



STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

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April 5, 2018

Joanna Ogintz, P.E.
Oldcastle Precast
5331 SW Macadam Ave., #376
Portland, OR 97239

RE: BioMod for Stormwater Runoff Filtration

Dear Ms. Ogintz:

The Washington State Department of Ecology (Ecology) finds the BioMod Modular Bioretention (BioMod) System functionally equivalent to a bioretention planter or planter box. The media specifications for BioMod System must adhere to the guidelines for Bioretention found in BMP T7.30 of the 2014 Stormwater Management Manual for Western Washington (SWMMWW) or BMP T5.31 in the Stormwater Management Manual for Eastern Washington (SWMMEW). The sizing procedure must also adhere to the procedure outlined in the Bioretention design criteria of the manuals mentioned above or the procedure Oldcastle submitted to Ecology for design of the BioMod System using WWHM, dated March 2018.

Contractors may use the BioMod System BMP at project sites without seeking additional Ecology approval to meet Minimum Requirement #6 or Core Element #5. The BioMod System is not equivalent to bioretention when using the list option of Minimum Requirement #5 in the SWMMWW.

Ecology does not endorse this product or its manufacturer. Users of the BioMod must follow the manufacturer's installation, operation, and maintenance recommendations.

For more information, contact me at douglas.howie@ecy.wa.gov, or (360) 407-6444.

Sincerely

Douglas C. Howie, P.E.
Senior Stormwater Engineer
Water Quality Program

cc: Carla Milesi, TAPE Technical Lead, Washington Stormwater Center

Enclosure





BIOMOD MODULAR BIORETENTION SYSTEM

Using WWHM2012 to Size and Evaluate
Stormwater Management Facilities

March 2018

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BioMod Modular Bioretention System – Using WWHM2012 to Size and Evaluate Stormwater Management Facilities

Introduction

The BioMod® Modular Bioretention System (BioMod) is a conventional, structural, vegetated bioretention system, designed as a series of modular precast concrete sections which are filled with layers of aggregate, bioretention media, plantings, and mulch (Figure 1). Standard components include trench and end sections as well as modules for inlet and pretreatment, placement of large trees or light posts, and overflow and bypass. The trench sections can be provided with open bottoms to promote infiltration and retain water on site, or with closed bottoms and underdrains. The BioMod system typically incorporates non-proprietary, low flow rate media, with materials and thicknesses specified by a local agency. A wide variety of plants and trees may be used in the BioMod. Plantings appropriate for the local area are typically specified by the designer. The number and size of sections, as well as the overall configuration of each system, is determined on a project-specific basis.

In addition, the BioMod could instead be configured as a planter box, consisting of a single concrete structure, as long as the single structure provides the needed bioretention surface area. Standard details for standard bioretention and bioretention with infiltration applications are attached. Also, an example detail drawing for a specific BioMod project in California is attached.

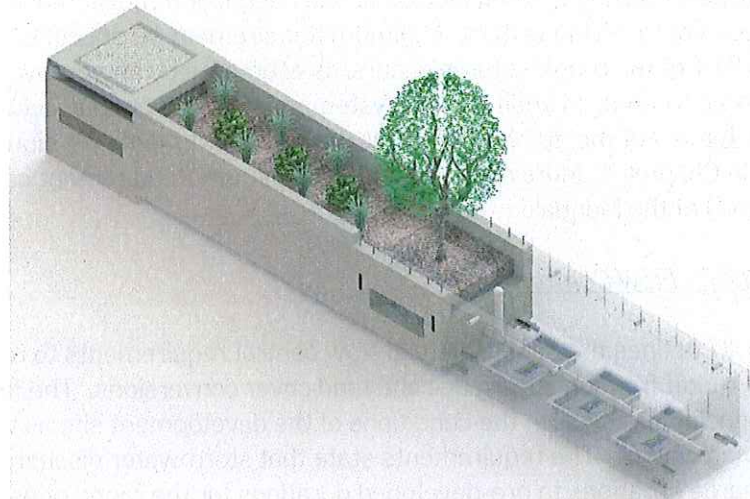


Figure 1. BioMod Schematic.

This document provides guidance on how the BioMod can be designed to meet the Washington State Department of Ecology (Ecology) stormwater requirements presented in the 2014 Stormwater Management Manual for Western Washington (SWMMWW). The BioMod is functionally equivalent to a Bioretention system and can be designed to meet the requirements outlined in BMP T7.30: Bioretention Cells, Swales, and Planter Boxes. This document provides guidance for demonstrating compliance with Ecology's Minimum Requirements as well as detailed instructions for sizing and evaluating the BioMod using the Western Washington Hydrology Model, Version 2012 (WVHM2012).

Using BioMod for Compliance with Minimum Requirements

The BioMod can be designed for compliance with the SWMMWW Minimum Requirements, found in Volume I, Chapter 2 of the 2014 SWMMWW. The applicability of Ecology's Minimum Requirements to a specific project is determined based on the size and type of the proposed project. Detailed flow charts for determining the requirements for new development and redevelopment projects can be found in the SWMMWW. Typically, Minimum Requirements #6 (Runoff Treatment) and #7 (Flow Control) are the ones most likely to result in the use of the BioMod. In some cases, Minimum Requirement #5 (On-Site Stormwater Management) may apply as well, since the BioMod can be provided with an open bottom to allow for infiltration.

Minimum Requirement #6 – Runoff Treatment

Minimum Requirement #6 specifies the site condition thresholds that necessitate the use of stormwater treatment facilities and provides facility sizing, selection, design and maintenance guidelines for their use. The objective of this requirement is to reduce pollutant loads and concentrations in stormwater using physical, biological and chemical removal mechanisms to protect the beneficial uses of receiving waters. Minimum Requirement #6 specifies that the flow rate at or below which 91% of the runoff volume occurs, as estimated by an approved continuous simulation model, must be treated. In addition, the system must be designed in accordance with the design criteria in Volume V of the 2014 SWMMWW; design requirements for bioretention systems can be found in Chapter 7. More detail about this Minimum Requirement can be found in Section I-2.5.6 of Volume I of the Manual.

Minimum Requirement #7 – Flow Control

Minimum Requirement #7 defines the applicability of flow control requirements to reduce the impacts of stormwater runoff from hard surfaces and land cover conversions. The flow control requirements vary depending on the both the conditions of the development site as well as the conditions of the receiving waters. The requirements state that stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow. The pre-developed conditions to be matched shall be forested land cover unless certain requirements have been met. More detail can be found in Section I-2.5.7 of Volume I of the Manual.

Minimum Requirement #5 – On-site Stormwater Management

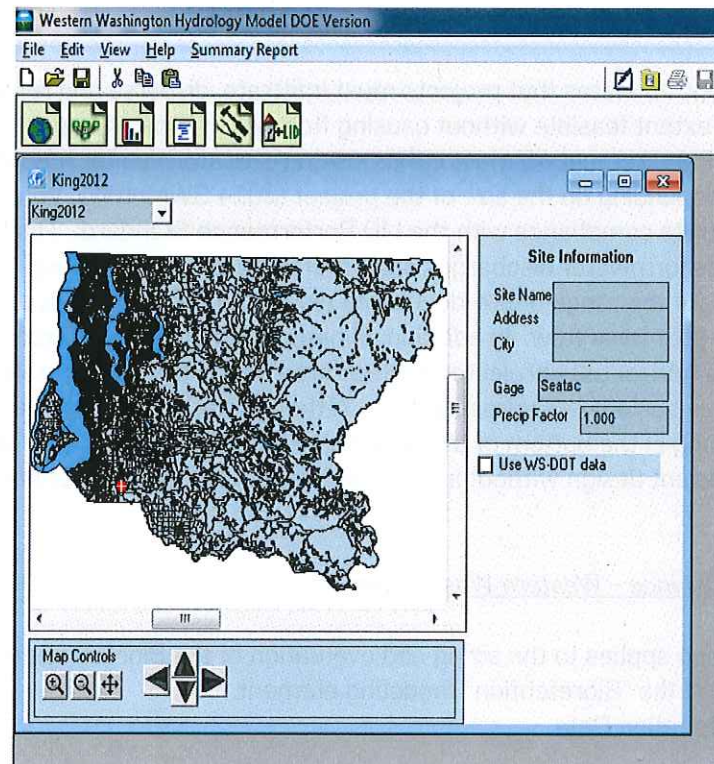
Minimum Requirement #5 states that projects must infiltrate, disperse and retain stormwater runoff on-site to the extent feasible without causing flooding or erosion impacts. Projects triggering Minimum Requirement #5 must either: use on-site stormwater management BMPs from one of the two lists depending on the size of the project (2014 SWMMWW, Volume 1, Chapter 2, page 56) or demonstrate compliance with the LID Performance Standard. The LID Performance Standard states that stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 8% of the 2-year peak flow to 50% of the 2-year peak flow. In addition, Minimum Requirement #5 requires that the bioretention facility's horizontally projected surface area below the overflow shall be at least 5% of the total impervious surface area draining to it. Although the BioMod can be designed for infiltration with opening in the bottom of the structure and no underdrain, this option may not provide the most efficient design without infiltration through the side slopes of systems with open sides.

BioMod Modeling Guidance – Western Washington

The following guidance applies to the sizing and evaluation of the BioMod system when modeled using WWHM2012 and the "Bioretention" modeling element.

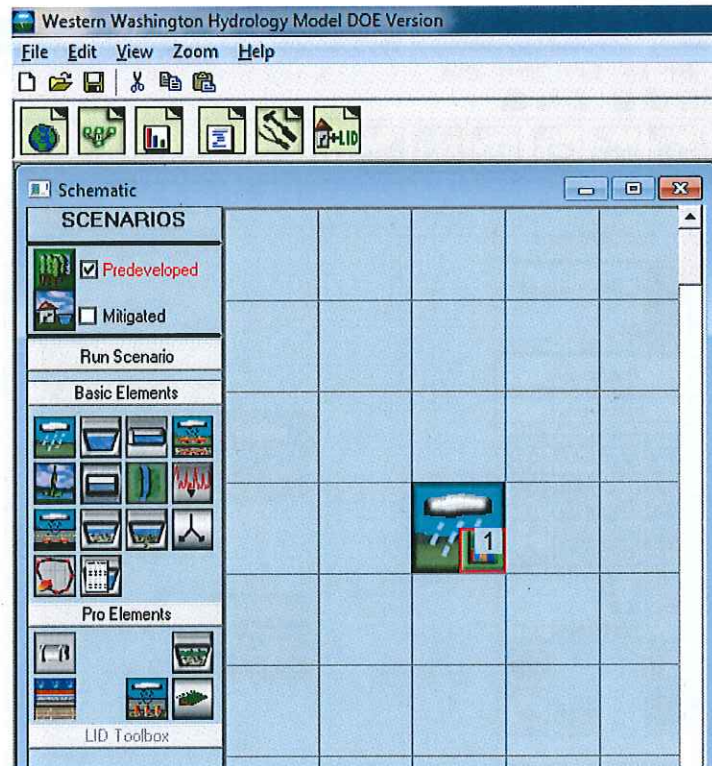
Step 1 – Define Precipitation Data

Use the County/City Map pulldown to select the region for the project. On the resulting map, click on the project location to select the site precipitation series in the Site Information dialog box.



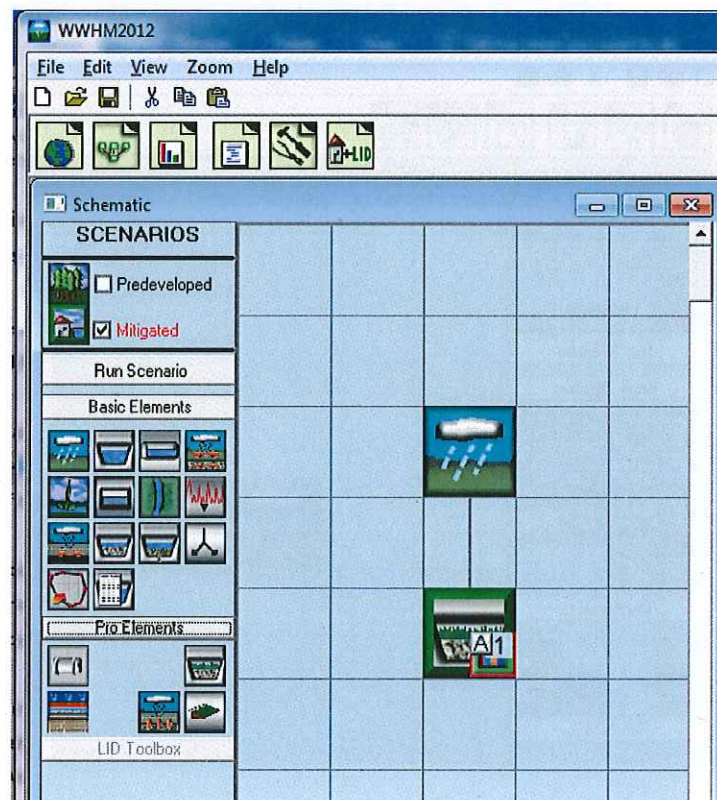
Step 2 – Define the Pre-Developed Scenario

- Click on the "General Project Information" button in the toolbar to open the Schematic window.
- Select the "Predeveloped Scenario" in the Schematic window to the left of the page
- Drag the "Land Use Basin" element (listed under Basic Elements) into the schematic window and drop into the grid.
- Click on the Basin and enter the pre-developed scenario drainage basin areas controlled by the BioMod system by soil and land use types. The land use is typically forested.
- Right-click on the Basin and select "Connect to Point of Compliance". Ensure Surface Flow and Interflow are checked and click "Connect". Once the Basin is connected to the Point of Compliance (POC) a "1" will appear in the lower right corner of the basin.



Step 3 – Define the Mitigated Scenario

- Click on the "General Project Information" button in the toolbar to open the Schematic window.
- Select the "Mitigated Scenario" in the Schematic window to the left of the page
- Drag the "Land Use Basin" element (listed under Basic Elements) into the schematic window and drop into the grid.
- Click on the Basin and enter the mitigated scenario pervious and/or impervious areas by soil and land use type.
- Add the BioMod BMP by dragging the "Bioretention" element (listed under Pro Elements) into the schematic window and dropping it into the grid, downstream of the Basin.
- Right-click on the Basin and select "Connect to Element". When the connection line appears, click on the Bioretention element. Ensure Surface Flow and Interflow are both checked and click "OK".
- Right-click on the Bioretention element and select "Connect to Point of Compliance". Ensure Outlet 1 is checked and click "Connect". Once the Bioretention element is connected to the Point of Compliance (POC) a "1" will appear in the lower right corner of the basin.



Step 4 – Define the BioMod BMP

- Click on the "Bioretention" element to open the Bioretention editor window.
- Ensure the "Use Simple Bioretention" box is unchecked.
- Check the "Underdrain Used" box:
 - Since BioMod does not require use of an orifice on the underdrain, enter the Orifice Diameter (in) equal to the Underdrain Diameter (ft), but note that the underdrain diameter is in feet while the orifice diameter is in inches. Typical BioMod underdrain diameter would meet local minimum requirements. For Washington, the minimum underdrain diameter requirement is 4 inches, but 4 to 8 inches is common.
 - If an orifice is needed to meet flow control or LID requirements, enter the orifice diameter in inches. The Offset (in) from the invert of the underdrain can also be entered if needed.
- Define BioMod dimensions – enter the BioMod dimensions in the section labeled "Bioretention Dimensions":
 - Bioretention Bottom Elevation (ft) – Enter the elevation of the proposed BioMod or use the default value of 0.
 - Bioretention Length (ft) – Enter the length of the BioMod system.
 - Bioretention Bottom Width (ft) – Enter the width of the BioMod system. A BioMod in Washington would typically be designed with a bottom width of 4 feet or 6 feet.

- Freeboard (ft) – Enter the freeboard required by per the design or the jurisdiction requirement. Ecology specifies a minimum of 6 inches unless otherwise specified.
- Over-road Flooding (ft) – Enter the over-road flooding if applicable. This value is not accessible while using the Riser Outlet Structure option.
- Effective Total Depth (ft) – No data entry required. This value represents the total depth of the facility, including filter media depth, ponding depth (riser height), and freeboard. Value is automatically entered by the model.
- Bottom slope of bioretention – Enter 0 for a flat facility.
- Front and Back side slopes (H/V) – Enter 0 to represent vertical walls for the front and back.
- Left Side Slope (H/V) – Enter 0 to represent vertical side walls.
- Right Side Slope (H/V) – Enter 0 to represent vertical side walls.

Bioretention 1 Mitigated

Facility Name Bioretention 1

Downstream Connection Outlet 1: 0, Outlet 2: 0, Outlet 3: 0

Facility Type Bioretention Swale

Use simple Bioretention Quick Swale Size Water Quality Size Facility

Underdrain Used

Bioretention Bottom Elevation 0

Underdrain Diameter(ft) 0 **Offset(in)** 0

Orifice Diameter(in) 0 **Flow Through Underdrain (ac-ft)** 0

Bioretention Dimensions

Bioretention Length (ft) 0.000 **Total Outflow (ac-ft)** 0

Bioretention Bottom Width (ft) 0.000 **Percent Through Underdrain** 0

Freeboard (ft) 0.000 **WQ Percent Filtered** 0

Over-road Flooding (ft) 0.000

Effective Total Depth (ft) 0

Bottom slope of bioretention.(0-1) 0.000

Sidewall Invert Location

Front and Back side slope (H/V) 0.000

Left Side Slope (H/V) 0.000

Right Side Slope (H/V) 0.000

Material Layers for

	Layer 1	Layer 2	Layer 3
Depth (ft)	0.000	0	0
Soil Layer 1	SMMWW 12 in/hr		
Soil Layer 2	GRAVEL		
Soil Layer 3	GRAVEL		

[Edit Soil Types](#)

KSat Safety Factor

None 2 4

Native Infiltration NO

Facility Dimension Diagram

Outlet Structure Data

Riser Outlet Structure

Outlet Structure Data

Riser Height Above bioretention surface (ft) 0

Riser Diameter (in) 0

Riser Type Flat

Orifice Number	Diameter (in)	Height (ft)
1	0	0
2	0	0
3	0	0

Show Bioretention [Open Table](#)

Bioretention Volume at Riser Head (ac-ft) .000

Precipitation on Facility (acre-ft) 0

Evaporation from Facility (acre-ft) 0

- Define BioMod Material Layers – enter the BioMod material layers and dimensions in the section labeled "Material Layers":
 - Soil Layer 1 – Select the SMMWW 12 in/hr soil type, as the standard bioretention media.
 - Soil Layer 2 – Select GRAVEL as the media for soil layer 2.
 - Layer 1 Depth (ft) – Enter 1.5 feet for depth of soil layer 1, to represent the 18" of bioretention media provided in the BioMod.
 - Layer 2 Depth (ft) – Enter 0.5 feet for depth of soil layer 2, to represent the 6" of gravel provided in the BioMod.
 - Soil Layer 3 and Layer 3 Depth – leave blank.
- Enter the K_{Sat} Safety Factor – Enter the appropriate safety factor to meet the required hydraulic conductivity. The manual states:

*"If the contributing area of the bioretention cell or swale is equal to or exceeds any of the following limitations:
5,000 square feet of pollution-generating impervious surface;
10,000 square feet of impervious surface;
¾ acre of lawn and landscape,
Use 4 as the infiltration rate (K_{sat}) safety factor. If the contributing area is less than all of the above areas, or if the design includes a pretreatment device for solids removal, use 2 as the K_{sat} safety factor."*
- Enter Native Infiltration parameters – If native soils are not going to be used for infiltration, leave this value as NO. If native soils are going to be used for infiltration, select YES and enter the following parameters:
 - Measured Infiltration Rate (in/hr) – Enter the native soil infiltration rate.
 - Reduction Factor – Enter a reduction factor, if applicable.
 - Use Wetted Surface Area – Select No since BioMod has vertical sidewalls.
- Enter the Outlet Structure Data – Enter information related to the outlet structure by first selecting the type of outlet structure. For BioMod, select Riser Outlet Structure and then enter the following parameters:
 - Riser Height Above bioretention surface (ft) – Enter a riser height equal to the ponding depth above the soil media layer of the BioMod. Ecology specifies a maximum ponding depth of 12 inches.
 - Riser Diameter (in) – A typical BioMod overflow device is a square unit with dimensions of 18" x 18". To approximate this overflow in WWHM, enter an equivalent riser diameter (20" diameter for an 18" x 18" square) to represent the overflow device.
 - Riser Type – Select the "Flat" riser type.

Step 5 – Analyze the Performance of the BioMod

The next step is to analyze the performance of the specified BioMod relative to the performance standards prescribed in Minimum Requirements #5, #6, and #7:

- Evaluate the water quality performance:

According to the 2014 SWMMWW, sites that trigger Minimum Requirement #6 (Water Quality Treatment) are required to infiltrate or filter at least 91 percent of the total runoff volume through a bioretention media that meets Ecology's requirements:

- In the Scenario Editor, check the box for "Predeveloped" scenario and then select Run Scenario.
- Then, in the Scenario Editor, check the box for "Mitigated" scenario and then select Run Scenario.
- If the facility uses an underdrain, confirm that the "WQ Percent Filtered" is equal to or greater than 91 percent.
- If the facility uses infiltration instead of an underdrain, confirm that the "Percent Infiltrated" is equal to or greater than 91 percent.
- If the facility does not reach the goal of 91 percent filtered or infiltrated, increase the size of the BioMod or decrease the basin area draining to the facility until the standard is met.

- Evaluate the flow control performance:

Sites that trigger Minimum Requirement #7 (Flow Control) are required to match pre-developed stormwater discharges for a range of flows. Evaluate the flow control performance of the system using the following steps:

- After running both Pre-developed and Mitigated scenarios, click on the "Analysis" button in the toolbar to open the Analysis window.
- Select the desired point of compliance (typically POC 1) from the tabs at the bottom of the Analyze Datasets window (lower left portion of the screen).
- Select the Stream Protection Duration tab from the upper left portion of the screen.
- Use this information to determine if the system design meets the requirements for flow control.
- If the facility does not meet the flow control performance requirements, increase the size of the BioMod, decrease the basin area draining to the facility until the standard is met, or provide additional retention/detention downstream of the BioMod system. If you change the post-development area, the pre-development area must be changed as well. A sufficient number of BioMod modules shall be provided to treat runoff from the entire project area.

- Evaluate the LID performance:

Sites that trigger Minimum Requirement #5 (On-site Stormwater Management) are required to use stormwater management BMPs from one of the two lists or demonstrate compliance with the LID Performance Standard. Evaluate the LID performance of the system against the LID Performance Standard using the following steps:

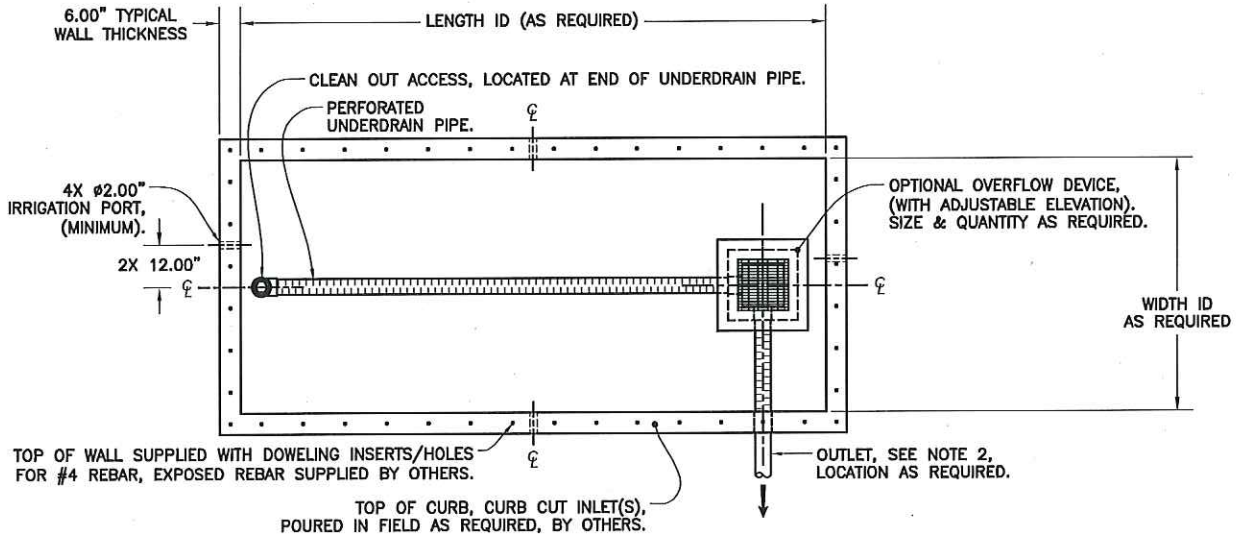
- After running both Pre-developed and Mitigated scenarios, click on the "Analysis" button in the toolbar to open the Analysis window.
- Select the desired point of compliance (typically POC 1) from the tabs at the bottom of the Analyze Datasets window (lower left portion of the screen).
- Select the LID Duration tab from the upper left portion of the screen.

- Use this information to determine if the system design meets the requirements for flow control.
- If the facility does not meet the LID performance requirements, increase the size of the BioMod, decrease the basin area draining to the facility until the standard is met, or use the appropriate list option. Note: the BioMod is not a substitute for bioretention when using the list options.
- Consider other factors that affect system sizing: finally, if there are any other governors that affect the size of the BioMod (such as a surface area that is a minimum percent of the draining surface area), apply those to the BioMod sizing in WWHM.

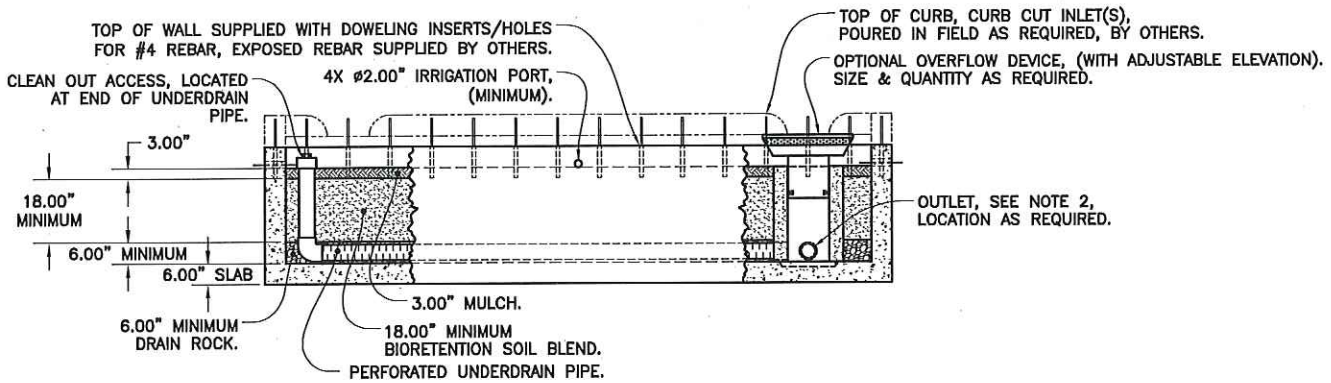
Eastern Washington Sizing Guidance

The BioMod can also be used for projects in eastern Washington. Sizing for projects in eastern Washington must comply with the standard sizing criteria for bioretention facilities and design flow rates appropriate for eastern Washington jurisdictions.

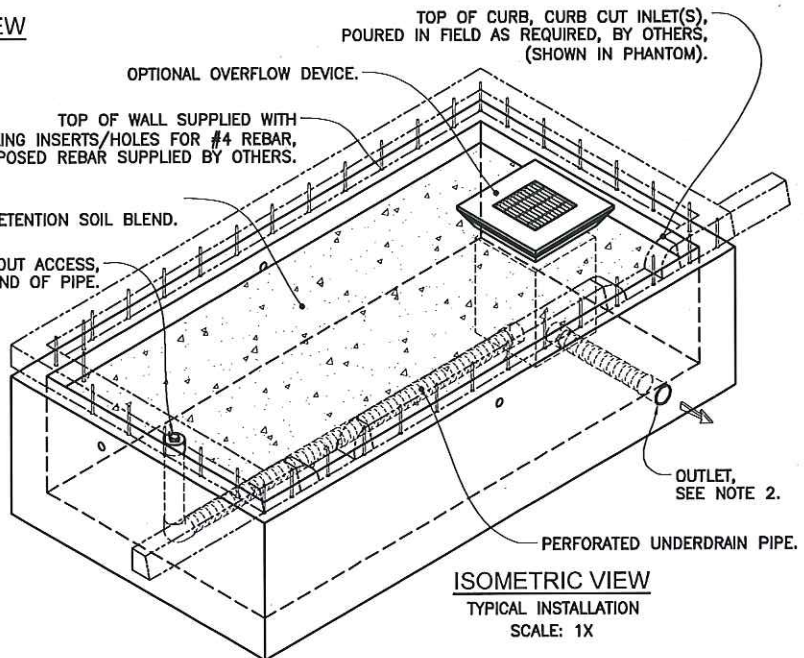
BM-0001



PLAN VIEW
SCALE: 1X



ELEVATION VIEW
SCALE: 1X



NOTES:

1. Provided storage volume & maximum pick weights vary with size.
2. PVC outlet cast monolithic. adaptors/angles & external piping by others.
3. BioMod® bioretention systems are designed & manufactured in accordance with ASTM C857 & C858.
4. All exterior surfaces supplied with "Form Finish". decorative & alternate surfaces by others.
5. Engineered bioretention soil blend may be substituted to meet local regulatory requirements.

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BioMod®
Modular Bioretention System



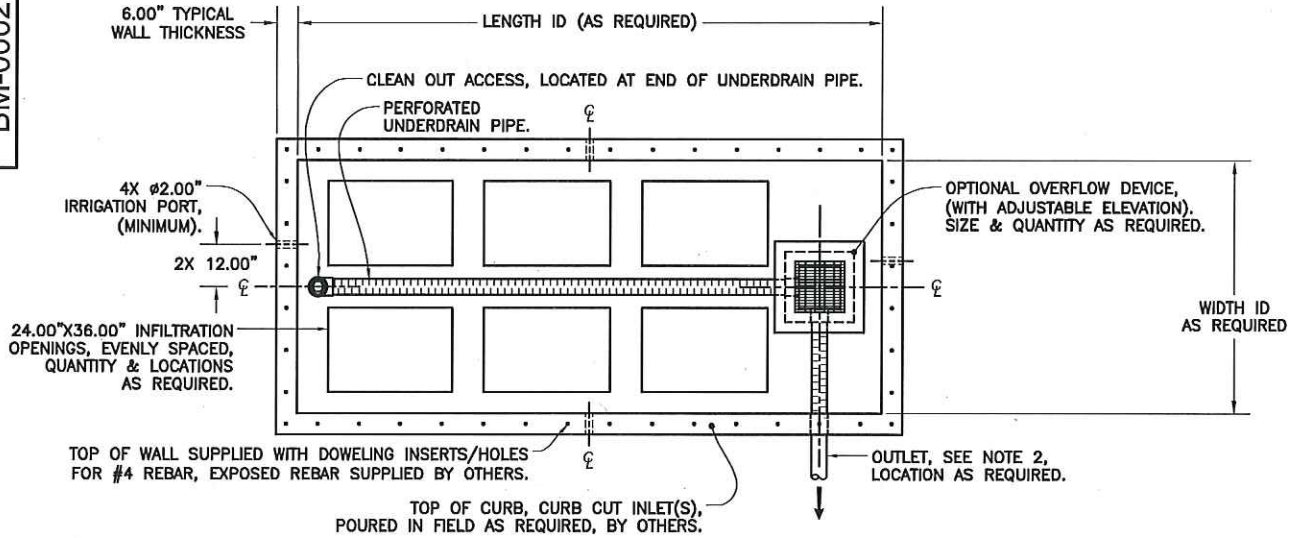
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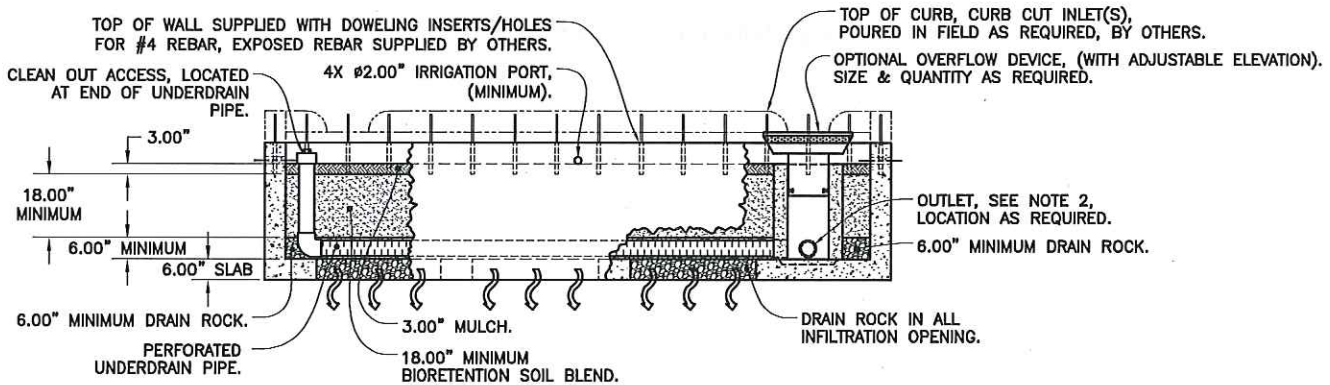
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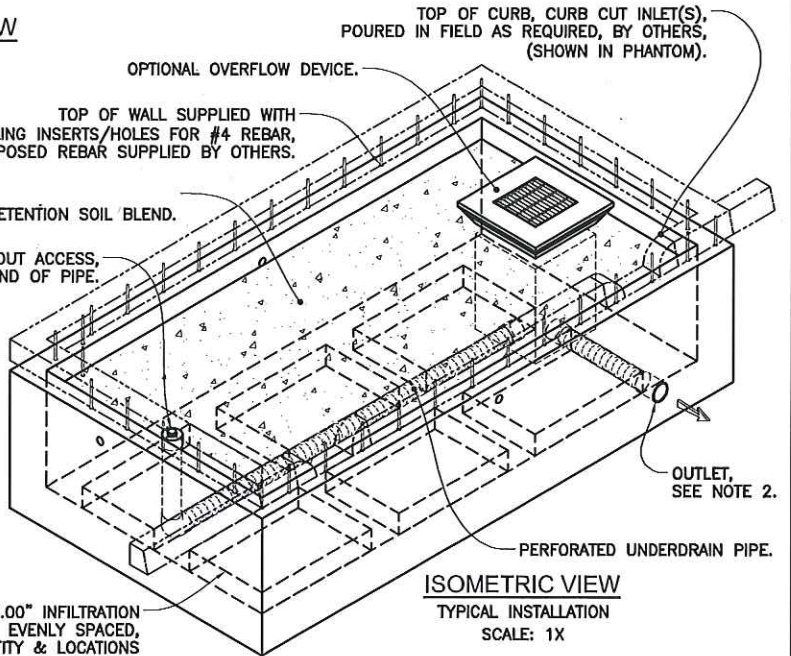
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PLAN VIEW
SCALE: 1X



ELEVATION VIEW
SCALE: 1X



ISOMETRIC VIEW
TYPICAL INSTALLATION
SCALE: 1X

NOTES:

1. Treatment Flow Rate & maximum pick weights vary with size.
2. PVC outlet cast monolithic, adaptors/angles & external piping by others.
3. BioMod® bioretention systems are designed & manufactured in accordance with ASTM C857 & C858.
4. All exterior surfaces supplied with "Form Finish". decorative & alternate surfaces by others.
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for Infiltration Applications



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