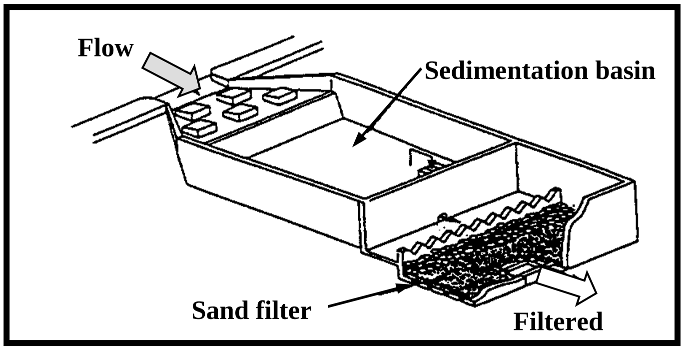
ACTIVITY: Water Quality Inlets and Media Filtration Inlets	ST – 06



CITY OF KNOXVILLE

Targeted Constituents

● Significant Benefit ◗ Partial Benefit ○ Low or Unknown Benefit

● Sediment	◗ Heavy Metals	◗ Floatable Materials	◗ Oxygen Demanding Substances	
◗ Nutrients	◗ Toxic Materials	◗ Oil & Grease	◗ Bacteria & Viruses	○ Construction Wastes

Description

This stormwater treatment BMP addresses a variety of water quality inlets, consisting of modified catch basins and media filtration inlets, with oil/water separators being specifically addressed in ST-07.

Modified catch basins contain an oversized sump, and also some type of inflow and outflow control to remove coarse sediments and floatable materials. Modified catch basins are effective as a pretreatment measure for other BMPs, but are not sufficient to provide stormwater treatment as a stand-alone measure.

Media filtration inlets use materials such as sand, peat, screens, or cloth to filter stormwater runoff. Sand filtration inlets can be constructed in a variety of layouts using precast vaults. Media filtration systems are available commercially with a wide range of materials and methods for easy installation and operation. Media filtration inlets will create a partial reduction in most pollutants if they are inspected, cleaned and maintained on a regular basis. A layer of organic material (such as peat moss) or potentially some types of clay can increase the removal of metallic ions and organic pollutants from stormwater runoff.

Suitable Applications

- Modified catch basins (with enhanced capability to capture coarse sediments and floating debris) and media filtration inlets may be used on commercial and industrial properties that have parking lots and vehicle traffic. This type of land use is likely to receive salts and sands for removing ice and snow, trash from vehicles, leaking oil and grease, and leaves and dirt from landscaping.
- Water quality inlets may be used for most impervious properties with parking lots and vehicles traffic. They are also highly recommended for commercial and industrial sites that generate fine particles, sediment, tailings, sawdust or other pollutants for which a media filtration inlet would be effective.

Approach

The various types of water quality inlets should be selected according to targeted constituents, site area constraints, cost and frequency of maintenance, and inspection requirements. Media filtration inlets can essentially be designed to filter any particle size and particle type imaginable at low to moderate flow rates. Many filtration systems are readily available from commercial vendors in a variety of sizes, layouts, and targeted pollutants. Water quality inlets can be designed for new property uses or can often be retrofitted onto existing stormwater drainage systems. <u>Water quality inlets must be</u>

constructed with watertight joints and seals to be effective.

A very important decision to be evaluated is the ability to bypass or convey large storm events that have the potential to damage the BMP system or resuspend collected pollutants. Figure ST-06-1 shows one method for allowing high-flow stormwater to bypass the BMP system; there are many other types of flow-splitting structures that allow the BMP system to function "off-line" rather than "on-line". It is recommended that water quality inlets and media filtration inlets should treat the 1-year design storm. Other storms which are mentioned in the vendor catalogs are also the 6-month design storm (80% of the 1-year storm) and the 3-month design storm (62% of the 1-year storm).

A very important consideration is the allocation of long-term resources for inspection, maintenance and repair. Water quality inlets should only be constructed if: 1) there is a maintenance plan to regularly inspect and maintain inlets on a long-term basis, and 2) there is an agreement or fiscal guarantee that the required maintenance resources will be available throughout the operation life of the water quality inlets. Without regular inspection and maintenance, a water quality inlet will fail and generally create a worse pollution problem than having no inlet at all.

Some advantages of water quality inlets are:

- Does not require a supply of water (such as wet detention basins or wetlands).
- Can be placed underground as part of the storm drainage system.
- Suitable for smaller catchments including parking lots and roadways.
- Many types of filters are suitable for larger drainage areas up to 5 or 10 acres.
- Sand or cartridged media filters may be particularly suitable for industrial sites because they can be located underground and industrial facilities generally have the resources to routinely inspect and maintain the systems.

This BMP fact sheet discusses the general uses of modified catch basins and media filtration inlets. The practices presented in ST-07, Oil/Water Separator, should also be reviewed when oil and grease are likely to be present in stormwater runoff.

A typical modified catch basin, as shown in Figure ST-06-2, will capture coarse sediments and floating debris. A modified catch basin could have many possible variations that will essentially perform the same function. The modified catch basin must have removable elements to allow inspection and cleaning of all pipes.

A sand filter is probably the most common type of media filtration system used.

Figure ST-06-3 shows a surface sand filter system, which is easier to inspect and usually less costly than an underground sand filter system. The detail shown can be sized to handle several acres. Filter cartridges or other media may also be acceptable alternatives to using sand if maintenance and operation considerations are addressed.

Figure ST-06-4 shows a manufactured BMP media filtration system called StormFilter, manufactured by Stormwater Management Inc. It is similar to the sand filter vault (shown in Figure ST-06-6), except for using media cartridges instead of sand. The internal valving, hardware and cartridges are installed into a precast concrete vault. Media cartridges are especially useful for industrial sites where specific types of particles can be targeted. Media cartridges can be designed to target specific pollutants such as sediments, oil and grease, organics, heavy metals, and soluble nutrients. StormFilter requires 2.3 feet of head differential across the unit to work properly. SMI also makes a high-flow bypass system called StormGate. Contact manufacturer for design and installation details and pricing at http://www.stormwaterinc.com

Two different types of underground sand filter layouts are also included as details.

Underground filtration systems are more difficult to inspect and maintain. On the other hand, underground filtration systems are protected from weather and other hazards, and they do not take up valuable real estate. Underground systems may exhibit odor problems during the summer because of a lack of bacterial degradation of accumulated organic matter and a lack of aeration within the wet pool.

The Delaware sand filter (Figure ST-06-5) is suitable for overland sheet flow from paved areas such as commercial properties or industrial sites. Originally designed by Mr. Earl Shaver for the state of Delaware, it has two parallel concrete trenches or vaults. The first concrete trench serves as a sedimentation basin and storage facility, to evenly distribute water across the sand filter in the second concrete trench. A clearwell is located at the end, with room for an overflow weir and underdrain system to outlet.

The underground sand filter (Figure ST-06-6) handles concentrated flow after it has already been collected within a storm drainage system. The front end of the system helps to trap sediment and floatable materials prior to entering the sand filter. The underground sand filter should contain an overflow bypass within the vault, or alternatively a flow-splitter prior to the system.

Figure ST-06-7 shows a grate inlet filter insert that uses trays to improve stormwater quality. Figure ST-06-8 shows a grate inlet filter insert that uses sorbent material to capture oil and grease. Some special types of sorbent material are durable and strong enough to remain in a filter tray for months, with exceptional capacity for absorbing oils and grease. Figure ST-06-9 shows two types of catch basin modifications that will produce clog-resistant media filtration inlets. In general, catch basin filter inserts should only be used wherever maintenance staff is available to check the filters frequently and where local flooding will not occur if the filters should clog. Some companies manufacture the insert frame (stainless steel or fiberglass), which can generally be fabricated in any size to match an existing or proposed inlet. The filter medium typically consists of a blown polypropylene filter with a dacron outer scrim, which is designed to handle oils, grease, PCBs and sediments. Contact manufacturers for design and installation details and pricing at:

http://www.aquashieldinc.com
http://www.suntreetech.com
http://www.abtechindustries.com

Two media filtration inlet manufacturers are included in this BMP. Manufactured systems should be selected on the basis of good design, suitability for desired pollution control goals, durability of materials, ease of installation, and reliability. The products listed here are not intended to be a specific endorsement or recommendation. It is incumbent upon the property owner and developer to carefully investigate the suitability and overall trustworthiness of each manufacturer and/or subcontractor.

Media filtration systems are most effective under smaller flow volumes such as the first flush volume (which is required to be treated according to the Knoxville Stormwater and Street Ordinance). Media filtration systems are generally not effective under conditions of heavy rainfall or floods. Furthermore, some systems can be damaged or the pollutants could be resuspended if operating under high-flow or flooding conditions. To prevent overloading filtration systems, there should be a mechanism to bypass or divert large flows. Commercially available systems may have a high-flow bypass built into the equipment.

Design Variables

There are no design requirements for a modified catch basin, other than the minimum dimensions shown in Figure ST-06-2. Extra attention may be required for multiple inlet pipes or special flow conditions, possibly requiring a larger size for a catch basin.

When using commercial products such as water quality inlets (media filtration inlets or oil/water separators), the manufacturer's recommendations should be considered in the product sizing and applicability. Verify that adequate stormwater treatment is provided and that high-flow bypass methods do not hinder the system from adequately treating the first flush volume. The first flush volume is described in the Knoxville Stormwater and Street Ordinance as 0.5" of stormwater runoff times the contributing drainage area.

A major drawback for a media filtration inlet is the need for elevation differences in the storm drainage system. A media filtration typically needs at least 5 feet of head loss available across the system, in order to accommodate live pool storage and sand filter thickness. Water quality inlets and media filtration inlets must be constructed with watertight joints and seals to be effective.

Filtration Volume:

The volume of the live pool for a sand filtration or other media filtration system shall usually be the first flush volume, which is intended to be slowly released through the filtration device after being treated. The live pool may include any storage capacity of incoming pipes and catch basins that is clearly not part of the dead pool volume. The dead pool volume is the portion of the filtration system which always has water (such as underground sand filters). Some examples of live pool volumes are shown in Figures ST-06-3, ST-06-5, and ST-06-6. Larger filtration volumes are typically much easier to accommodate within an open system such as the surface sand filter.

Filtration Surface Area:

The following equation is commonly used in Austin TX and throughout the state of Virginia (references 9 and 180) to determine the surface area of a sand filter:

$$A_S = 3630\ A_D\ D_{FF}\ D_S\ /\ (K\ T_D\ (D_S + D_W))$$

A_S = surface area of sand filter (square feet)

3630 = conversion factor from acre-inches to cubic feet

A_D = area draining to facility (acres)

D_{FF} = first flush depth (inches) - 0.5" for the City of Knoxville

D_S = depth of sand filter (feet) - 1.5' to 2.0' recommended sand depth

D_W = average water depth over sand filter (feet) - usually one-half the difference between top of sand and maximum water surface elevation

K = sand filter permeability (feet / hour) - recommended 2.0 feet / hour

T_D = drawdown time (hours) - 24 hours for the City of Knoxville

This equation is appropriate for sand filters with typical gradation from 0.02 to 0.04 inches diameter. Sand meeting standards of clean concrete sand (ASTM C 33) or fine aggregate for concrete (TDOT Section 903.01 in reference 172) will satisfy gradation requirements. The filter area must be increased if a smaller size of sand is used. Alternatively, measured values of sand filter permeability may be used to compute surface area with an appropriate safety factor (2.0 to 3.0) for clogging and compaction.

Additional design criteria for the surface sand filter (Figure ST-06-3) include:

- Size the control orifice or perforated riser pipe to allow for a 24-hour drawdown time, in conjunction with allowable sand filtration loading rate.
- Provide an energy dissipator prior to the sedimentation basin to reduce

turbulence. Consider using some type of flow-splitter immediately upstream of a surface sand filter.

- Typical length-to-width ratio of the sedimentation basin should be at least 3:1 (L:W) to prevent possible shortcutting. Allow for a minimum freeboard of 6”. Provide easy vehicle access to basin for maintenance and cleaning.

Additional design criteria for the Delaware sand filter (Figure ST-06-5) and the underground sand filter (Figure ST-06-6) include:

- The live pool volume typically is the most stringent requirement to meet. An adjacent vault may be needed to provide additional live pool volume. Ensure that stormwater runoff flow entering the sand filter is distributed evenly.
- Structural design should be performed by a professional engineer in areas where traffic loading is a concern. Otherwise, prevent vehicles from driving onto any type of underground structure while ensuring nearby access.
- Provide baffled walls to reduce entrance velocities. The front portion of the structure should contain a dead storage pool to retain floatable materials and sediment. For ease of inspection and maintenance, limit the depth of the dead pool volume to less than 4 feet.
- Provide adequate access for inspection, cleaning and maintenance activities for each chamber. Removable access covers are recommended for chambers that do not have adequate standing room. Provide steps or rungs as needed.
- Use geotextile fabric on top of the sand layer to prevent displacement. Use geotextile fabric beneath the sand layer to prevent loss of material through the gravel underdrain layer. Typical underdrain pipe is 4” diameter schedule 40 PVC pipe, with 3/8” perforations around the pipe diameter at 6” spacing. Place underdrains at 5’ lateral spacing with a 1% to 2% positive grade.

A pretreatment sedimentation basin is essential to avoid rapid clogging of the filter medium. Since peat seems to be very effective at removing dissolved contaminated such as heavy metals, there has been research into using peat/sand mixtures (references 47 and 119) which are subject to clogging problems. Research has also indicated that compost made from leaves is very effective at removing dissolved phosphorus and metals, and oil and grease (reference 110). Field research at Austin, Texas (reference 10) indicates that the surface sand filter has a removal efficiency of total suspended solids that is similar to wet and dry detention basins: about 70 to 90%. Removal rates for heavy metals, oil and grease vary from 20% to 80%, depending on the application.
Consult references 10, 105, and 120 for additional design and maintenance criteria. Inspection and maintenance frequency will also greatly affect pollutant removal rates.

Catch Basin Inserts

Catch basin inserts are ideal for industrial sites as they fit into existing catch basins, and therefore may avoid the need for an “end-of-pipe” facility. Typical catch basin inserts are shown in Figures ST-06-7 and ST-06-8, consisting of a series of trays or sorbent roles/tubes. The top trays are designed to capture coarse sediments, and lower trays may capture finer sediments or specific pollutants. Inserts made from fiberglass insulation materials can achieve up to 90% removal for heavy metals, oils and grease (reference 74). Since catch basin inserts require frequent inspection and maintenance, they should only be used where a full-time maintenance person is located on the site (typically at large commercial or industrial facilities). A typical insert design may have a high-flow bypass and should be hydraulically designed to allow stormwater runoff into the drain system without danger of local flooding.

Maintenance

- Inspect modified catch basins and media filtration systems on a regular basis, typically every month and after heavy rainfalls. Record observations in an inspection log and takes pictures as necessary to document conditions. Make immediate repairs as needed. Clean or replace filtration media as needed to prevent clogging.
- Perform cleanout on a regular basis using confined-space procedures and equipment as required by OSHA regulations, such as nonsparking electrical equipment, oxygen meter, flammable gas meter, etc. Remove trash, debris, sediments or clogged media as needed, and then dispose of them properly. Sediments or clogged media may contain heavy metals or other toxic substances and should be handled as hazardous waste. Removal of sediment or clogged media depends on the accumulation rate, available storage, watershed size, nearby construction, industrial or commercial activities upstream, etc. Sediment or clogged media should be tested for identification of pollutants prior to disposal.
- Some sediment may contain contaminants for which the Tennessee Department of Environment and Conservation (TDEC) requires special disposal procedures. Consult TDEC - Division of Water Pollution Control (594-6035) if uncertain about what the sediments contain or if it is known to contain contaminants. Generally, give special attention or sampling to sediments accumulated in industrial or manufacturing facilities, fueling centers or automotive maintenance areas, large parking areas, or other areas where pollutants are suspected to accumulate.
- It is generally more cost efficient to clean the filtration media. For sand filters, cleaning or replacement of the top few inches may restore the permeability rate. Failure to clean the filter surface regularly may result in the need to replace the entire media because of penetration of fines into the filter.

Limitations

- Media filtration systems and modified catch basins will require more frequent inspection and maintenance than most other stormwater treatment BMPs. Filtration media will need to be cleaned and/or replaced frequently. There is very high potential for severe clogging or reduced pollutant removal efficiency in filtration systems, particularly if there are unstabilized soil surfaces upstream. Do not operate filtration systems until upstream erosion areas are controlled.
- Media filtration systems cause a large head loss that may require special consideration in the hydraulic design of the overall stormwater collection system. Systems may typically require vertical filtration through at least 18 inches of sand and 6 inches of underdrain material, for an absolute minimum head loss of 2.5 feet.

References **9, 10, 31, 33, 34, 35, 38, 47, 74, 77, 105, 110, 119, 120, 172, 180, vendor information** (see BMP Manual Chapter 10 for list)

A high-flow bypass structure may also be constructed in a rectangular structure or an open channel using diversion weirs.

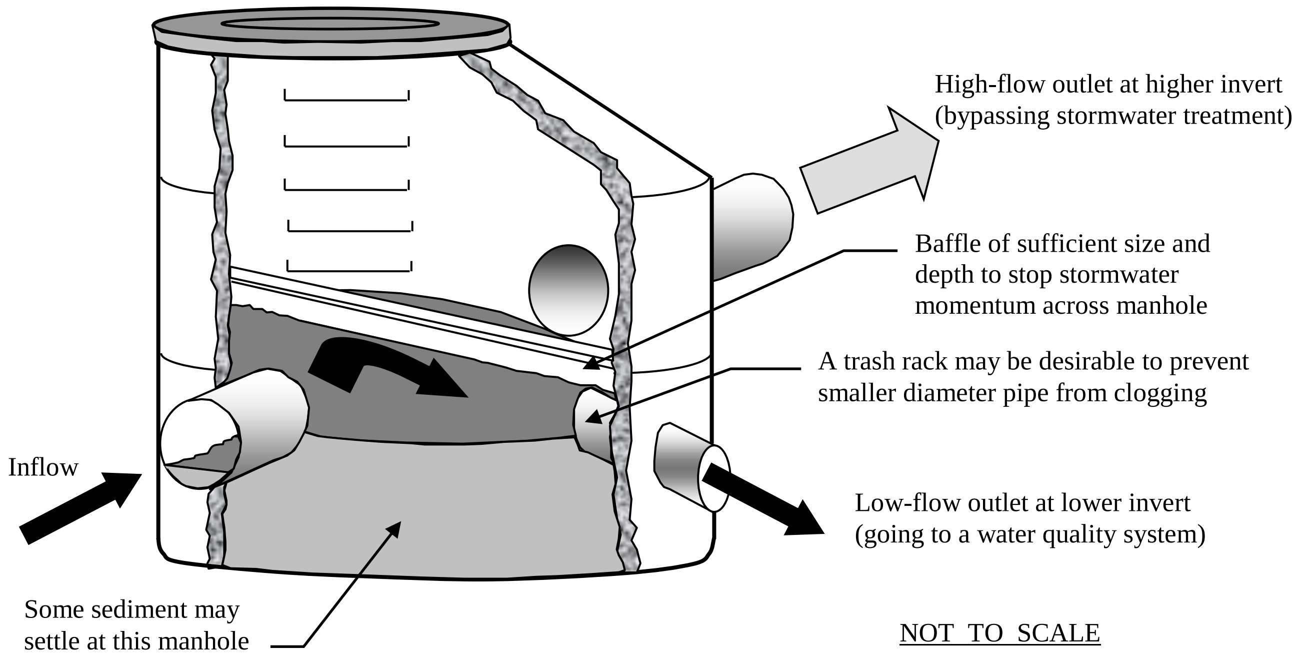


Figure ST-06-1
Typical Stormwater High-Flow Bypass Manhole

Notes:

1. Securely attach pipe elbow, tee or cross to the manhole or structure to resist expected flow velocities and forces. Bolts or other removable fasteners should preferably be used. Cross braces or other supports may be necessary.
2. A modified catch basin is a good practice for areas with potential sediment loads, and as a pretreatment unit for most other stormwater treatment BMPs.

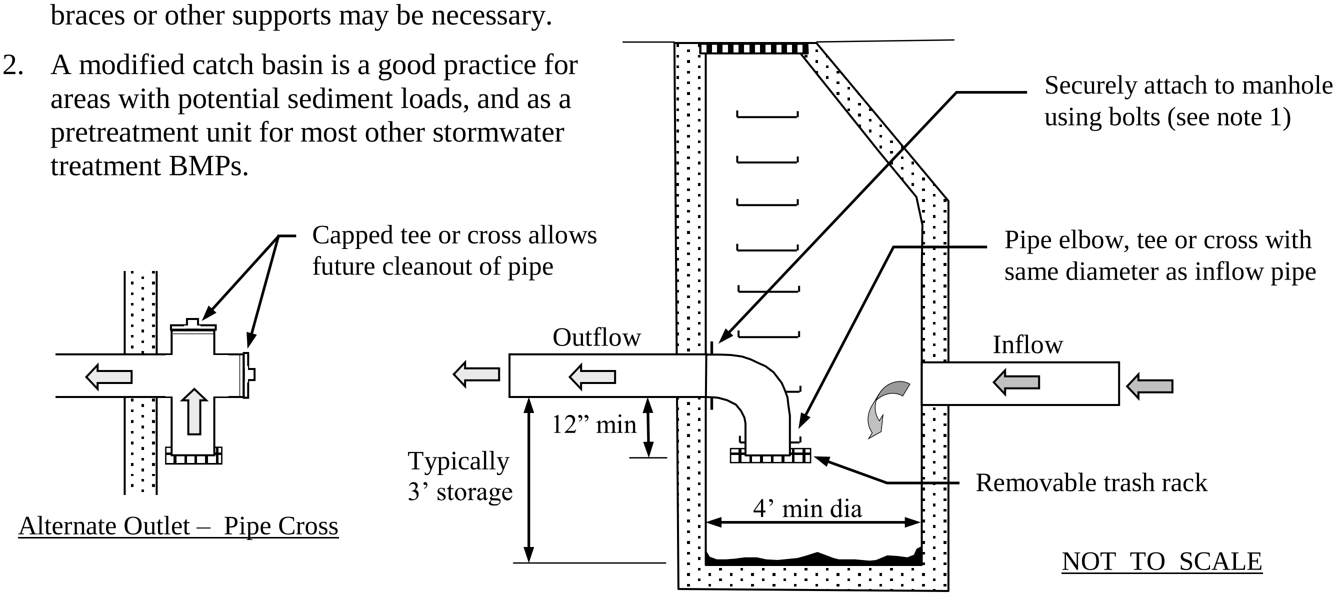


Figure ST-06-2
Modified Catch Basin

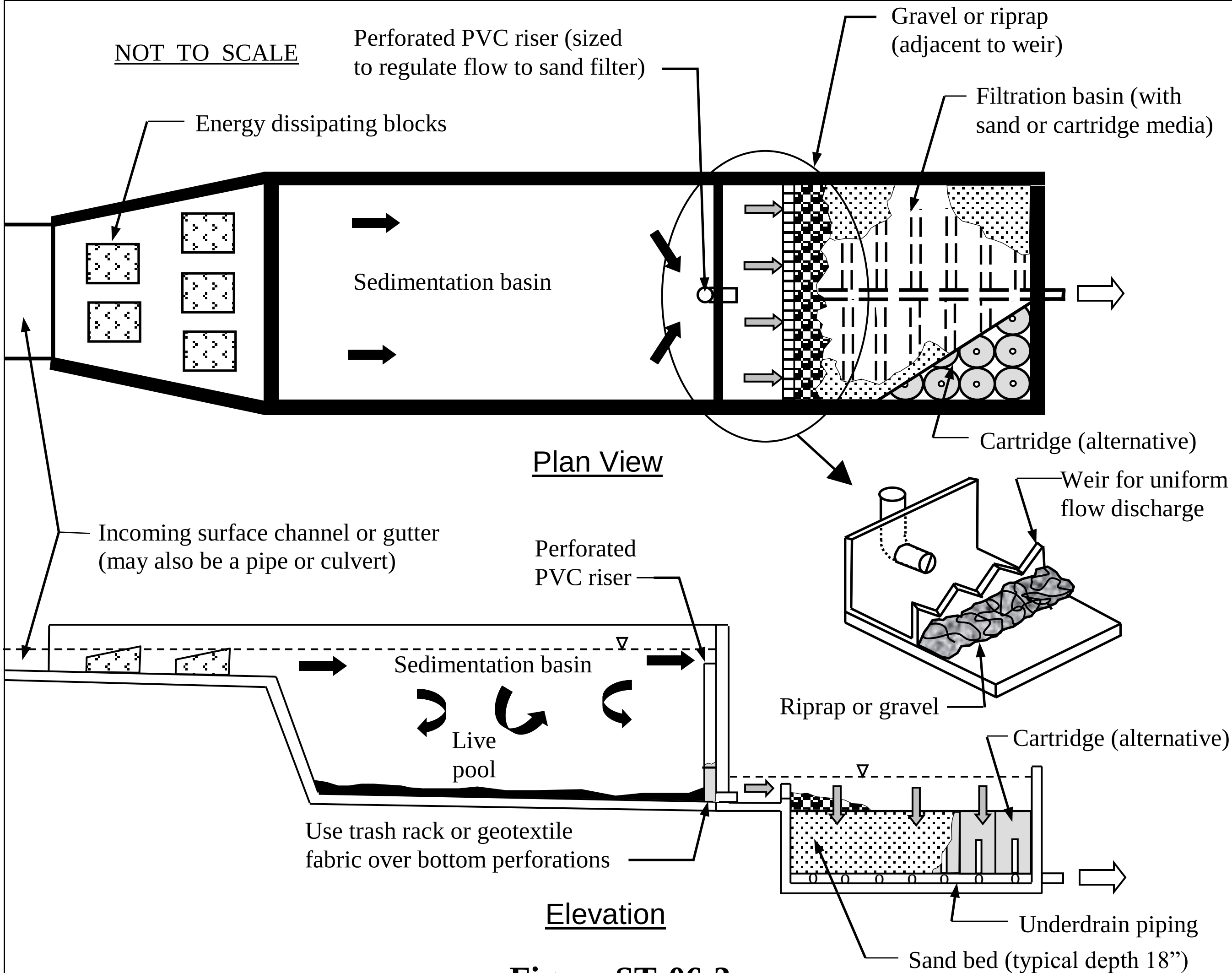
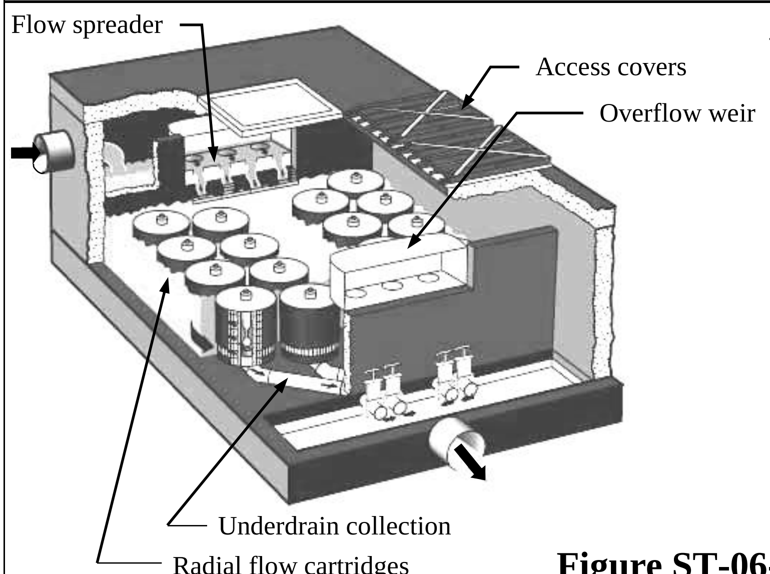


Figure ST-06-3
Surface Sand Filter



Notes:

1. StormFilter is manufactured by Stormwater Management Inc. located in Portland, Oregon. The end product consists of a precast vault (sized by SMI and produced by a local precast vendor) and the necessary valving and hardware. SMI also makes a high-flow bypass system called StormGate. See http://www.stormwaterinc.com for details.
2. Media cartridges can be designed to target specific pollutants such as sediments, oil and grease, organics, heavy metals, and soluble nutrients. The StormFilter requires 2.3 feet of head differential across unit.

NOT TO SCALE

Figure ST-06-4
StormFilter (Media Cartridge)

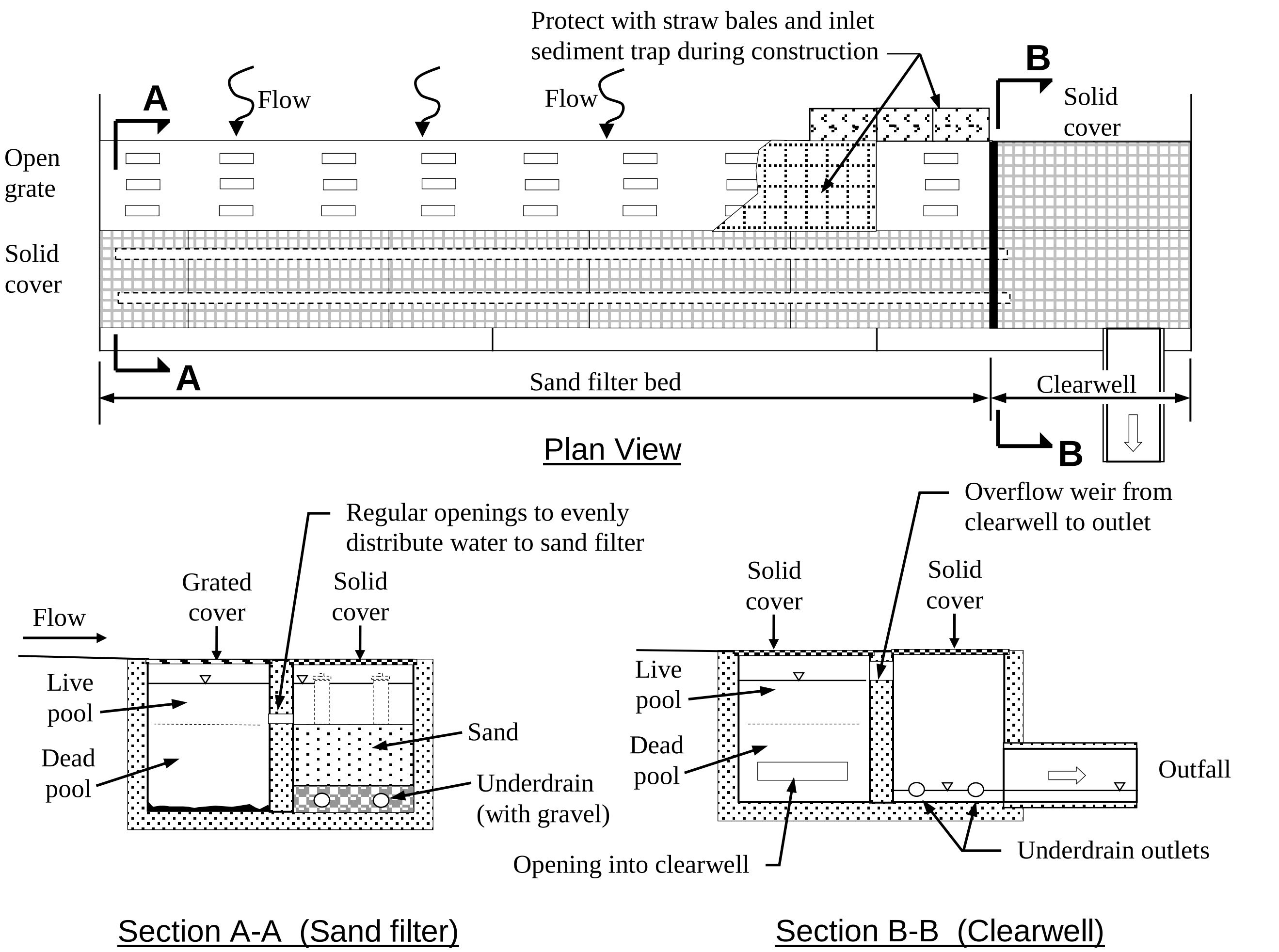


Figure ST-06-5
Delaware Sand Filter

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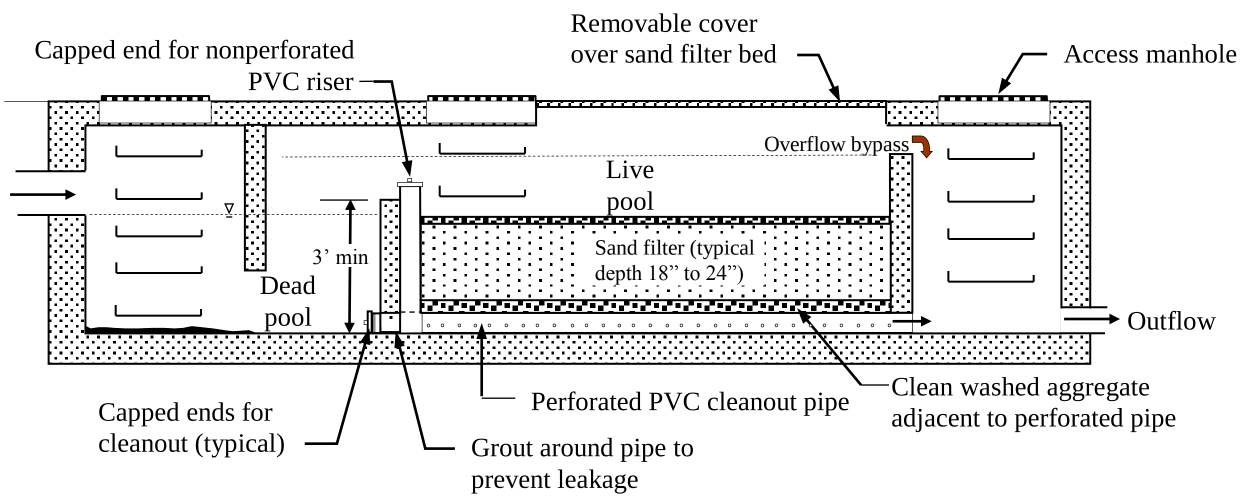

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Figure ST-06-6
Underground Sand Filter

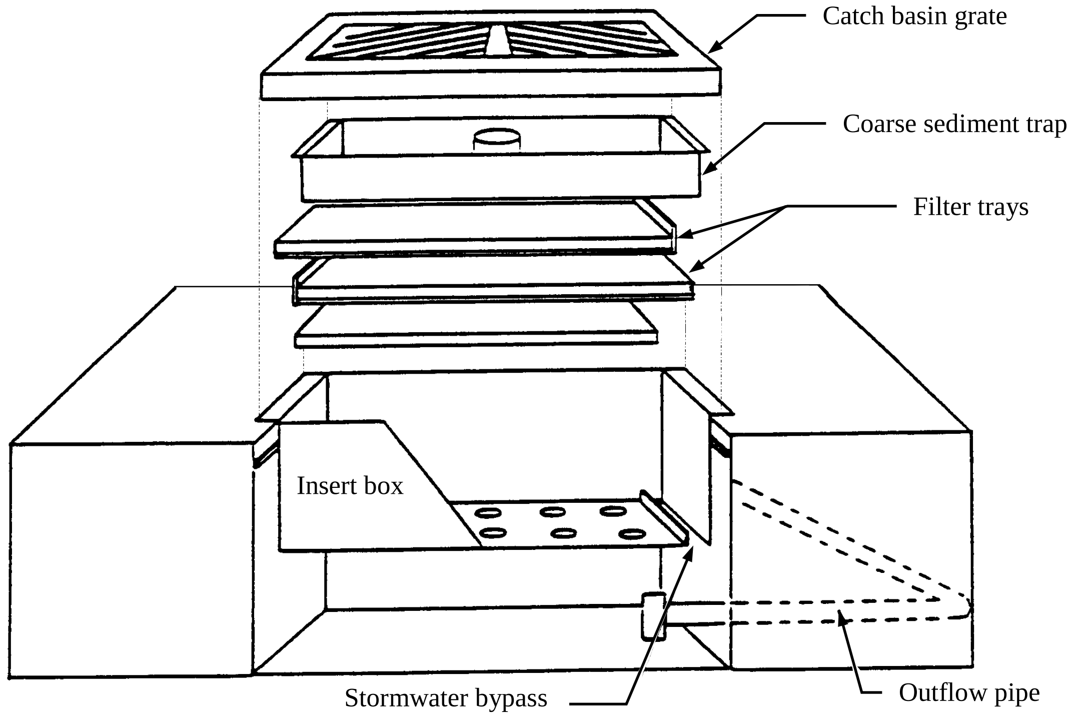

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Figure ST-06-7
Typical Grate Inlet Filter (with Filter Trays)

Typical manufacturers of grate inlet inserts –

http://www.aquashieldinc.com

http://www.suntreetech.com.

http://www.abtechindustries.com

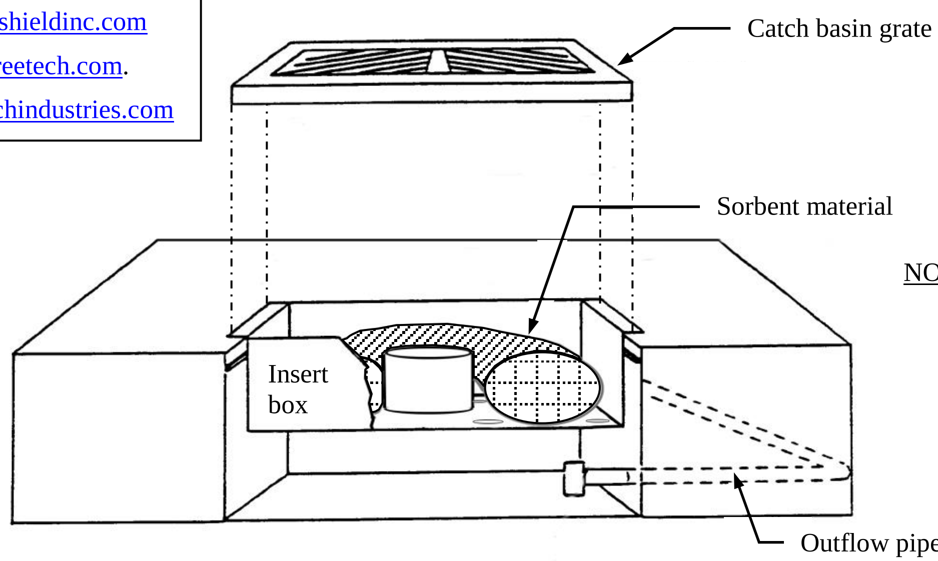

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Figure ST-06-8
Typical Grate Inlet Filter (with Sorbent Material)

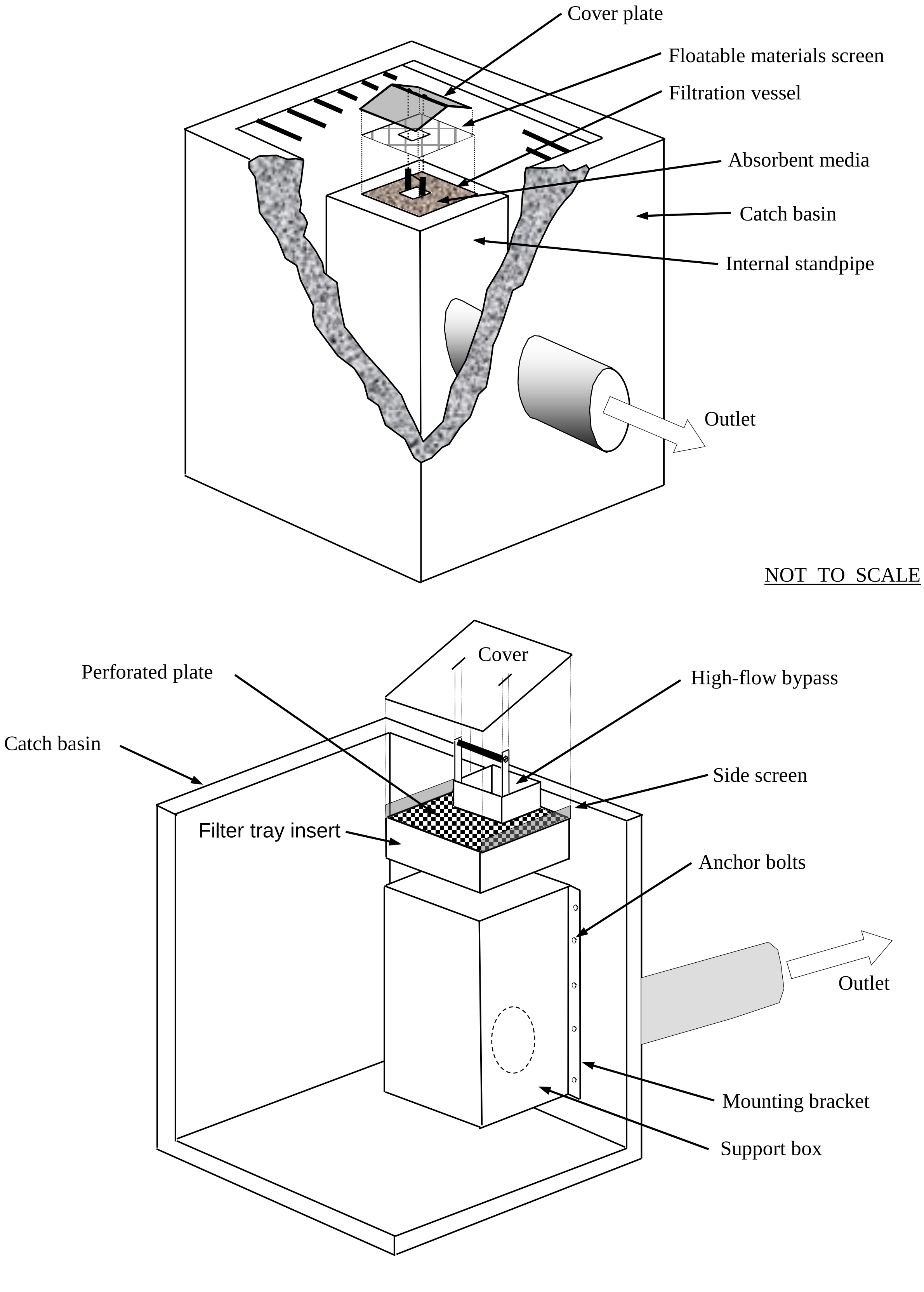

Figure ST-06-9
Clog-Resistant Media Filtration Inlets