Section 3.6. Stormwater Filtering Systems

Definition. Practices that capture and temporarily store the design storm volume and pass it through a filter bed of sand media. Filtered runoff may be collected and returned to the conveyance system or allowed to partially infiltrate into the soil. Design variants include:

- F-1 Non-structural sand filter
- F-2 Surface sand filter
- F-3 Three-chamber underground sand filter
- F-4 Perimeter sand filter
- F-5 Proprietary filters

Bioretention also functions as a stormwater filtering system; however, due to the prevalence and variety of these particular practices, bioretention is included as a separate section (Section 3.5) in this Stormwater Management Guidebook (SWMG).

Stormwater filters are a useful practice to treat stormwater runoff from small, highly impervious sites. Stormwater filters capture, temporarily store, and treat stormwater runoff by passing it through an engineered filter media, collecting the filtered water in an underdrain, and then returning it back to the storm drainage system. The filter consists of two chambers: the first is devoted to settling, and the second serves as a filter bed consisting of a sand filter media.

Stormwater filters are a versatile option because they consume very little surface land and have few site restrictions. They provide moderate pollutant removal performance at small sites where space is limited. However, filters have limited or no runoff volume reduction capability, so designers should consider using up-gradient runoff reduction practices, which have the effect of decreasing the design storm volume and size of the filtering practices. Filtering practices are also suitable to provide special treatment at designated stormwater hotspots. A list of potential stormwater hotspots operations can be found in Appendix Q.

Filtering systems are typically not to be designed to provide stormwater detention (Qp_2, Qp_{15}), but they may be in some circumstances. Filtering practices are generally combined with separate facilities to provide this type of control. However, the three-chamber underground sand filter can be modified by expanding the first or settling chamber, or adding an extra chamber between the filter chamber and the clear well chamber to handle the detention volume, which is subsequently discharged at a pre-determined rate through an orifice and weir combination.

Proprietary filters must be verified for adequate performance, sizing, and longevity (see Section 3.12).

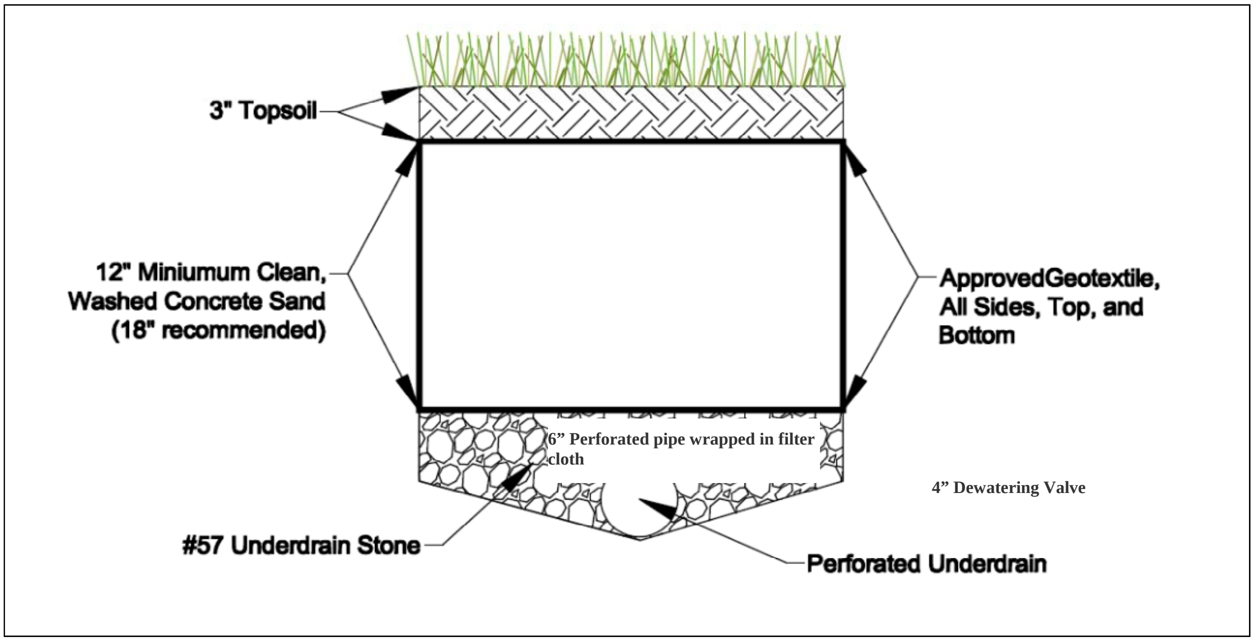

Figure 3.6.1. A Typical Schematic for a Surface Sand Filter (F-2). *Note: Material specifications are indicated in Table 3.6.1.*

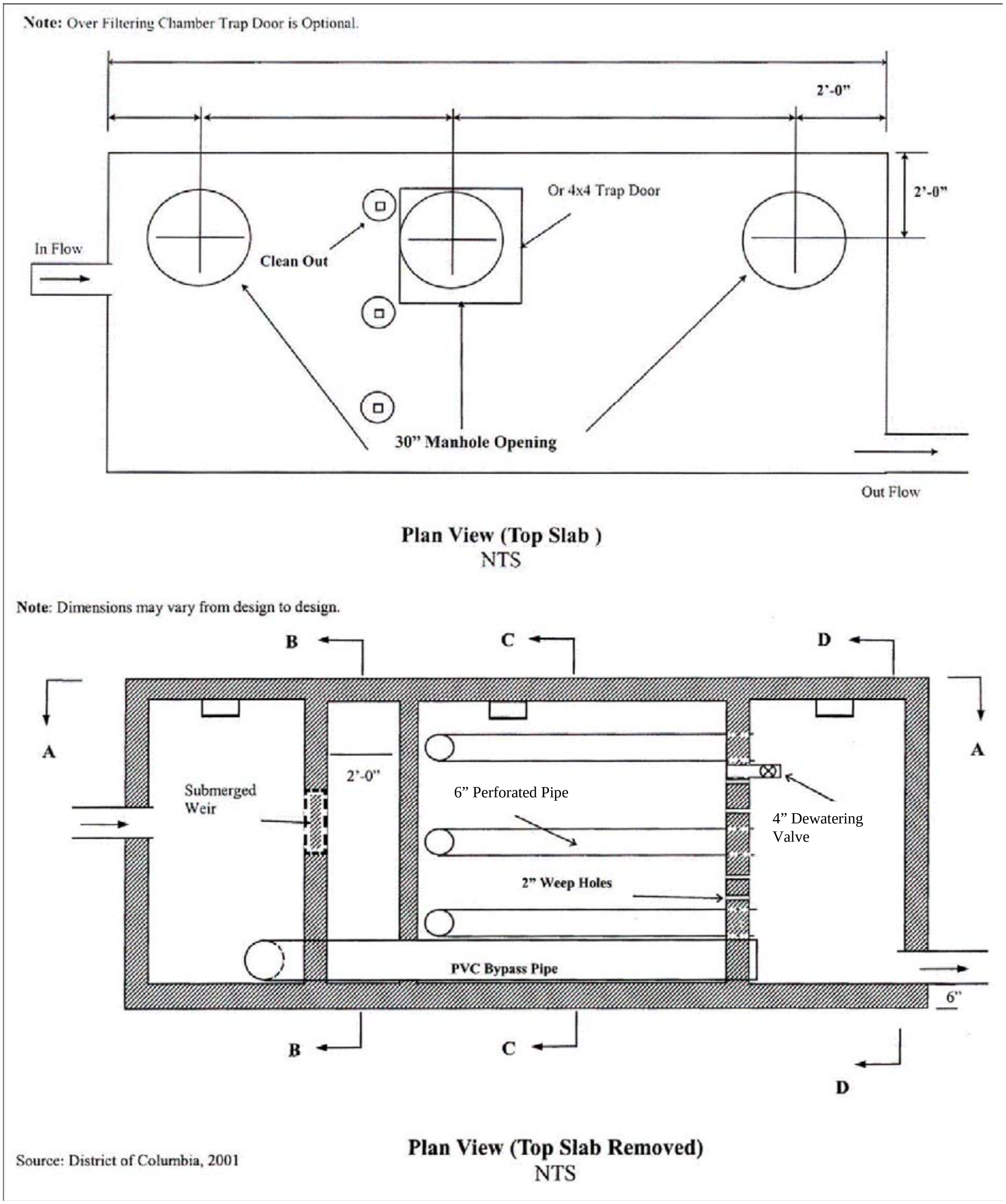

Figure 3.6.2(a). Example of Three-Chamber Underground Sand Filter (F-3) for Separate Sewer Areas. *Note: Material specifications are indicated in Table 3.6.1.*

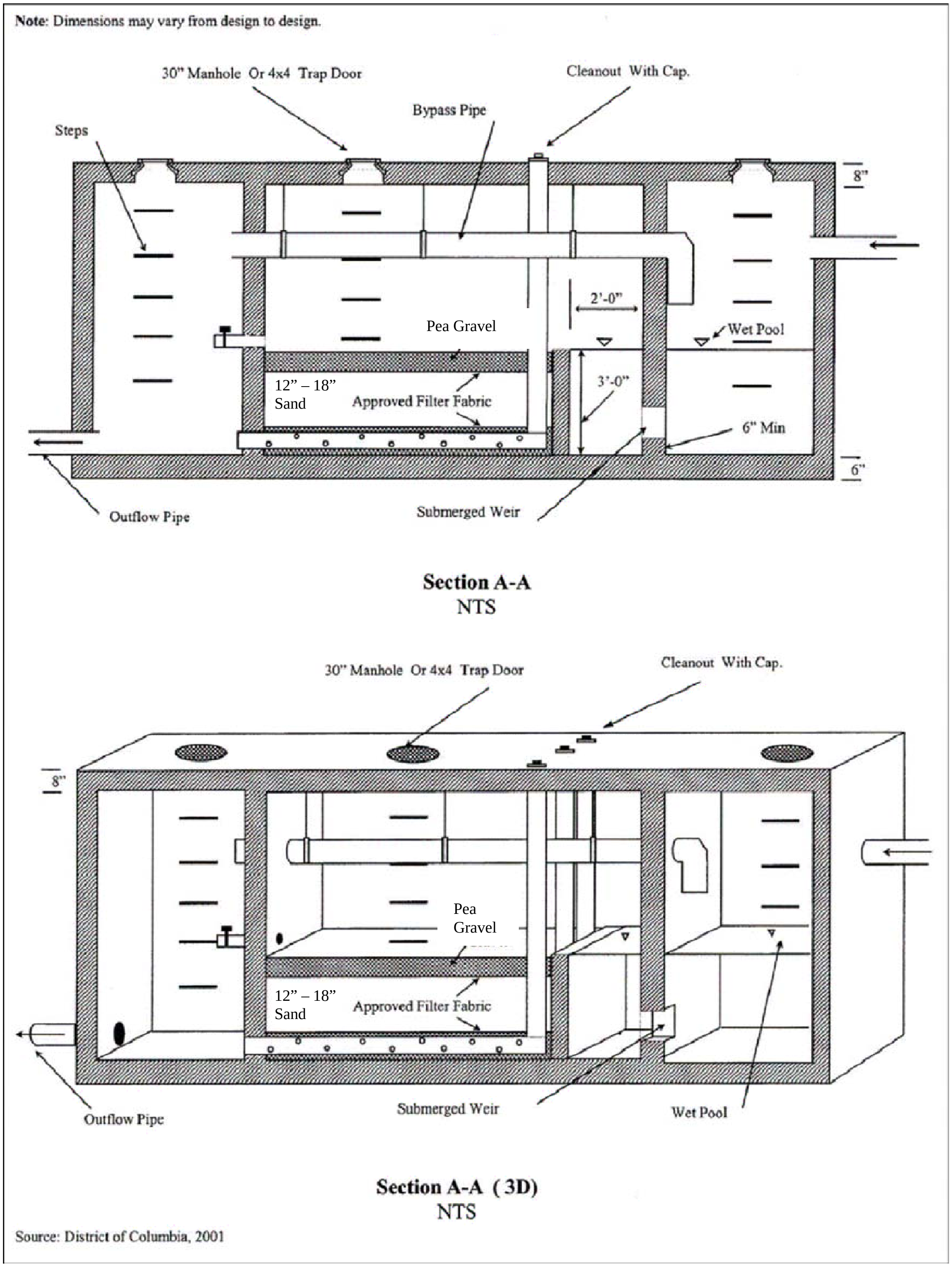

Figure 3.6.2(b). Example of Three-Chamber Underground Sand Filter (F-3) for Separate

Sewer Areas. *Note: Material specifications are indicated in Table 3.6.1.*

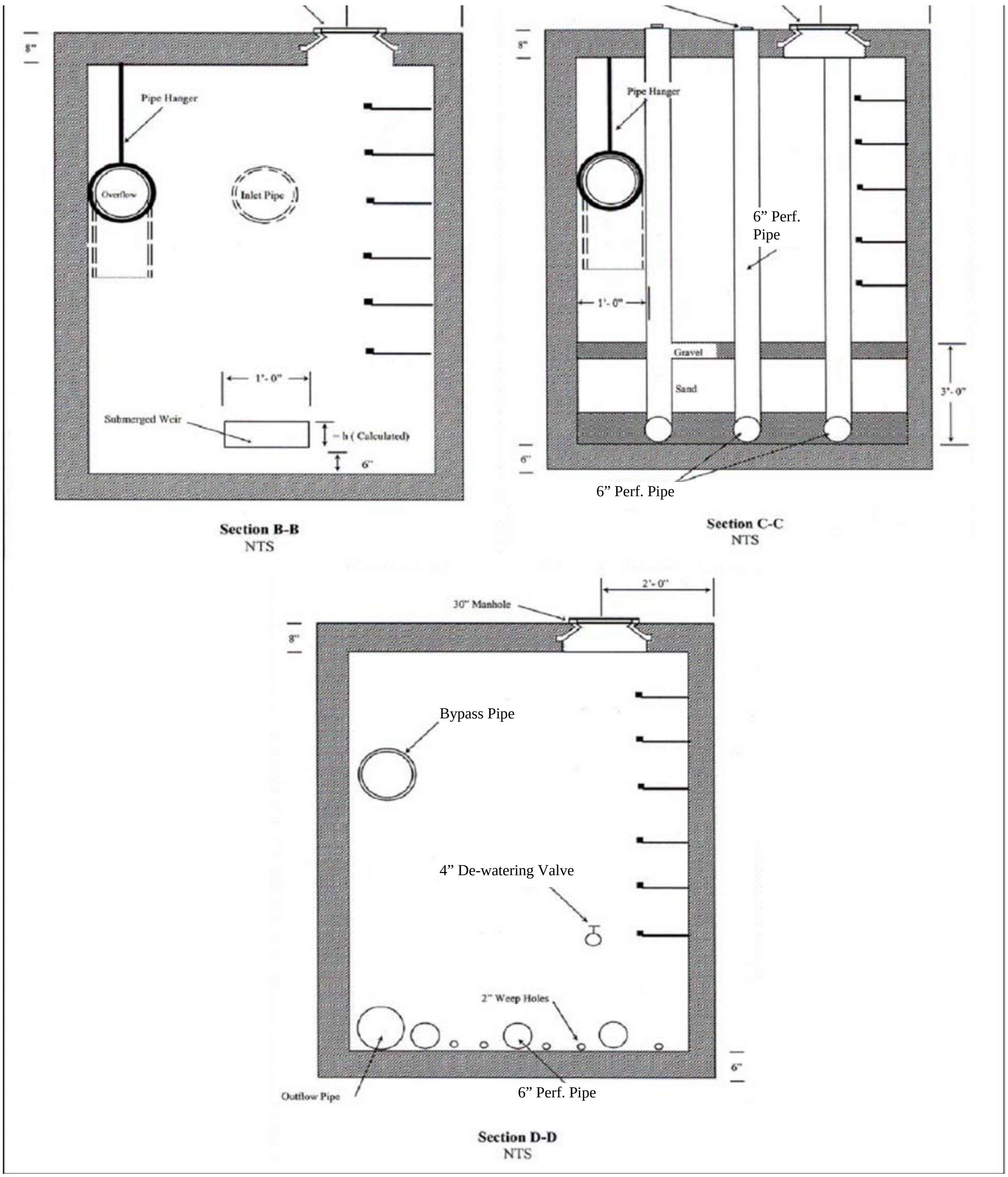

Figure 3.6.2(c). Example of Three-Chamber Underground Sand Filter (F-3) for Separate

Sewer Areas. *Note: Material specifications are indicated in Table 3.6.1.*

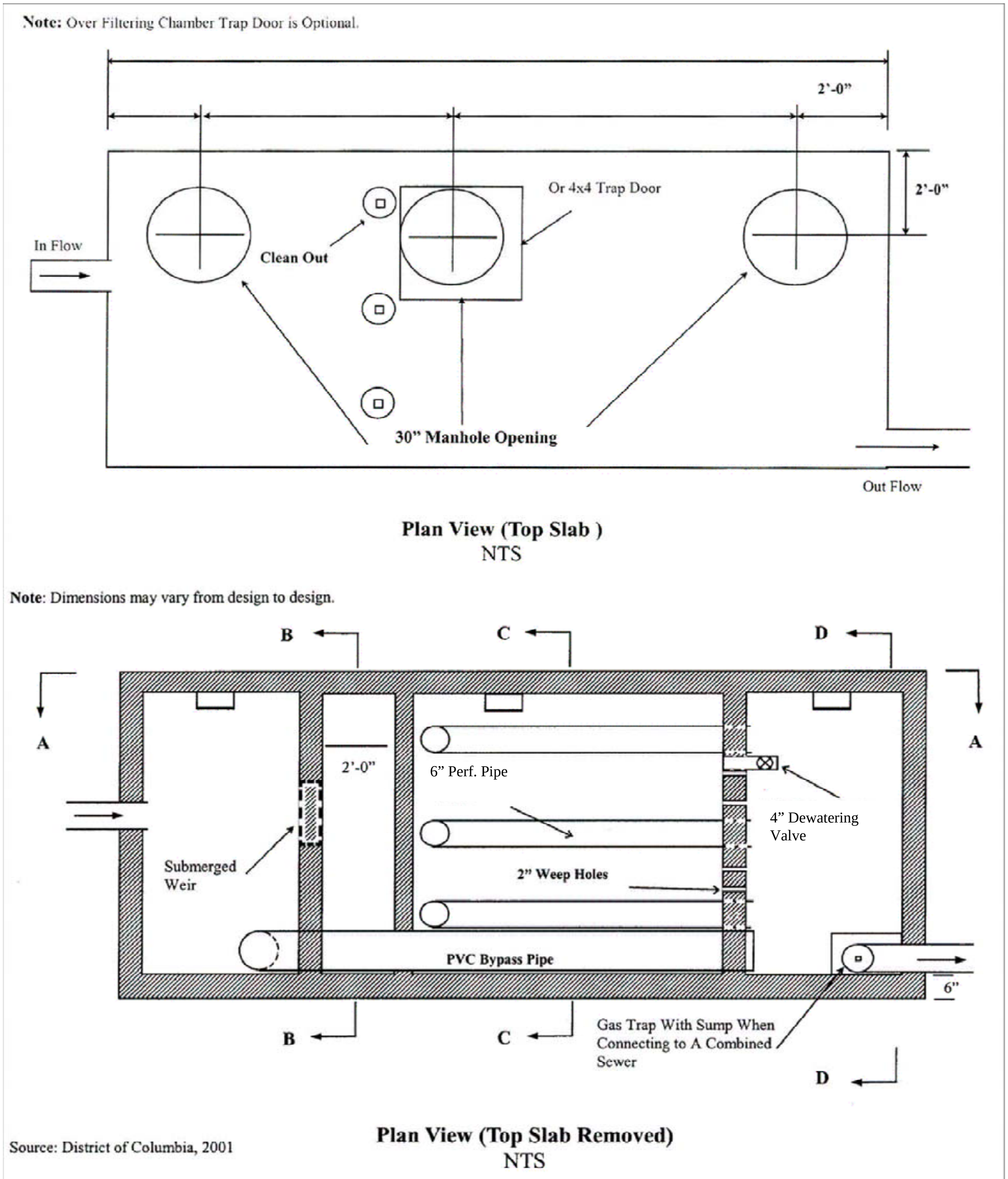

Figure 3.6.3(a). Example of Three-Chamber Underground Sand Filter (F-3) for Combined Sewer Areas. *Note: Material specifications are indicated in Table 3.6.1.*

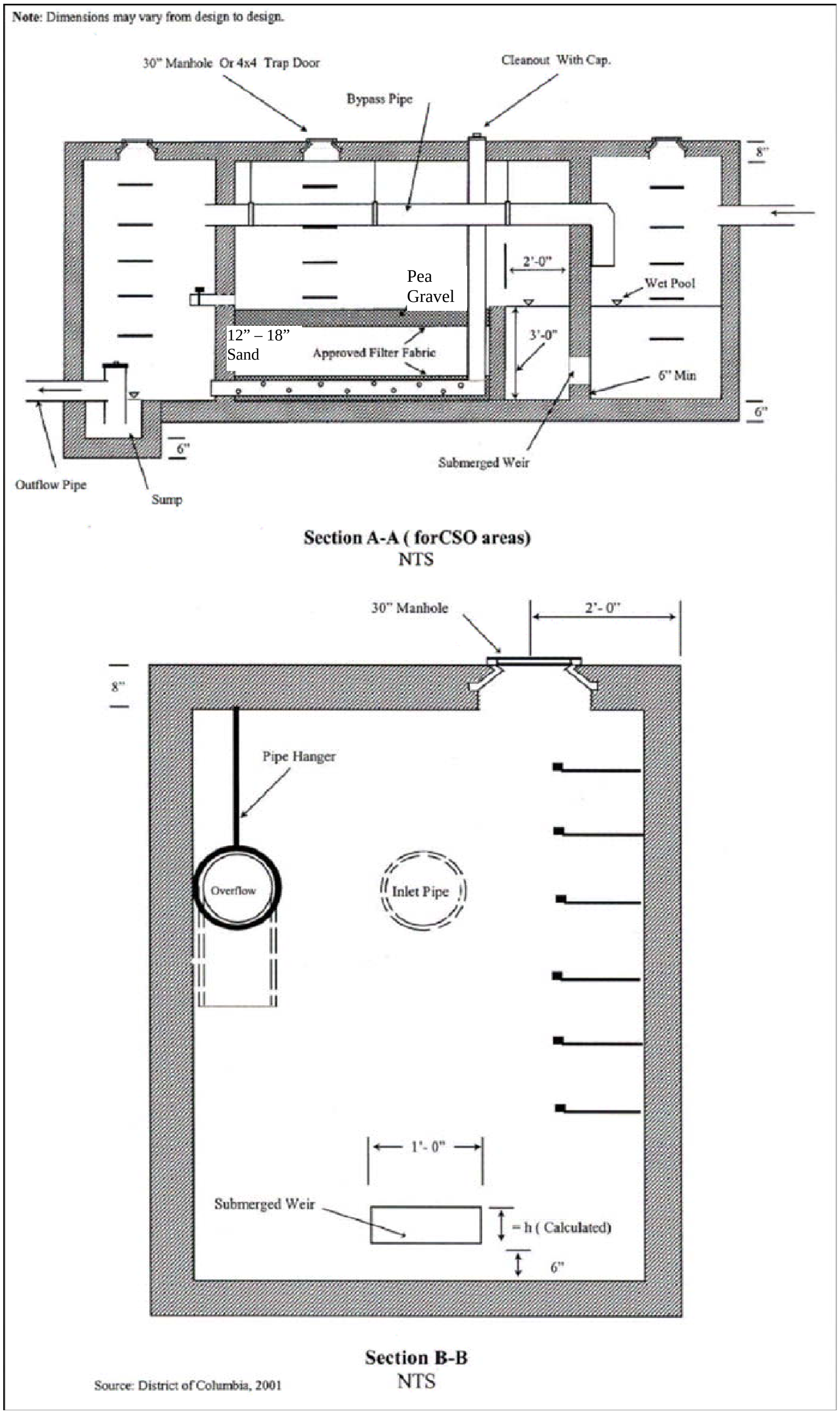

Figure 3.6.3(b). Example of Three-Chamber Underground Sand Filter(F-3) for Combined

Sewer Areas. *Note: Material specifications are indicated in Table 3.6.1.*

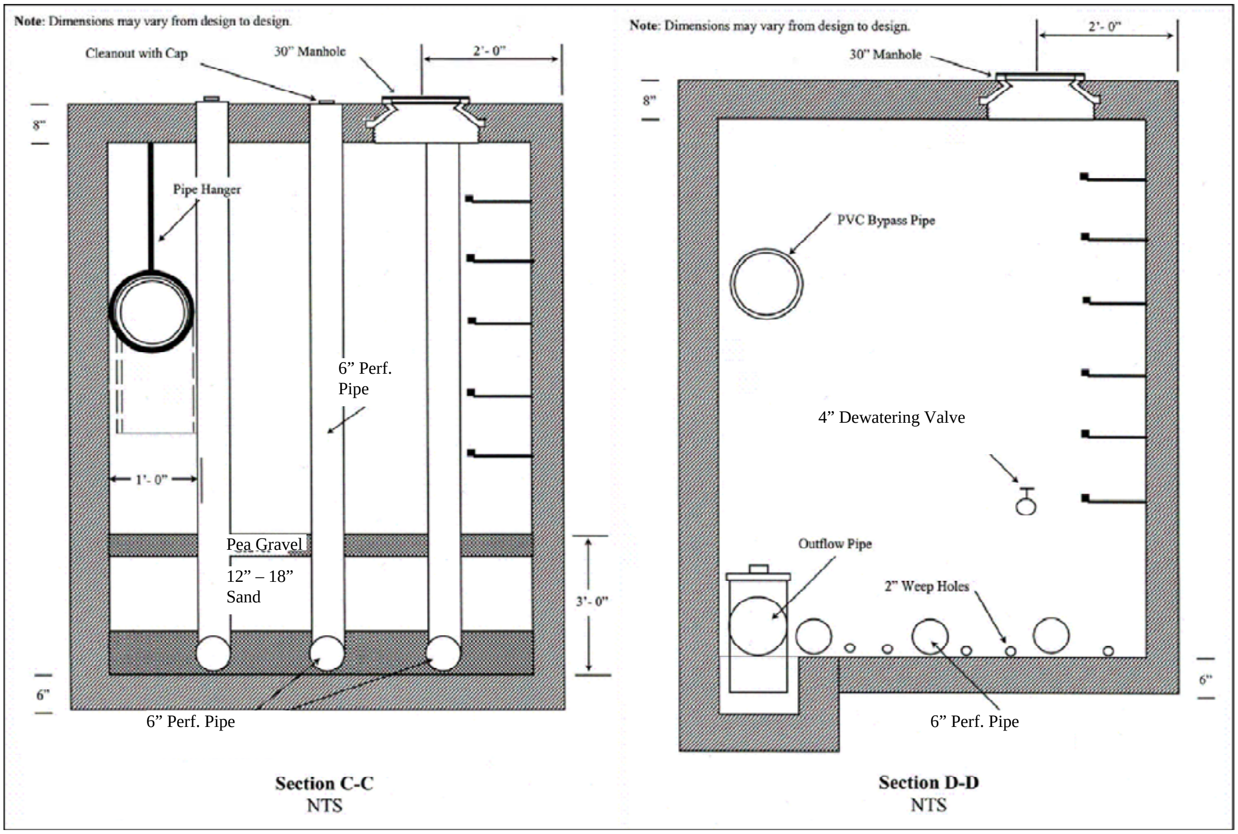

Figure 3.6.3(c). Example of Three-Chamber Underground Sand Filter (F-3) for Combined Sewer Areas. *Note: Material specifications are indicated in Table 3.6.1.*

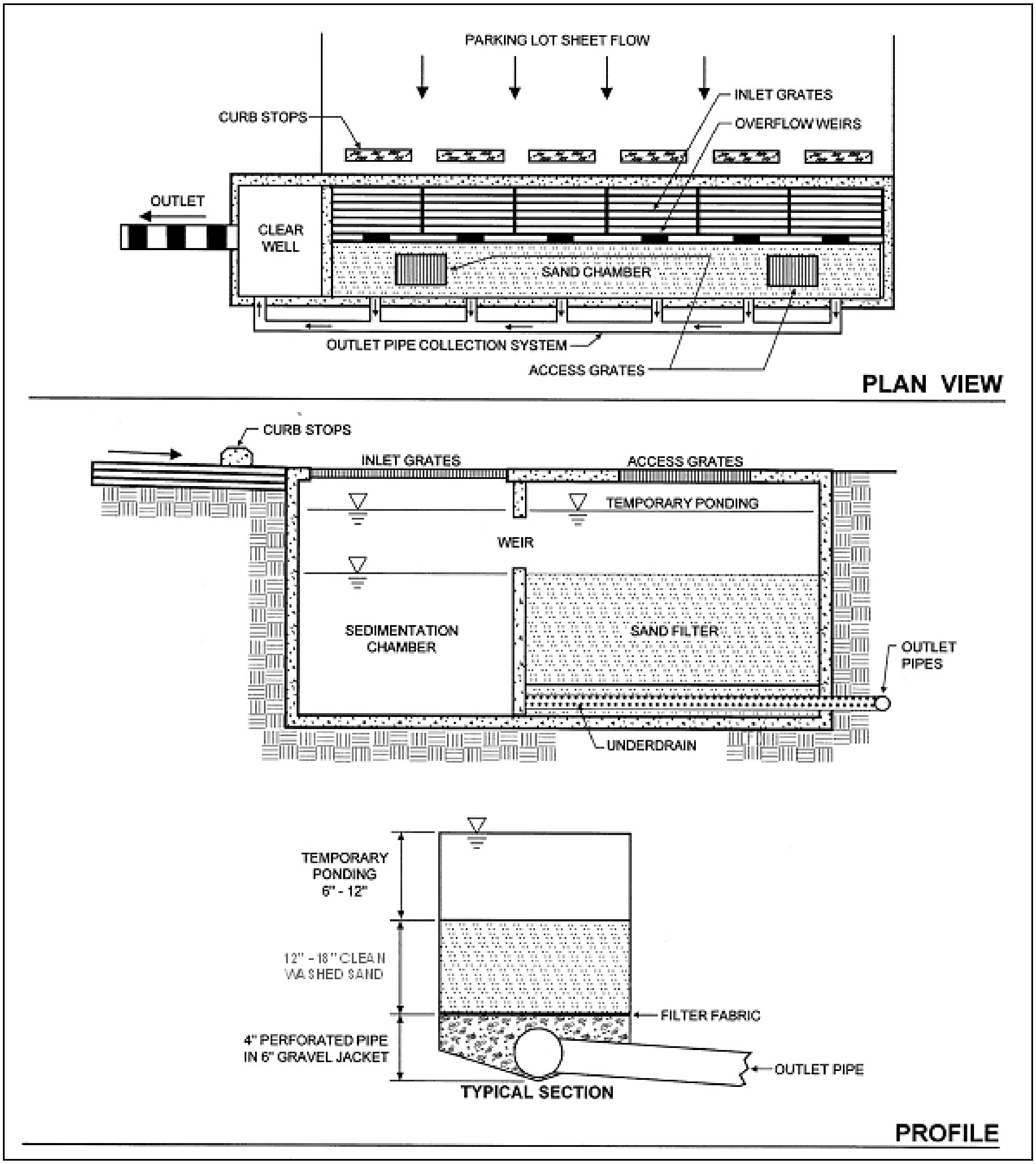

Figure 3.6.4. Example of Perimeter Sand Filter (F-4). *Note: Material specifications are indicated in Table 3.6.1.*

3.6.1. Filtering Feasibility Criteria

Stormwater filters can be applied to most types of urban land. They are not always cost-effective, given their high unit cost and small area served, but there are situations where they may clearly be the best option for stormwater treatment (e.g. hotspot runoff treatment, small parking lots, ultra-urban areas, etc.). The following criteria apply to filtering practices:

Available Hydraulic Head. The principal design constraint for stormwater filters is available hydraulic head, which is defined as the vertical distance between the top elevation of the filter and the bottom elevation of the existing storm drain system that receives its discharge. The head required for stormwater filters ranges from 2 to 10 feet, depending on the design variant. It is difficult to employ filters in extremely flat terrain, since they require gravity flow through the filter. The only exception is the perimeter sand filter, which can be applied at sites with as little as 2 feet of head.

Depth to Water Table and Bedrock. The designer must assure a standard separation distance of at least 2 feet between the seasonally high groundwater table and/or bedrock layer and the bottom invert of the filtering practice.

Contributing Drainage Area. Filters are best applied on small sites where the contributing drainage (CDA) area is as close to 100% impervious as possible in order to reduce the risk that eroded sediments will clog the filter. A maximum CDA of 5 acres is recommended for surface sand filters, and a maximum CDA of 2 acres is recommended for perimeter or underground filters. Filters have been used on larger drainage areas in the past, but greater clogging problems have typically resulted. The one-chamber sand filter is only applicable for impervious area less than 10,000 ft^2 (1/4 acre).

Space Required. The amount of space required for a filter practice depends on the design variant selected. Surface sand filters typically consume about 2% to 3% of the CDA, while perimeter sand filters typically consume less than 1%. Underground stormwater filters generally consume no surface area except their manholes.

Land Use. As noted above, filters are particularly well suited to treat runoff from stormwater hotspots and smaller parking lots. Other applications include redevelopment of commercial sites or when existing parking lots are renovated or expanded. Filters can work on most commercial, industrial, institutional, or municipal sites and can be located underground if surface area is not available.

Site Topography. Filters shall not be located on slopes greater than 6%.

Utilities. All utilities shall have a minimum 5 feet horizontal clearance from the filtering practice.

Facility Access. All filtering systems shall be located in areas where they are accessible for inspection and for maintenance (by vacuum trucks).

Soils. Soil conditions do not constrain the use of filters. At least one soil boring must be taken at a low point within the footprint of the proposed filtering practice to establish the water table and bedrock elevations and evaluate soil suitability. A geotechnical investigation is required for all underground stormwater Best Management Practices (BMPs), including underground filtering systems. Geotechnical testing requirements are outlined in Appendix P.

3.6.2. Filtering Conveyance Criteria

Most filtering practices are designed as off-line systems so that all flows enter the filter storage chamber until it reaches capacity, at which point larger flows are then diverted or bypassed around the filter to an outlet chamber and are not treated. Runoff from larger storm events should be bypassed using an overflow structure or a flow splitter. Claytor and Schueler (1996) and ARC (2001) provide design guidance for flow splitters for filtering practices.

Some underground filters will be designed and constructed as on-line BMPs. In these cases, designers must indicate how the device will safely pass larger storm events (e.g. the 15-year event) to a stabilized water course without resuspending or flushing previously trapped material.

All stormwater filters should be designed to drain or dewater within 72 hours after a storm event to reduce the potential for nuisance conditions.

3.6.3. Filtering Pre-treatment Criteria

Adequate pre-treatment is needed to prevent premature filter clogging and ensure filter longevity. Dry or wet pre-treatment shall be provided prior to filter media. Pre-treatment devices are subject to the following criteria:

- Sedimentation chambers are typically used for pre-treatment to capture coarse sediment particles before they reach the filter bed.
- Sedimentation chambers may be wet or dry but must be sized to accommodate at least 25% of the total design storm volume (inclusive).
- Sediment chambers should be designed as level spreaders such that inflows to the filter bed have near zero velocity and spread runoff evenly across the bed.
- Non-structural and surface sand filters may use alternative pre-treatment measures, such as a grass filter strip, forebay, gravel diaphragm, check dam, level spreader, or a combination of these. The grass filter strip must be a minimum length of 15 feet and have a slope of 3% or

less. The check dam may be wooden or concrete and must be installed so that it extends only 2 inches above the filter strip and has lateral slots to allow runoff to be evenly distributed across the filter surface. Alternative pre-treatment measures should contain a non-erosive flow path that distributes the flow evenly over the filter surface. If a forebay is used, it should be designed to accommodate at least 25% of the total design storm volume (inclusive).

3.6.4. Filtering Design Criteria

Detention time. All filter systems should be designed to drain the design storm volume from the filter chamber within 72 hours after each rainfall event.

Structural Requirements. If a filter will be located underground or experience traffic loads, a licensed structural engineer should certify the structural integrity of the design.

Geometry. Filters are gravity flow systems that normally require 2 to 5 feet of driving head to push the water through the filter media through the entire maintenance cycle; therefore, sufficient vertical clearance between the inverts of the inflow and outflow pipes is required.

Type of Filter Media. The normal filter media consists of clean, washed AASHTO M-6/ASTM C-33 medium aggregate concrete sand with individual grains between 0.02 and 0.04 inches in diameter.

Depth of Filter Media. The depth of the filter media plays a role in how quickly stormwater moves through the filter bed and how well it removes pollutants. The recommended filter bed depth is 18 inches. An absolute minimum filter bed depth of 12 inches above underdrains is required; although, designers should note that specifying the minimum depth of 12 inches will incur a more intensive maintenance schedule and possibly result in more costly maintenance.

Underdrain and Liner. Stormwater filters are normally designed with an impermeable liner and underdrain system that meet the criteria provided in Table 3.6.1 below.

Underdrain Stone. The underdrain should be covered by a minimum 6-inch gravel layer consisting of clean, washed No. 57 stone.

Type of Filter. There are several design variations of the basic filter that enable designers to use filters at challenging sites or to improve pollutant removal rates. The choice of which filter design to apply depends on available space, hydraulic head, and the level of pollutant removal desired. In ultra-urban situations where surface space is at a premium, underground sand filters are often the only design that can be used. Surface and perimeter filters are often a more economical choice when adequate surface area is available. The most common design variants include the following:

- **Non-Structural Sand Filter (F-1).** The non-structural sand filter is applied to sites less than 2 acres in size and is very similar to a bioretention practice (see Section 3.5), with the following exceptions:

  - The bottom is lined with an impermeable liner and always has an underdrain.
  - The surface cover is sand, turf, or pea gravel.
  - The filter media is 100% sand.
  - The filter surface is not planted with trees, shrubs, or herbaceous materials.
  - The filter has two cells, with a dry or wet sedimentation chamber preceding the sand filter bed.

  The non-structural sand filter is the least expensive filter option for treating hotspot runoff. The use of bioretention areas is generally preferred at most other sites.

- **Surface Sand Filter (F-2).** The surface sand filter is designed with both the filter bed and sediment chamber located at ground level. The most common filter media is sand; however, a peat/sand mixture may be used to increase the removal efficiency of the system. In most cases, the filter chambers are created using pre-cast or cast-in-place concrete. Surface sand filters are normally designed to be off-line facilities, so that only the desired water quality or runoff reduction volume is directed to the filter for treatment. However, in some cases they can be installed on the bottom of a Dry Extended Detention (ED) Pond (see Section 3.8).

- **Underground Sand Filter.** The underground sand filter is modified to install the filtering components underground and is often designed with an internal flow splitter or overflow device that bypasses runoff from larger stormwater events around the filter. Underground sand filters are expensive to construct, but they consume very little space and are well suited to ultra-urban areas.

  <u>Three-Chamber Underground Sand Filter (F-4)</u>. The three-chamber underground sand filter is a gravity flow system. The facility may be precast or cast-in-place. The first chamber acts as a pretreatment facility removing any floating organic material such as oil, grease, and tree leaves. It should have a submerged orifice leading to a second chamber, and it should be designed to minimize the energy of incoming stormwater before the flow enters the second chamber (i.e. filtering or processing chamber).

  The second chamber is the filtering or processing chamber. It should contain the filter material consisting of gravel and sand and should be situated behind a weir. Along the bottom of the structure should be a subsurface drainage system consisting of a parallel perforated PVC pipe system in a stone bed. A dewatering valve should be installed at the top of the filter layer for safety release in cases of emergency. A bypass pipe crossing the second chamber to carry overflow from the first chamber to the third chamber is required.

The third chamber is the discharge chamber. It should also receive the overflow from the first chamber through the bypass pipe when the storage volume is exceeded.

Water enters the first chamber of the system by gravity or by pumping. This chamber removes most of the heavy solid particles, floatable trash, leaves, and hydrocarbons. Then the water flows to the second chamber and enters the filter layer by overtopping a weir. The filtered stormwater is then picked up by the subsurface drainage system that empties it into the third chamber.

Whenever there is insufficient hydraulic head for a three-chamber underground sand filter, a well pump may be used to discharge the effluent from the third chamber into the receiving storm or combined sewer. For three-chamber sand filters in combined-sewer areas, a water trap shall be provided in the third chamber to prevent the back flow of odorous gas.

- **Perimeter Sand Filter (F-5).** The perimeter sand filter also includes the basic design elements of a sediment chamber and a filter bed. The perimeter sand filter typically consists of two parallel trenches connected by a series of overflow weir notches at the top of the partitioning wall, which allows water to enter the second trench as sheet flow. The first trench is a pre-treatment chamber removing heavy sediment particles and debris. The second trench consists of the sand filter layer. A subsurface drainage pipe must be installed at the bottom of the second chamber to facilitate the filtering process and convey filter water into a receiving system.

  In this design, flow enters the system through grates, usually at the edge of a parking lot. The perimeter sand filter is usually designed as an on-line practice (i.e. all flows enter the system), but larger events bypass treatment by entering an overflow chamber. One major advantage of the perimeter sand filter design is that it requires little hydraulic head and is therefore a good option for sites with low topographic relief.

- **Proprietary Filters.** Proprietary filters use various filter media and geometric configurations to achieve filtration and provide manageable maintenance processes and access within a packaged structure. In some cases, these systems can provide excellent targeting of specific pollutants. However, designers must verify that the particular product has been reviewed for performance, sizing, and longevity and has been approved as a viable practice by the District (see Section 3.12).

Surface Cover. The surface cover for non-structural and surface sand filters should consist of a 3-inch layer of topsoil on top of the sand layer. The surface may also have pea gravel inlets in the topsoil layer to promote filtration. The pea gravel may be located where sheet flow enters the filter, around the margins of the filter bed, or at locations in the middle of the filter bed.

Underground sand filters should have a pea gravel layer on top of the sand layer. The pea gravel helps to prevent bio-fouling or blinding of the sand surface.

Maintenance Reduction Features. The following maintenance issues should be addressed during filter design to reduce future maintenance problems:

- ***Observation Wells and Cleanouts.*** Non-structural and surface sand filters should include an observation well consisting of a 6-inch diameter non-perforated PVC pipe fitted with a lockable cap. It should be installed flush with the ground surface to facilitate periodic inspection and maintenance. In most cases, a cleanout pipe will be tied into the end of all underdrain pipe runs. The portion of the cleanout pipe/observation well in the underdrain layer should be perforated. At least one cleanout pipe must be provided for every 2000 square feet of filter surface area.
- ***Access.*** Good maintenance access is needed to allow crews to perform regular inspections and maintenance activities. "Sufficient access" is operationally defined as the ability to get a vacuum truck or similar equipment close enough to the sedimentation chamber and filter to enable cleanouts. Direct maintenance access shall be provided to the pre-treatment area and the filter bed. For underground structures, sufficient headroom for maintenance should be provided. A minimum head space of 5 feet above the filter is recommended for maintenance of the structure. However, if 5 feet headroom is not available, manhole access should be installed.
- ***Manhole Access (for Underground Filters).*** Access to the headbox and clearwell of Underground Filters must be provided by manholes at least 30 inches in diameter, along with steps to the areas where maintenance will occur.
- ***Visibility.*** Stormwater filters should be clearly visible at the site so inspectors and maintenance crews can easily find them. Adequate signs or markings should be provided at manhole access points for Underground Filters.
- ***Confined Space Issues.*** Underground Filters are often classified as a *confined space*. Consequently, special OSHA rules apply, and training may be needed to protect the workers that access them. These procedures often involve training about confined space entry, venting, and the use of gas probes.

Filter Material Specifications. The basic material specifications for filtering practices that utilize sand as a filter media are outlined in Table 3.6.1. Proprietary filters, including those being utilized for pre-treatment for rainwater harvesting systems, infiltration, and other applications that utilize alternative media must be evaluated as noted in Section 3.6.4.

Table 3.6.1. Filtering practice material specifications.

Material	Specification
Surface Cover	*Non-structural and surface sand filters*: 3-inch layer of topsoil on top of the sand layer.

	The surface may also have pea gravel inlets in the topsoil layer to promote filtration. *Underground sand filters:* Clean, washed No. 57 stone on top of the sand layer.
Sand	Clean AASHTO M-6/ASTM C-33 medium aggregate concrete sand with a particle size range of 0.02 to 0.04 inch in diameter.
Geotextile/ Filter Fabric	Woven monofilament polypropylene geotextile fabric with a flow rate greater than 100 gpm/sq. ft. (ASTM D4491).
Underdrain/ Perforated Pipe	4- or 6-inch perforated schedule 40 PVC pipe, with 3/8-inch perforations at 6 inches on center.
Underdrain Stone	Use #57 stone or the ASTM equivalent (1 inch maximum).
Impermeable Liner	Use a thirty mil (minimum) PVC Geomembrane liner covered by 8 to 12 oz./sq. yd. non-woven geotextile.

Filter Sizing. Filtering devices are sized to accommodate a specified design storm volume (typically Stormwater Retention Volume (SWRv)). The volume to be treated by the device is a function of the storage depth above the filter and the surface area of the filter. The storage volume is the volume of ponding above the filter. For a given design volume, Equation 3.6.1 below is used to determine the required filter surface area.

Equation 3.6.1. Minimum Filter Surface Area for Filtering Practices.

$$SA_{filter} = (DesignVolume)(d_f)/\left[(k)(h_{avg} + d_f)(t_f)\right]$$

Where:

SA_{filter} = Area of the filter surface (sq. ft.)
$DesignVolume$ = Design storm volume, typically the SWRv (cu. ft.)
d_f = Filter media depth (thickness) = minimum 1 ft. (ft.)
k = Coefficient of permeability – partially clogged sand (ft./day) = 3.5 ft./day
h_f = Average height of water above the filter bed (ft.), with a maximum of 5 ft./2
t_f = Allowable drawdown time = 1.67 days

The coefficient of permeability (ft./day) is intended to reflect the worst case situation (i.e. the condition of the sand media at the point in its operational life where it is in need of replacement or maintenance). Filtering practices are therefore sized to function within the desired constraints at the end of the media's operational life cycle.

The entire filter treatment system, including pretreatment, shall temporarily hold at least 75% of the design storm volume prior to filtration (see Equation 3.6.2 below). This reduced volume takes into account the varying filtration rate of the water through the media, as a function of a gradually declining hydraulic head.

Equation 3.6.2. Required Ponding Volume for Filtering Practices.

$$V_{ponding} = 0.75(DesignVolume)$$

Where:

$V_{ponding}$ = storage volume required prior to filtration (cu. ft.)

The total storage volume for the practice (Sv) can be determined using Equation 3.6.3 below.

Equation 3.6.3. Storage Volume for Filtering Practices.

$$Sv = 1.33(V_{ponding})$$

3.6.5. Filtering Landscaping Criteria

A dense and vigorous vegetative cover shall be established over the contributing pervious drainage areas before runoff can be accepted into the facility. Native plants should be used where possible. Filtering practices should be incorporated into site landscaping to increase their aesthetics and public appeal.

Surface filters (e.g. surface and non-structural sand filters) can have a grass cover to aid in pollutant adsorption. The grass should be capable of withstanding frequent periods of inundation and drought.

3.6.6. Filter Construction Sequence

Erosion and Sediment Control. No runoff shall be allowed to enter the filter system prior to completion of all construction activities, including revegetation and final site stabilization. Construction runoff shall be treated in separate sedimentation basins and routed to bypass the filter system. Should construction runoff enter the filter system prior to final site stabilization, all contaminated materials must be removed and replaced with new clean filter materials before a regulatory inspector approves its completion. The approved erosion and sediment control plans shall include specific measures to provide for the protection of the filter system before the final stabilization of the site.

Filter Installation. The following is the typical construction sequence to properly install a structural sand filter. This sequence can be modified to reflect different filter designs, site conditions, and the size, complexity, and configuration of the proposed filtering application.

Step 1: Stabilize Drainage Area. Filtering practices should only be constructed after the contributing drainage area to the facility is completely stabilized, so sediment from the CDA does not flow into and clog the filter. If the proposed filtering area is used as a sediment trap or basin during the construction phase, the construction notes should clearly specify that, after site construction is complete, the sediment control facility will be dewatered, dredged, and regraded to design dimensions for the post-construction filter.

Step 2: Install E&S Controls for the Filtering Practice. Stormwater should be diverted around filtering practices as they are being constructed. This is usually not difficult to accomplish for off-line filtering practices. It is extremely important to keep runoff and eroded sediments away from the filter throughout the construction process. Silt fence or other sediment controls should be installed around the perimeter of the filter, and erosion control fabric may be needed during construction on exposed side-slopes with gradients exceeding 4H:1V. Exposed soils in the vicinity of the filtering practice should be rapidly stabilized by hydro-seed, sod, mulch, or other method.

Step 3: Assemble Construction Materials on-site. Make sure they meet design specifications and prepare any staging areas.

Step 4: Clear and Strip the project area to the desired subgrade.

Step 5: Excavate/Grade until the appropriate elevation and desired contours are achieved for the bottom and side slopes of the filtering practice.

Step 6: Install the Filter Structure and check all design elevations (i.e. concrete vaults for surface, underground, and perimeter sand filters). Upon completion of the filter structure shell, inlets and outlets should be temporarily plugged and the structure filled with water to the brim to demonstrate water tightness. Maximum allowable leakage is 5% of the water volume in a 24-hour period. If the structure fails the test, repairs must be performed to make the structure watertight before any sand is placed into it.

Step 7: Install the gravel, underdrains, and choker layer of the filter.

Step 8: Spread Sand Across the Filter Bed in 1 foot lifts up to the design elevation. Backhoes or other equipment can deliver the sand from outside the filter structure. Sand should be manually raked. Clean water is then added until the sedimentation chamber and filter bed are completely full. The facility is then allowed to drain, hydraulically compacting the sand layers. After 48 hours of drying, refill the structure to the final top elevation of the filter bed.

Step 9 (Surface Sand Filters only): Add a 3-inch topsoil layer and pea gravel inlets and immediately seed with the permanent grass species. The grass should be watered, and the facility should not be switched on-line until a vigorous grass cover has become established.

Step 10: Stabilize Exposed Soils on the perimeter of the structure with temporary seed mixtures appropriate for a buffer. All areas above the normal pool should be permanently stabilized by hydroseed, sod, or seeding and mulch.

Step 11**:** ***Conduct the final construction inspection.*** Multiple construction inspections are critical to ensure that stormwater filters are properly constructed. Inspections are recommended during the following stages of construction:

- Pre-construction meeting;
- Initial site preparation, including installation \ Erosion and Sediment (E&S) controls;
- Excavation/grading to design dimensions and elevations;
- Installation of the filter structure, including the water tightness test;
- Installation of the underdrain and filter bed;
- Check that turf cover is vigorous enough to switch the facility on-line; and
- Final inspection after a rainfall event to ensure that it drains properly and all pipe connections are watertight. Develop a punch list for facility acceptance. Log the filtering practice's GPS coordinates and submit them for entry into the BMP maintenance tracking database.

An example construction phase inspection checklist for filters can be found in Appendix L.

3.6.7. Filtering Maintenance Criteria

Maintenance of filters involves several routine maintenance tasks, which are outlined in Table 3.6.2 below. A cleanup should be scheduled at least once a year to remove trash and floatables that accumulate in the pretreatment cells and filter bed. Frequent sediment cleanouts in the dry and wet sedimentation chambers are recommended every 1 to 3 years to maintain the function and performance of the filter. If the filter treats runoff from a stormwater hotspot, crews may need to test the filter bed media before disposing of the media and trapped pollutants. Petroleum hydrocarbon contaminated sand or filter cloth must be disposed of according to District solid waste disposal regulations. Testing is not needed if the filter does not receive runoff from a designated stormwater hotspot, in which case the media can be safely disposed of in a landfill.

Table 3.6.2. Suggested annual maintenance activities for filtering practices.

Maintenance Tasks	Frequency
▪ Remove blockages and obstructions from inflows. Trash collected on the grates protecting the inlets shall be removed regularly to ensure the inflow capacity of the BMP is preserved. ▪ Stabilize contributing drainage area and side-slopes to prevent erosion. Filters with a turf cover should have 95% vegetative cover.	As needed
▪ Mow grass filter strips and perimeter turf around surface sand filters. Maximum grass heights should be less than 12 inches.	At least 4 times per growing season
▪ Check to see if sediment accumulation in the sedimentation chamber has exceeded 6 inches. If so, schedule a cleanout.	2 times per year (may be more or less frequent depending on land use)
▪ Conduct inspection and cleanup ▪ Dig a small test pit in the filter bed to determine whether the first 3 inches of sand are visibly discolored and need replacement. ▪ Check to see if inlets and flow splitters are clear of debris and are operating properly. ▪ Check concrete structures and outlets for any evidence of spalling, joint failure, leakage, corrosion, etc. ▪ Ensure that the filter bed is level and remove trash and debris from the filter bed. Sand or gravel covers should be raked to a depth of 3 inches.	Annually
▪ Replace top sand layer. ▪ Till or aerate surface to improve infiltration/grass cover	Every 5 years
▪ Corrective maintenance is required any time the sedimentation basin and sediment trap do not draw down completely after 72 hours (i.e. no standing water is allowed).	Upon failure

Regular inspections are critical to schedule sediment removal operations, replace filter media, and relieve any surface clogging. Frequent inspections are especially needed for underground and perimeter filters, since they are out of sight and can be easily forgotten. Depending on the level of traffic or the particular land use, a filter system may either become clogged within a few months of normal rainfall or could possibly last several years with only routine maintenance. Maintenance inspections should be conducted within 24 hours following a storm that exceeds 1/2 inch of rainfall, to evaluate the condition and performance of the filtering practice. Example maintenance inspection checklists for filters can be found in Appendix M. Note: Without regular maintenance, reconditioning sand filters can be very expensive.

A maintenance covenant is required for all stormwater management practices. The covenant specifies the property owner's primary maintenance responsibilities, and authorizes DDOE staff to access the property for inspection or corrective action in the event the proper maintenance is not performed. The covenant is attached to the deed of the property (see standard form, variations exist for scenarios where stormwater crosses property lines). The covenant is between the property and the District Government. It is submitted through the Office of the Attorney General. All SWMPs have a maintenance agreement stamp that must be signed for a building permit to proceed. There may be a maintenance schedule on the drawings themselves or the plans may refer to the maintenance schedule (schedule c in the covenant).

Covenants are not required on government properties but maintenance responsibilities should be defined through a partnership agreement or a memorandum of understanding.

Waste material from the repair, maintenance, or removal of a BMP or land cover change shall be removed, and the maintenance contractor shall submit a written report to DDOE within forty-eight (48) hours after disposing of the waste material. The report shall include:

(a) The name, address, phone number, and business license number of the contractor transporting the waste materials;
(b) Date of removal;
(c) The address of the BMP;
(d) Type of BMP serviced;
(e) Amount and type of waste material removed;
(f) The name and location of the facility where the waste material was disposed of; and
(g) A sworn statement that disposal was in compliance with applicable federal and District law.

3.6.8. Filtering Volume Compliance Calculations

Filtering practices receive 0% retention value and 60% TSS EMC reduction for the amount of storage volume (Sv) provided by the practice (Table 3.6.3).

Table 3.6.3. Filter retention value and pollutant removal

Retention Value	= 0
Additional Pollutant Removal	60% TSS EMC reduction for *Sv* provided

The practice must be sized using the guidance detailed in Section 3.6.4.

3.6.9. References

Atlanta Regional Commission (ARC). 2001. *Georgia Stormwater Management Manual, First Edition*. Available online at: http://www.georgiastormwater.com

Claytor, R. and T. Schueler. 1996. *Design of Stormwater Filtering Systems*. Chesapeake Research Consortium and the Center for Watershed Protection. Ellicott City, MD. http://www.cwp.org/PublicationStore/special.htm

Virginia DCR Stormwater Design Specification No. 12: Filtering Practices Version 1.7. 2010 .