system, or FSD outlet structure. Below is a description of each maintenance activity, the objectives, and frequency of actions:

3.6 Routine Maintenance Activities

The majority of this work consists of scheduled mowing, trash and debris pickups and landscape care for the bioretention during the growing season. It also includes activities such as weed control. For the FSD outlet structure, this includes items such as the removal of debris/material that may be clogging the outlet structure well screens and trash racks. These activities normally will be performed numerous times during the year. These items do not require any prior approval by El Paso County, however, completed inspection and maintenance forms shall be filed for each inspection and maintenance activity.

The Routine Maintenance Activities are summarized below, and further described in the following sections.

Table 3. Summary of Routine Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Mowing	Twice Annually	Excessive grass height / aesthetics	Mow or trim to 2" – 4" grass height
Trash / Debris Removal	Twice Annually	Trash & debris in bioretention	Remove and dispose of trash / debris
FSD Outlet Works Cleaning	As needed – after significant rain events – twice annual minimum	Clogged outlet structure; ponding water above outlet elevation	Remove and dispose of debris / trash / sediment to allow outlet to function properly
Weed Control	As needed, based upon inspection	Noxious weeds; unwanted vegetation	Treat w/ herbicide or hand pull; consult a local weed inspector

3.6.1 Mowing

Routine mowing of the turf or native grass embankments is necessary to improve the overall appearance of the bioretention area. Grass should be mowed to a height of 2 to 4 inches and shall be bagged to prevent potential contamination of the filter media.

Maintenance Frequency: Routine – Minimum of twice annually or depending on aesthetics.

3.6.2 Trash / Debris Removal

Trash and debris must be removed from the entire bioretention area to minimize outlet clogging and to improve aesthetics. This activity must be performed prior to mowing operations.

Maintenance Frequency: Routine – Prior to mowing operations and minimum of twice annually.

3.6.3 FSD Outlet Works Cleaning

Debris and other materials can clog the outlet work's well screen, orifice plate(s) and trash rack. This activity must be performed anytime other maintenance activities are conducted to ensure proper operation.

Maintenance Frequency: Routine – After significant rainfall event or concurrently with other maintenance activities.

3.6.4 Weed Control

Noxious weeds and other unwanted vegetation must be treated as needed throughout the bioretention. This activity can be performed either through mechanical means (mowing/pulling) or with herbicide. Consultation with a local Weed Inspector is highly recommended prior to the use of herbicide. Herbicides should be utilized sparingly and as a last resort. All herbicide applications should be in accordance with the manufacturer's recommendations.

Maintenance Frequency: Routine – As needed based on inspections.

3.7 Restoration Maintenance Activities

This work consists of a variety of isolated or small-scale maintenance / operational problems. Most of this work can be completed by a small crew, hand tools, and small equipment. These items do not require approval by El Paso County. Completed inspection and maintenance forms shall be filed by the property owner or property manager. In the event that the bioretention needs to be dewatered, care should be given to ensure sediment, filter material and other pollutants are not discharged. All dewatering activities shall be properly permitted.

Table 4. Summary of Restoration Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Sediment / Pollutant Removal	As needed; based on infiltration test	Sediment buildup; decrease in infiltration rate	Remove and dispose of sediment
Erosion Repair	As needed; based upon visual inspection	Rill / gullies forming on embankments	Repair eroded areas & revegetate; address cause of erosion
Jet Vac / Cleaning Underdrain System	As needed; based upon visual inspection	Sediment buildup / non draining system	Clean drains; Jet-Vac if needed

3.7.1 Sediment / Pollutant Removal

Sediment/Pollutant removal is necessary to ensure proper function of the filter media. The infiltration rate of the bioretention needs to be checked in order to ensure proper functioning of the bioretention facility. Generally, a bioretention should drain completely within 12 hours of a storm event. If drain times exceed the 12-hour drain time then maintenance of the filter media or underdrain system shall be required.

Generally, the top 3 inches of filter media should be removed at each removal period. Additional amounts of filter media may need to be removed if deeper sections of the filter media are contaminated. New filter media will need to replace the removed filter media. It is critical that only the approved filter media shown on the Construction Drawings in ***Appendix C*** be utilized in the replacement of the filter media.

Other types of sand or soil material may lead to clogging of the bioretention. The minor sediment removal activities can typically be addressed with shovels, rakes, and smaller equipment. Major sediment removal activities will require larger and more specialized equipment. Extreme care should be taken when utilizing motorized or heavy equipment to ensure damage to the underdrain system does not occur. The major sediment removal activities will also require surveying with an engineer's level to ensure design volumes/grades are achieved.

Stormwater sediments removed from bioretention areas do not meet the regulatory definition of "hazardous waste." However, these sediments can be contaminated with a wide array of organic and inorganic pollutants and handling must be done with care. Sediments should be transported by motor vehicle only after they are dewatered. All sediments must be taken to a licensed landfill for proper disposal. Should a spill occur during transportation, prompt and thorough cleanup and disposal is imperative.

Maintenance Frequency: Non-routine – As necessary, based upon inspections and infiltration tests. Sediment removal in the impact basin may be necessary as frequently as every 1-2 years.

3.7.2 Erosion Repair

The repair of eroded areas is necessary to ensure the proper functioning of the bioretention facility, to minimize sediment transport, and to reduce potential impacts to other features. Erosion can vary in magnitude from minor repairs to filter media and embankments, to rills and gullies in the embankments and inflow points. The repair of eroded areas may require the use of excavators, earthmoving equipment, riprap, concrete, and sod. Extreme care should be taken when utilizing motorized or heavy equipment to ensure damage to the underdrain system does not occur. Consultation with a licensed Professional Engineer prior to any major erosion repair to the embankments, spillways, and adjacent to structures is recommended.

Maintenance Frequency: Non-routine – As necessary, based upon inspections.

3.7.3 Jet-Vac / Cleaning Undrains and FSD Outlet Structure

A bioretention facility contains an underdrain system that allows treated stormwater runoff to exit the facility. These underdrain systems can develop blockages that can result in a decrease of hydraulic capacity and create standing water. Many times the blockage to this infrastructure can be difficult to access and/or clean. Specialized equipment (jet-vac machines) may be necessary to clear debris from these difficult areas. Location of underdrain cleanouts are show on the Construction Drawings provided in ***Appendix C***.

An FSD outlet works contains many openings, and pipes that can be frequently clogged with debris. These blockages can result in a decrease of hydraulic capacity of the outlet. Many times the blockage to this infrastructure can be difficult to access and/or clean. Specialized equipment (jet-vac machines) may be necessary to clear debris from these difficult areas.

Maintenance Frequency: Non-routine – As necessary, based upon inspections.

3.8 Rehabilitation Maintenance Activities

This work consists of larger maintenance/operational problems and failures within the stormwater management facilities. All of this work requires consultation with a licensed Professional Engineer to ensure the proper maintenance is performed. This work may also require more specialized maintenance equipment, design/details, surveying, or assistance through private contractors and consultants.

Table 5. Summary of Rehabilitation Maintenance Activities

Maintenance Activity	Minimum Frequency	Look for:	Maintenance Action
Major Sediment / Pollutant Removal	As needed; based upon scheduled inspections	Large quantities of sediment; reduced pond capacity	Remove and dispose of sediment. Repair vegetation as needed
Major Erosion Repair	As needed; based upon scheduled inspections	Severe erosion including gullies forming, excessive soil displacement, areas of settlement, holes	Repair erosion – find cause of problem and address to avoid future erosion
Structural Repair	As needed; based upon scheduled inspections	Deterioration and/or damage to structural components – broken concrete, damaged pipes & outlet works	Structural repair to restore the structure to its original design
Bioretention Rebuild	As needed; due to complete failure of bioretention facility	Fouling of filter media and collapse of underdrain system	Contact licensed Professional Engineer

3.8.1 Major Sediment / Pollutant Removal

Major sediment removal consists of removal of large quantities of pollutants/sediment/filter media/landscaping material. Extreme care should be taken when utilizing motorized or heavy equipment to ensure damage to the underdrain system does not occur. This bioretention facility also contains a geotextile liner that can be easily damage if care is not taken when removing the filter media / underdrain aggregate. Stormwater sediments removed from bioretention facilities do not meet the regulatory definition of "hazardous waste." However, these sediments can be contaminated with a wide array of organic and inorganic pollutants and handling must be done with care to ensure proper removal and disposal. Sediments should be transported by motor vehicle only after they are dewatered. All sediments must be taken to a licensed landfill for proper disposal. Should a spill occur during transportation, prompt and thorough cleanup and disposal is imperative. Vegetated areas need special care to ensure design volumes and grades are preserved or may need to be replaced due to the removal activities.

Maintenance Frequency: Non-routine – Repair as needed, based upon inspections.

3.8.2 Major Erosion Repair

Major erosion repair consists of filling and revegetating areas of severe erosion. Determining the cause of the erosion as well as correcting the condition that caused the erosion should also be part of the erosion repair. Care should be given to ensure design grades and volumes are preserved. Extreme care should be taken when utilizing motorized or heavy equipment to ensure damage to the underdrain system does not occur.

Maintenance Frequency: Non-routine – Repair as needed, based upon inspections.

3.8.3 Structural Repair

This bioretention facility includes a FSD concrete outlet and overflow structure that can deteriorate or be damaged during the service life of the facility. These structures are constructed of steel and concrete that can degrade or be damaged and may need to be repaired or re-constructed from time to time. Major repairs to structures may require input from a licensed Professional Engineer and specialized contractors. Consultation with a Professional Engineer shall take place prior to all structural repairs.

Maintenance Frequency: Non-routine – Repair as needed, based upon inspections.

3.8.4 Bioretention Rebuild

In very rare cases, a bioretention facility may need to be rebuilt. Generally, the need for a complete rebuild is a result of improper construction, improper maintenance resulting in structural damage to the underdrain system, or extensive contamination of the bioretention facility. Consultation with licensed Professional Engineer shall take place prior to any rebuild project.

Z:\Project Files\02-03\031-090\031-090.300\Engineering\Site Development Plan - El Paso County\BMP Operations and Maintenance Manual\Appedix A - Standard Operation Procedures Bioretention\Appendix A - FLMD WTP SOP for Inspection and Maintenance - .docx

Appendix B

BIORETENTION FACILITY / FULL SPECTRUM DETENTION OUTLET WORKS INSPECTION FORM

Date:_____

Subdivision/Business Name:_____ Inspector:_____

Subdivision/Business Address:_____ _____

Weather: _____

Date of Last Rainfall:_____ Amount:_____ Inches

Property Classification: Residential Multi Family Commercial Other:_____
(Circle One)

Reason for Inspection: Routine Complaint After Significant Rainfall Event
(Circle One)

INSPECTION SCORING - For each facility inspection item, insert one of the following scores:

0 = No deficiencies identified
1 = Monitor (potential for future problem)
2 = Routine maintenance required
3 =Immediate repair necessary
N/A = Not applicable

FEATURES

1.) Inflow Points
- ____Rip Rap Displaced/Rundown or Pipe Damage
- ____Erosion Present/Outfall Undercut
- ____Sediment Accumulation
- ____Structural Damage

2.) Filter Media
- ____Infiltration Rate Check
- ____Sediment Removal
- ____Filter Replacement

3.) Landscaping
- ____Woody Growth/Weeds Present
- ____General Landscape Care

4.) Underdrain System
- ____Evidence of clogged system (jet-vac cleaning required)

5.) Embankments
- ____Vegetation Sparse
- ____Erosion Present

6.) FSD Outlet Works
- ____Structural Damage
- ____Woody Growth/Weeds Present
- ____Trash/Debris
- ____Trash Rack / Well Screen Clogged
- ____Orifice Plate(s) Missing / Not Secure

6.) Emergency Spillway
- ____Riprap Displaced
- ____Erosion Present
- ____Woody Growth / Weeds Present
- ____Obstructions / Debris

8.) Miscellaneous
- ____Encroachment in Easement Area
- ____Graffiti/Vandalism
- ____Public Hazards
- ____Other

Inspection Summary / Additional Comments:_____

OVERALL FACILITY RATING (Circle One)

0 = No Deficiencies Identified
1 = Monitor (potential for future problem exists)
2 = Routine Maintenance Required
3 = Immediate Repair Necessary

This inspection form shall be kept indefinitely and made available to El Paso County upon request.

BIORETENTION FACILITY / FULL SPECTRUM DETENTION OUTLET WORKS MAINTENANCE FORM

Subdivision/Business Name:_____ Completion Date:_____

Subdivision/Business Address:_____ Contact Name:_____

Maintenance Category: Routine Restoration Rehabilitation
(Circle all that apply)

MAINTENANCE ACTIVITIES PERFORMED

ROUTINE WORK

____ MOWING
____ TRASH/DEBRIS REMOVAL
____ OUTLET WORKS CLEANING (TRASH RACK/WELL SCREEN)
____ WEED CONTROL (HERBICIDE APPLICATION)

RESTORATION WORK

____ **SEDIMENT REMOVAL**
- ____ INFLOW POINT
- ____ OUTLET WORKS
- ____ FILTER MEDIA

____ **EROSION REPAIR**
- ____ INFLOW POINT
- ____ EMBANKMENTS
- ____ OUTLET WORKS

____ **REVEGETATION**
- ____ EMBANKMENTS

____ **JET-VAC/CLEARING DRAINS**
- ____ OUTLET WORKS
- ____ INFLOWS
- ____ UNDERDRAIN SYSTEM

REHABILITATION WORK

____ **SEDIMENT REMOVAL (DREDGING)**
- ____ FILTER MEDIA
- ____ INFLOW POINT

____ **EROSION REPAIR**
- ____ OUTLET WORKS
- ____ EMBANKMENTS
- ____ BOTTOM STAGE

____ **STRUCTURAL REPAIR**
- ____ INFLOW
- ____ OUTLET WORKS
- ____ FILTER MEDIA

OTHER: _____

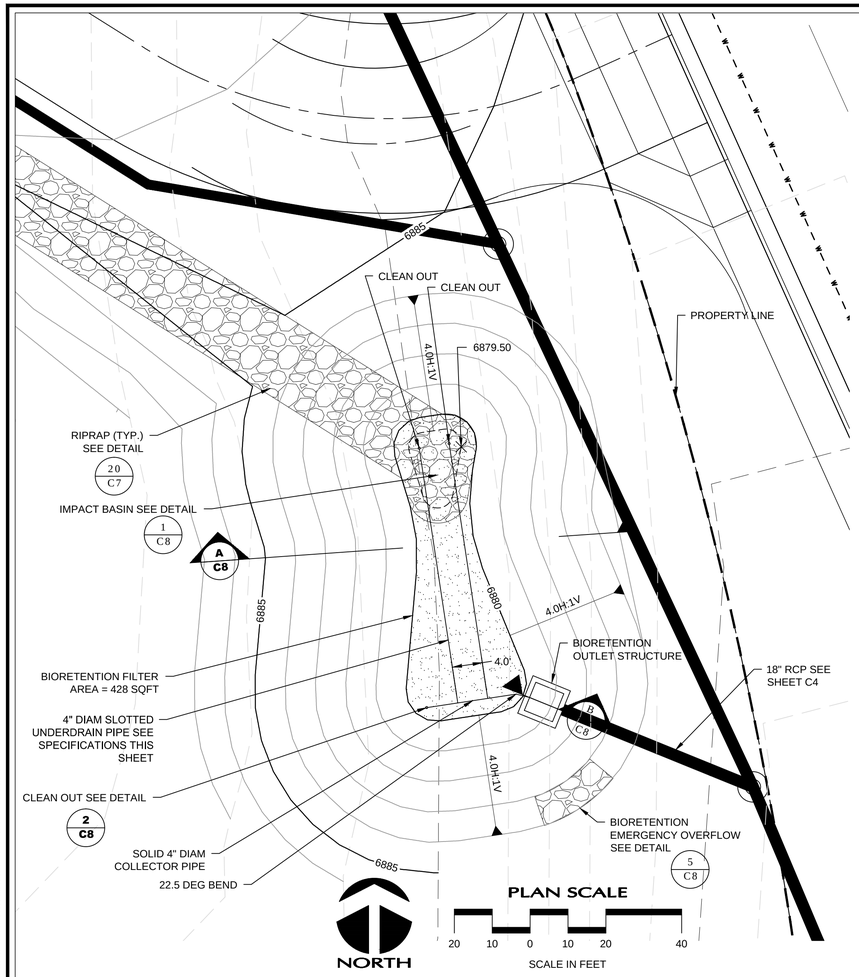
ESTIMATED TOTAL MANHOURS: _____

EQUIPMENT/MATERIAL USED: _____

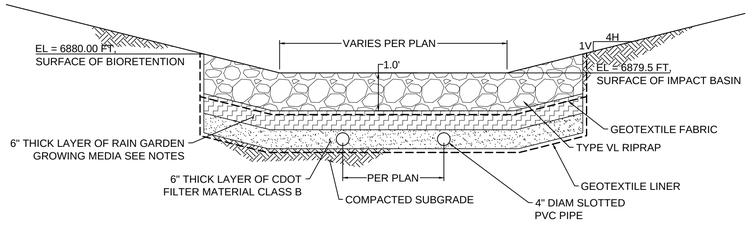
COMMENTS/ADDITIONAL INFO: _____

This Maintenance Activity Form shall be kept indefinitely and made available to El Paso County upon request.

Appendix C

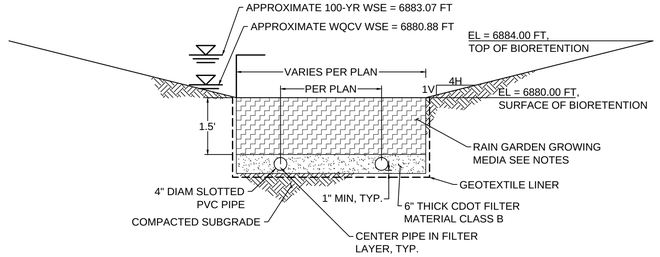


BIORETENTION PLAN



1 C8 **IMPACT BASIN DETAIL**

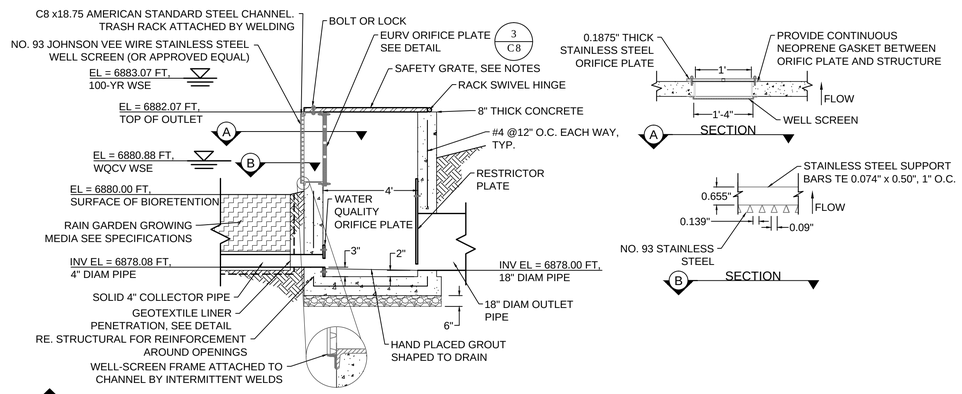
N.T.S.



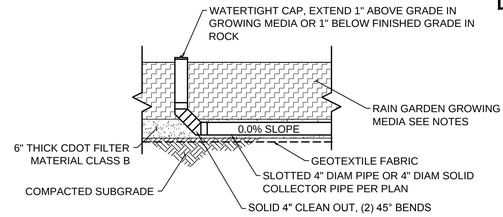
A C8 **BIORETENTION SECTION**

ISSUED FOR REGULATORY REVIEW

FOR INFORMATION ONLY
NOT FOR CONSTRUCTION



B C8 **OUTLET STRUCTURE SECTION**



2 C8 **CLEANOUT DETAIL**

N.T.S.

BIORETENTION NOTES AND SPECIFICATIONS

GENERAL NOTES:

1. GEOTEXTILE LINER SHALL BE MIRAFI 170N OR APPROVED EQUAL.
2. CONCRETE REINFORCING BARS SHALL BE EPOXY COATED #4 AND SHALL HAVE A MINIMUM 2" CLEARANCE FROM ANY FACE. SEE STRUCTURAL FOR REINFORCEMENT REQUIREMENTS AROUND OPENINGS.

ORIFICE PLATE NOTES:

1. PROVIDE CONTINUOUS NEOPRENE GASKET MATERIAL BETWEEN THE ORIFICE PLATE AND CONCRETE
2. BOLT PLATE TO CONCRETE 12" MAX ON CENTER.

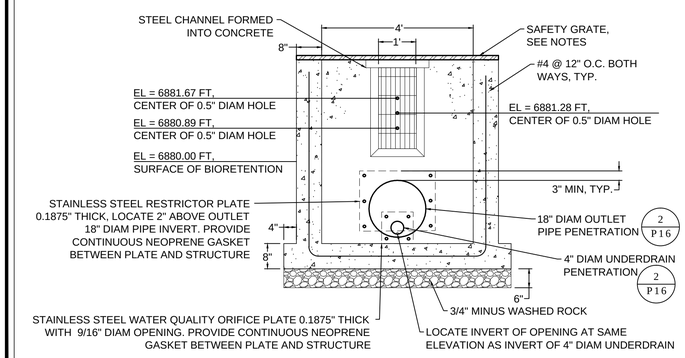
EURV PLATE AND TRASH RACK NOTES:

1. WELL-SCREEN TRASH RACKS SHALL BE STAINLESS STEEL AND SHALL BE ATTACHED BY INTERMITTENT WELDS ALONG THE EDGE OF THE MOUNTING FRAME.

SAFETY GRATE:

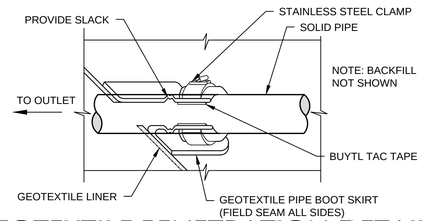
1. ALL SAFETY GRATES SHALL BE MOUNTED USING STAINLESS STEEL HARDWARE AND PROVIDED WITH HINGED AND LOCKABLE OR BOLTABLE ACCESS PANELS. SAFETY GRATE BARS SHALL BE S4 x 7.7 BEAMS..
2. SAFETY GRATES SHALL BE STAINLESS STEEL, ALUMINUM, OR STEEL. STEEL GRATES SHALL BE HOT DIP GALVANIZED AND MAY BE HOT POWDER COATED AFTER GALVANIZING.
3. MAXIMUM CLEAR DISTANCE BETWEEN SAFETY GRATE BARS SHALL BE 5 INCHES AND NO LESS THAN 4 INCHES.

Material		Specification			Submittals	Testing	Notes
Bioretention Growing Media (soil + organics)	Bioretention soil	Particle size distribution: 80-90% sand (0.05 - 2.0 mm diameter) 3-17% silt (0.002-0.5 mm diameter) 3-17% clay (<0.002 diameter) Chemical attribute and nutrient analysis: pH 6.8 - 7.5 organic matter < 1.5% nitrogen < 15 ppm phosphorus < 15 ppm salinity < 6 mmhos/cm			Particle size distribution and nutrient analysis required.		Percentages are in weight.
	Bioretention organics	3 to 5% shredded mulch (by weight of growing media)					bioretention soil required. Aged 6 months (minimum).
Landscape mulch		Shredded hardwood					Aged 6 months (minimum). No weed fabric allowed.
Underdrain aggregate	CDOT filter material (Class B or C as specified)		Mass Percent Passing Square Mesh Sieve		Particle size distribution required.		
		Sieve Size	Class B	Class C			
		37.5 mm (1.5")	100				
		19.0 mm (0.75")		100			
		4.75 mm (No. 4)	20-60	60-100			
		1.18 um (No. 16)	10-30				
		300 um (No. 50)	0-10	10-30			
		150 um (No. 100)		0-10			
		75 um (No. 200)	0-3	0-3			
Underdrain Pipe		Pipe diameter and type	Maximum slot width (inches)	Minimum open area (per foot)	Required	Pipe must conform to requirements of ASTM designation F949. There shall be no evidence of splitting, cracking, or breaking when the pipe is tested per ASTM test method D2412 in accordance with F949 section 7.5 and ASTM F794 section 8.5.	Contech A-2000 slotted pipe (or equal)
		4-inch slotted PVC	0.032	1.90 in.²			
		6-inch slotted PVC	0.032	1.98 in.²			



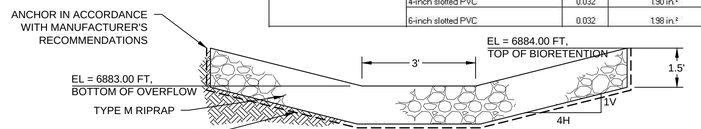
3 C8 **OUTLET STRUCTURE ELEVATION VIEW**

N.T.S.



4 C8 **GEOTEXTILE PENETRATION DETAIL**

N.T.S.



5 C8 **EMERGENCY OVERFLOW DETAIL**

N.T.S.

CALL UTILITY NOTIFICATION
CENTER OF COLORADO
1-800-922-1987
CALL 3-BUSINESS DAYS IN ADVANCE
BEFORE YOU DIG, GRADE, OR EXCAVATE
FOR THE MARKING OF UNDERGROUND
MEMBER UTILITIES

WWE
WRIGHT WATER ENGINEERS, INC.
2490 W. 26TH AVE. SUITE 100A
DENVER, CO 80211
(303)480-1700 FAX(303)480-1020

NO.	BY	DATE	DESCRIPTION	COMMENTS
0	HAL	11/31/2017	ISSUED FOR EL PASO COUNTY REVIEW	-
1	HAL	12/06/2017	REISSUED FOR EL PASO COUNTY REVIEW	----
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		DATE
DESIGN	HAL	11/31/17
DETAIL	JKG	11/31/17
CHECK	WFL	11/31/17
APPROVAL		
SCALE		SHOWN
C8 BIORETENTION PLAN AND DETAILS.dwg		

FOREST LAKES METROPOLITAN DISTRICT WATER INTAKE AND TREATMENT PLANT

BIORETENTION PLAN AND DETAILS

JOB NO. 031-090.300
REVISION NO. 0
SHEET NO. 06

Appendix D

DENVER
2490 W. 26th Avenue Suite 100A
Denver, Colorado 80211
Phone: 303.480.1700
Fax: 303.480.1020

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818 Colorado Avenue
P.O.Box 219
Glenwood Springs, Colorado 81602
Phone: 970.945.7755
Fax: 970.945.9210

DURANGO
1666 N. Main Avenue Suite C
Durango, Colorado 81301
Phone: 970.259.7411
Fax: 970.259.8758

www.wrightwater.com

WWE

Wright Water Engineers, Inc.