

Technical Note

TN 1.15 EcoStream® Enhanced Treatment – TSS, Phosphorus, & Metals

Overview

The EcoStream Biofiltration System (EcoStream) is a structural stormwater treatment system developed by Advanced Drainage Systems, Inc. (ADS) that provides water quality treatment through settling, filtration, and sorption processes. The system is typically constructed using precast concrete or other structurally adequate containment vessel and can be used for treatment applications across a broad range of urban settings.

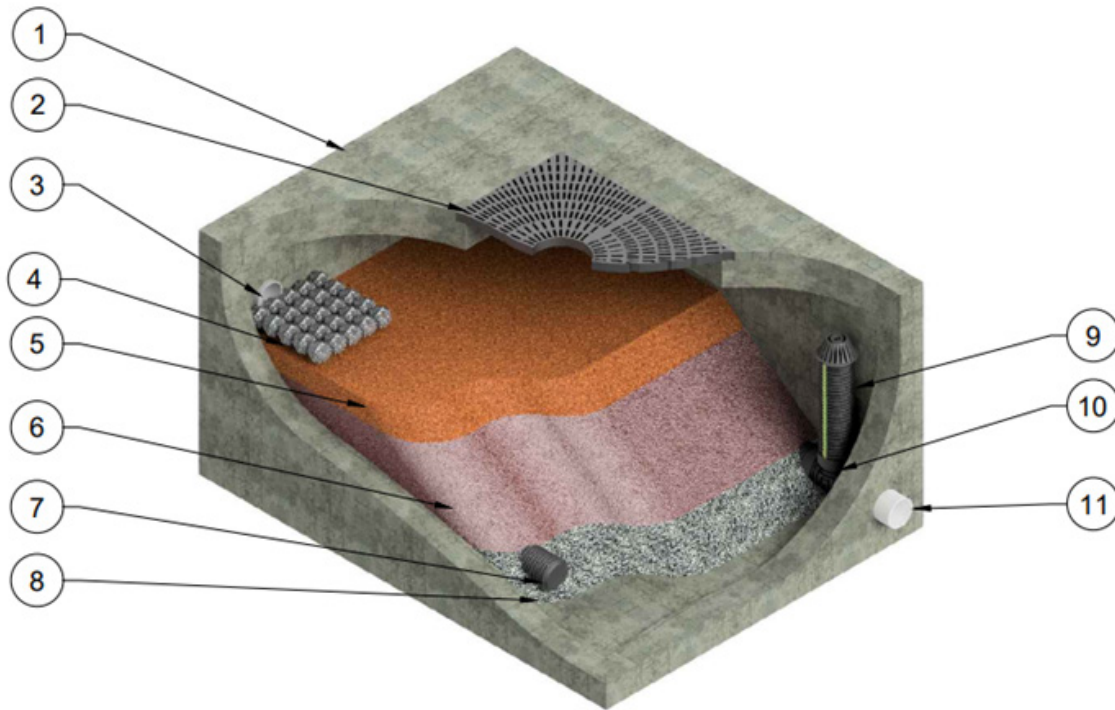
The EcoStream system treats water as it flows vertically via gravity through mulch, media, and gravel layers. The mulch layer provides pretreatment by retaining the coarse sediment, trash, and debris. The fine sediment is further treated through the media bed. Treated water is collected in the underdrain stone and piping before exiting the system.

The EcoStream media holds many regulatory approvals across the country, including the Washington State Department of Ecology (WSDOE) General Use Level Designation (GULD) approval for basic, metals, and phosphorus treatment. This approval is based on a media infiltration rate of 300 in/hr, which equates to a hydraulic loading rate of 3.125 gpm/ft² of media surface area. The WSDOE GULD approval was granted to the EcoStream BioFilter system in August 2024.



Physical Description

Figure 1: EcoStream System Components



1	Concrete Vault	Designed for H-20 loading, meeting the specifications outlined in ASTM C857 and ASTM C858. The concrete shall have a minimum unconfined compressive strength of 4000 psi.
2	Tree Grate or Access Cover	Supplied by ADS. Access cover can be used when trees or plants are not required.
3	Inlet Pipe or Curb Inlet	Size and material per plan.
4	Energy Dissipation Stone	Supplied by contractor. Rip rap stone for energy dissipation.
5	Mulch	Supplied by contractor. Mulch shall be hardwood brown mulch, double shredded, with no dyes added.
6	Biofiltration Media	Supplied by ADS. EcoStream proprietary high flow media blend.
7	Underdrain Pipe	Supplied by ADS. Perforated underdrain comprised of HDPE and PVC pipe and fittings.
8	Underdrain Stone	Supplied by ADS. Underdrain stone shall be washed, clean, #57 stone installed by ADS precaster.
9	High Flow Bypass w/ Beehive Grate	Supplied by ADS. Standpipe comprised of HDPE pipe and fittings
10	Flow Control Orifice	Supplied by ADS. Orifice control sized to ensure treatment flow rates are met.
11	Outlet Pipe	Size and material per plan.

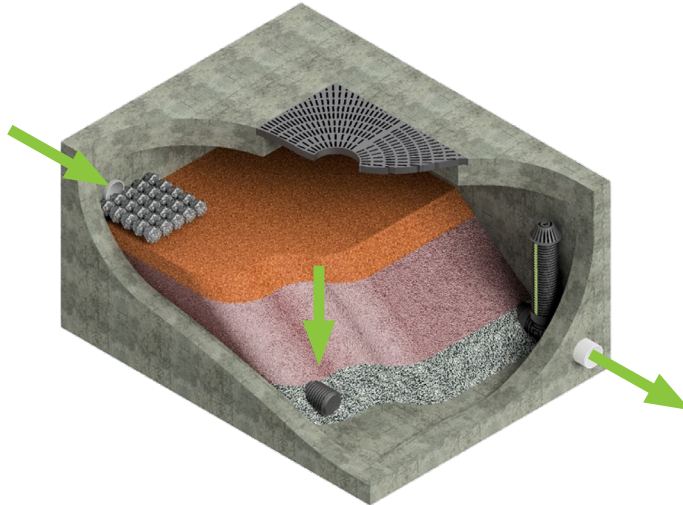
The EcoStream system has two primary inlet configurations: Curb inlet and/or pipe inlet.

Typically, 3" to 4" (75 mm to 100 mm) angular stone is used as an energy dissipator at all inlet points to the filtration cell.

Functionality

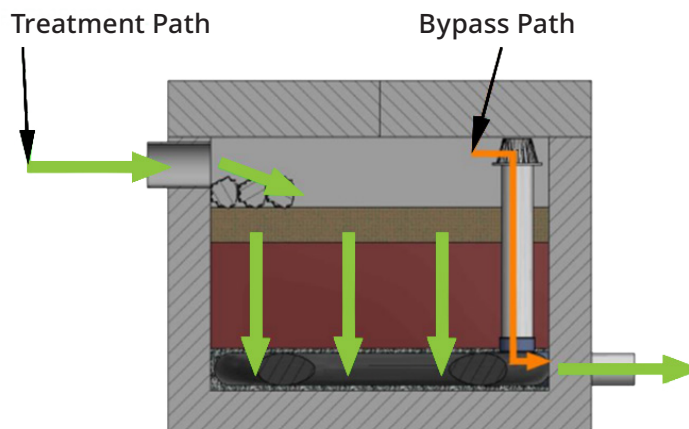
1. Stormwater runoff enters the unit through a curb inlet or subsurface pipe inlet. (Item 3 in Figure 1) Energy dissipation stone is present to reduce the flow velocity. (Item 4 in Figure 1)

Figure 2: Treatment Flow Path shown through a Unit with an Inlet Pipe



2. After entering the unit, runoff will flow downward via gravity through the EcoStream system. The top mulch layer will filter out coarse sediment and gross pollutants. The biofiltration media layer is designed to remove fine sediments, phosphorus, nutrients, and dissolved metals such as copper and zinc.
3. Treated water enters the perforated underdrain pipe (Item 7 in Figure 1) and then exits the EcoStream through the outlet pipe. (Item 11 in Figure 1) A flow control orifice is included in the underdrain piping to limit the flow rate through the system, to ensure adequate residence time within the system. (Item 10 in Figure 1).

Figure 3: Treatment Flow Pathway shown in Profile View



4. During peak storm events where the treatment capacity of the system is exceeded, runoff will pond up and begin to flow through the bypass standpipe. (Item 9 in Figure 1.) Figure 3 above shows the treatment flow path through the unit in green and the bypass flow path in orange.

Treatment Processes

Settling and Screening

The EcoStream system removes coarse sediment and floatables through screening and settling. As runoff is introduced into the EcoStream unit, large floatables are either captured in the mulch or in the trash screen during bypass conditions. The top of the media bed removes gross solids, debris, oils, and larger particulate matter.

Filtration

Filtration occurs as the flow passes through the biofiltration media layer. Particulate material is removed by filtration as the flow passes through the graded media.

Sorption

Sorption is a surface phenomenon and is responsible for the removal of organic and inorganic pollutants through adsorption and ion exchange. Intermolecular forces or attraction cause pollutants to adhere on the solid surfaces of the treatment media. The biofiltration media bed has been specifically engineered to sorb dissolved phosphorus and dissolved metals.

Biological Processing

Bacterial growth on filter media also provides several treatment processes. These processes vary as a function of moisture, temperature, pH, salinity, pollutant concentrations, and available oxygen. The following biological treatment processes take place within the EcoStream system: nutrient assimilation, nitrification/denitrification, biodegradation, bioremediation, and phytoremediation.

Water Quality Parameters

The EcoStream media is WSDOE GULD approved for Basic, Phosphorus, and Metals treatment, at a media infiltration rate of 300 in/hr, which equates to a hydraulic loading rate of 3.125 gpm/ft² of media surface area.

To obtain the GULD approval, the collected volume-weighted composite samples were analyzed for the following water quality parameters:

- Total Suspended Solids
- Total Phosphorus
- Total and dissolved copper
- Total and dissolved zinc

Table 1: Summary Results from Previous EcoStream Lab Testing

Parameter	Total Suspended Solids	Total Phosphorus	Dissolved Copper	Dissolved Zinc
TAPE goal	>80% removal	≥50% removal	>30% removal	>60% removal
Median percent removal	85%	70%	39%	65%

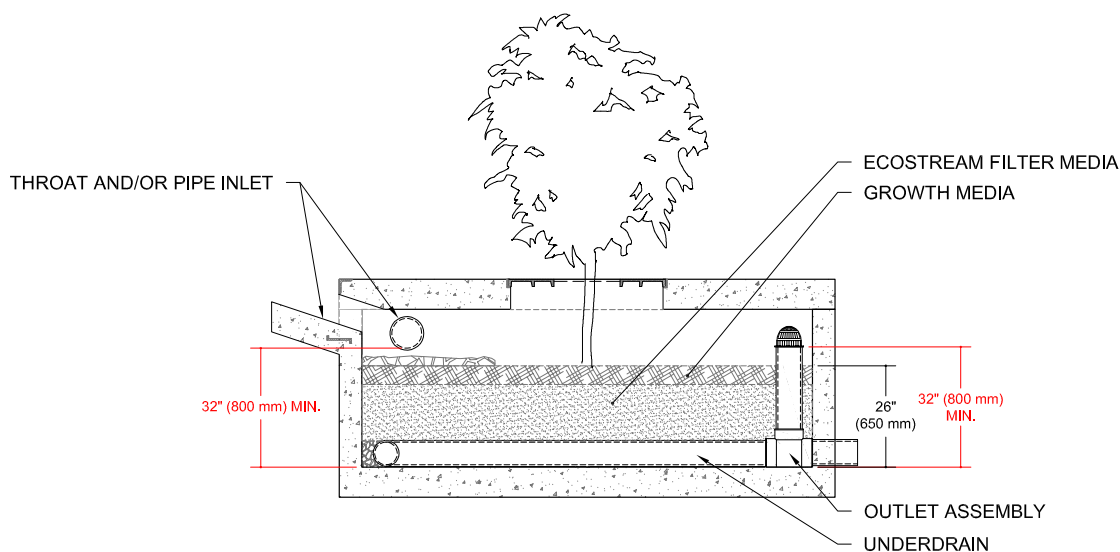
TAPE = Technology Assessment Protocol-Ecology

Design Considerations – Inverts/Elevations

In addition to ensuring that the correctly sized EcoStream unit is selected for the project based upon the above treatment parameters, there are additional factors to consider when designing a site with an EcoStream unit.

The required design head of the system is 32" (800 mm), meaning a minimum of 32" (800 mm) should be provided from the invert of the outlet pipe to the top of the bypass pipe. Inlet connections to the unit should be designed with the flowline above the bypass at a minimum of 32" (800 mm) above the outlet of the unit.

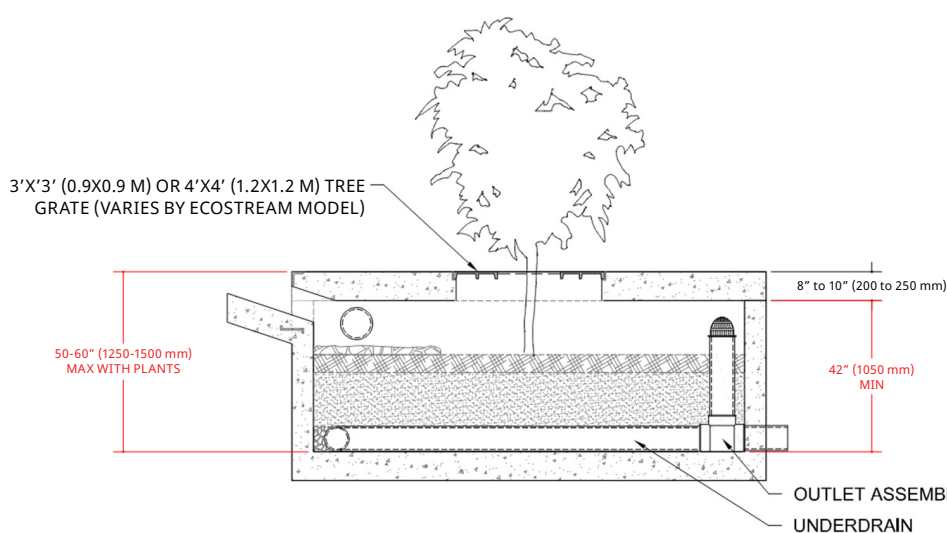
Figure 4: Minimum Inlet Invert & Bypass Requirements



The total depth of the media is 26" (650 mm); a layer of growth media (mulch) at 5" (125 mm) thick, a layer of the EcoStream media at 15" (375 mm) thick, and a stone layer at 6" (150 mm) thick.

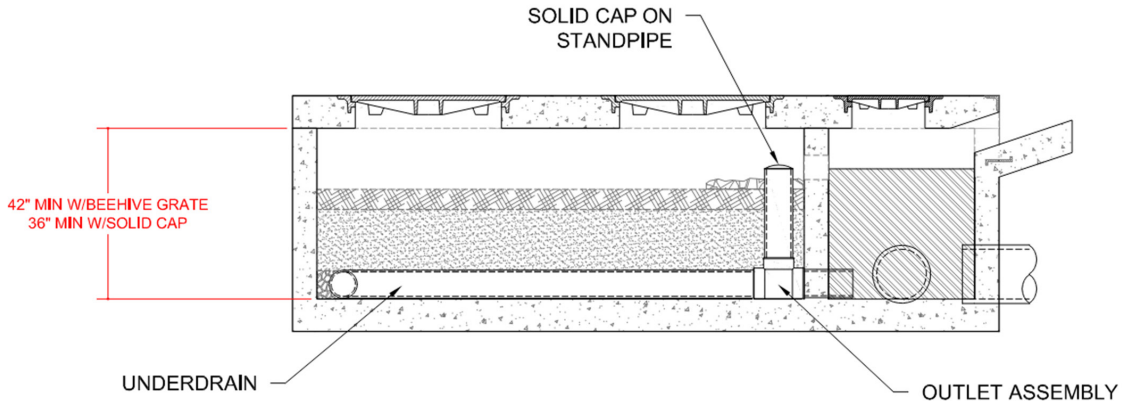
When trees are utilized, the maximum depth from top of structure to outlet is limited to 60" (1500 mm). For planted units without a bypass bay, minimum internal vault height from the bottom of top slab to outlet invert is 42" (1050 mm).

Figure 5: Minimum and Maximum Vault Heights for Planted Unit



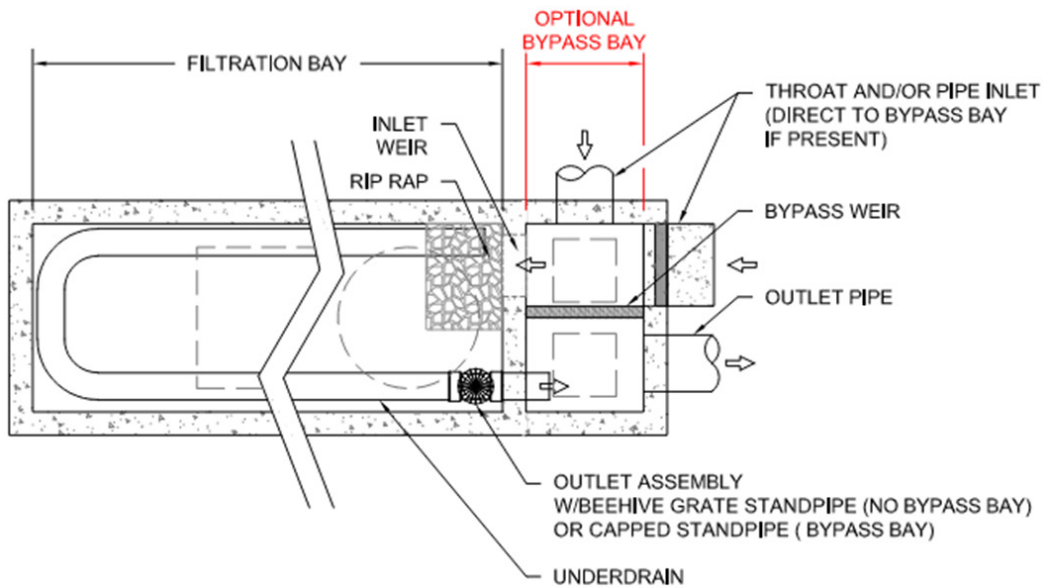
For units without plants, it is possible to lower the minimum internal height to 42" (1050 mm) with the typical bypass grate, or 36" (900 mm) with a solid cap. Note, a solid cap prevents bypass from occurring within the media bay. Appropriate measures should be taken to ensure peak flows can still bypass the unit (e.g., the addition of a bypass bay or an external bypass).

Figure 6: Minimum Internal Vault Heights for Non-Planted Units



For units where peak flows exceed the maximum hydraulic capacity of a unit, a bypass bay is recommended. All flows should be routed to the bypass when this configuration is utilized. The width of the bypass bay should be adjusted based on the required length of the bypass weir to achieve peak flows based on available head and freeboard. Note, the weir should maintain a minimum height of 32" (800 mm) corresponding to the design head required to achieve the treatment flow rate. The inlet weir to the treatment bay is set 29" (725 mm) above the outlet invert to ensure the treatment flow enters the treatment bay prior to any water bypassing the EcoStream media.

Figure 7: Three Bay Configuration for Units with Optional Bypass Bay



Installation

Installation of the EcoStream unit will involve subsurface excavation, placement of sub-base aggregate material, positioning/casting of the vault, and arrangement of the internal components. Proper installation of the unit is crucial to ensure performance in alignment with the parameters specified above. Please refer to the *EcoStream BioFiltration Installation Guide* for specifics on how the unit should be installed. Variance from the steps outlined in this document can result in an improperly functioning unit.

Depth to Groundwater Limitations

Non-infiltrating EcoStream system vaults are sealed so that they are watertight; therefore, they do not have depth-to-groundwater limitations. Once the system is filled with media it will be negatively buoyant. For infiltrating configurations of the EcoStream system, seasonal high groundwater elevation is an important factor to consider. Pursuant to the Stormwater Management Manual for Western Washington (Ecology 2019a), a groundwater mounding analysis should be conducted to determine the effect of local hydrologic conditions on BMP performance if seasonally high groundwater is within 15' (4.57 m) of the base of the system and the drainage area is greater than an acre. If this analysis indicates that infiltration will be infeasible, then the system should be installed in a non-infiltrating configuration.

Plants

Plants are not required to be utilized but if desired, choice of plant should align with local requirements and/or be chosen by a qualified landscape architect. If guidance is required, ADS can provide a generic plant guide for assistance in design. Please refer to local requirements/approvals to determine if plants are required for the EcoStream BioFilter in your area.



Design Summary Table

EcoStream Model	Media Bay Dimensions ¹ (Typical) ft x ft (m x m)	Media Bay Size ft ² (m ²)	Treatment Rate ² cfs (L/s)
ES16E	4 x 4 (1.2 x 1.2)	16 (1.49)	0.111 (3.1)
ES24E	4 x 6 (1.2 x 1.8)	24 (2.23)	0.167 (4.7)
ES32E	4 x 8 (1.2 x 2.4)	32 (2.97)	0.222 (6.3)
ES36E	6 x 6 (1.8 x 1.8)	36 (3.34)	0.250 (7.1)
ES40E	4 x 10 (1.2 x 3.0)	40 (3.72)	0.278 (7.9)
ES48E	6 x 8 (1.8 x 2.4)	48 (4.46)	0.333 (9.4)
ES60E	6 x 10 (1.8 x 3.0)	60 (5.57)	0.417 (11.8)
ES72E	6 x 12 (1.8 x 3.7)	72 (6.69)	0.500 (14.2)
ES80E	8 x 10 (2.4 x 3.0)	80 (7.43)	0.556 (15.7)
ES96E	8 x 12 (2.4 x 3.7)	96 (8.92)	0.667 (18.9)
ES112E	8 x 14 (2.4 x 4.3)	112 (10.41)	0.778 (22.0)
ES128E	8 x 16 (2.4 x 4.9)	128 (11.89)	0.889 (25.2)

1. These are typical dimensions. Models with different treatment cell dimensions are possible.
2. MTRF is based on 3.125 gpm/ft² (0.009 cfs/ft²) of effective filtration treatment area.

