For **Pressurized Shallow-Narrow Drainfield (PSND)**
and
Bottomless Sand Filter (BSF)
design, installation and O&M guidance,

please refer to

"**Guidelines for the Design, Use and Maintenance of Pressurized Drainfields**"
adopted in November 2013.

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
235 Promenade Street, Providence, RI 02908-5767 TDD 401-222-4462

Date: **June 24, 2011**

To: **OWTS Designers/Interested Parties**

Subject: **Addendum 2 to "Revised Sand Filter and Pressurized Shallow-Narrow Drainfield Guidance Document" Revised March 2010**

Effective immediately, the Infiltrator Quick4 Equalizer 24 Low Profile Chamber is an approved equivalent for the PSND dome material specified in the *"Revised Sand Filter and Pressurized Shallow-Narrow Drainfield Guidance Document"* **Revised March 2010.**

This chamber may be installed as part of a PSND.

When not specified on the approved plan, installation of this chamber as the PSND dome must be documented by the designer's submission of As-built plans, submitted with the designer's Certificate of Construction.

Design and installation parameters specific to this chamber are specified in the Infiltrator Design and Installation Manual for Quick4 Chambers in Rhode Island. This manual is available at http://www.infiltratorsystems.com/ or by contacting Infiltrator Systems, Inc. at (800) 221-4436.

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
235 Promenade Street, Providence, RI 02908-5767 TDD 401-222-4462

Date: **September 14, 2010**

To: **OWTS Designers/Interested Parties**

Subject: **Addendum 1 to "Revised Sand Filter and Pressurized Shallow-Narrow Drainfield Guidance Document" Revised March 2010**

Please note that when designing pressurized shallow-narrow drainfields (PSNDs), the design loading rate shall be based upon the texture, structure, and consistence (described in Table 3. Hydraulic loading rates for PSNDs) of the most restrictive soil horizon within 1.5 feet below the proposed base of the PSND.

RHODE ISLAND
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
235 Promenade Street, Providence, RI 02908-5767 TDD 401-222-4462

Date: **March 9, 2010**

To: **OWTS Designers/Interested Parties**

Subject: **Revised Sand Filter and Pressurized Shallow-Narrow Drainfield Guidance Document**

Attached herewith is a document entitled "Guidelines for the Design and Use of Sand Filters and Pressurized Shallow-Narrow Drainfields" also know as the "Sand Filter Guidance Document" (SFGD). The document, which was initially issued in April 2000, contains guidance on the design, installation, and operation and maintenance of recirculating sand filters (RSF), single-pass sand filters (SPSF), and pressurized shallow-narrow drainfields (PSND). In this revised document the design parameters for PSNDs have changed substantively. In addition, a few minor clarifying edits have been made throughout. The Department is working on development of a guidance document for design, installation and O&M of all pressurized drainfield options approved in Rhode Island. When this comprehensive guidance becomes available, it will replace the guidance on PSNDs contained in this manual.

The Department hereby recognizes these systems to be at least equal to conventional OWTSs, in terms of protection of public health and the protection of groundwater and surface water quality, and therefore will approve of their use in all areas where conventional systems are allowed under current OWTS Rules. The use of these technologies will not require a variance from the Department provided the design of each system is in compliance with all other OWTS Rules. These systems are listed on the DEM's approved list of alternative or experimental OWTS technologies. PSND design parameters have changed and important restrictions and provisions applying to sand filters and PSNDs are detailed below.

PSND Design Parameters Revised in March 2010

<u>Trench Spacing</u>
Minimum trench spacing shall be two and one-half (2.5) foot on-center (one and one-half-foot edge-to-edge).

<u>Separation to Seasonal High Groundwater Table and Impervious Layer</u>
Separation to the seasonal high water table is two (2) feet statewide unless otherwise specified by permit; separation to impervious layer shall be four (4) feet statewide unless otherwise specified by permit.

<u>Loading Rates</u>
Note that loading rates are assigned partly on the basis of the type of advanced-treatment system preceding the PSND (see Table 3).

General Provisions

The design of each system shall be in strict conformance with the guidance contained in the SFGD. The RSF and SPSF systems are for residential strength wastewater only.

RSF Systems

The RSF system consists of a septic tank with effluent filter, a recirculation (or mixing) tank, a sand filter, and a leachfield. The RSF system requires two pumps and associated control equipment. Wastewater is time-dosed to the sand filter; the pump to the leachfield is operated by a simple float switch. The system is defacto time-dosed. The recirculation rate is generally between 3-5 times the actual forward flow. The RSF system is a generic technology which can be assembled from components manufactured by a number of different manufacturers. The RSF system is capable of reducing BOD and TSS levels in typical residential strength wastewater to less than 10 mg/l each and fecal coliform levels to less than or equal to 10,000 cfu/100 ml. An RSF that is designed, installed and operated in accordance with the SFGD shall be recognized by DEM as a nitrogen reducing OWTS, capable of removing 50% or more of the total nitrogen contained in septic tank effluent. Treated effluent from the RSF system may be expected to contain less than or equal to 19 mg/l of total nitrogen.

SPSF Systems

The SPSF consists of a septic tank with effluent filter, a dosing chamber with pump, a sand filter (either low-rate or high-rate), another dosing chamber with pump, and a leachfield. A screened pump vault inside the final compartment of a double compartment septic tank system may be used in lieu of a separate effluent filter and dosing chamber. The drainfield dosing pump may be located in a sump installed in the center of the sand filter in lieu of a dosing chamber outside the sand filter. The SPSF system is also a generic technology which can be assembled from components manufactured by a number of different manufacturers. The SPSF system is capable of reducing BOD and TSS levels in typical residential strength wastewater to less than 10 mg/l each and fecal coliform levels to less than or equal to 1,000 cfu/100 ml. The low-rate SPSF may be even more effective in reducing pathogens in wastewater. The SPSF is not generally effective in reducing total nitrogen levels in septic tank effluent.

PSND Systems

PSNDs may only be used with the RSF, SPSF or with other alternative/experimental technologies where the PSND is specifically authorized by DEM as an allowed alternative to a conventional leachfield. The PSND will only be allowed with a system that provides advanced wastewater treatment (i.e. minimum treatment standards of 30 mg/L or less for each BOD and TSS and FOG of less than or equal to 5 mg/L, see Table 3) prior to the leachfield. The PSND trenches shall be installed a minimum of 2.5 feet on center in all soils with all systems. DEM will allow a 2-foot design separation distance to the seasonal high water table and a four-foot separation to an impervious layer with these systems statewide. In addition, the invert perimeter shall be 5 feet provided a 3:1 slope be maintained beyond the 5 feet to original grade. For purposes of design, the invert and bottom bed of PSNDs shall be held to be the same, equal to the elevation of the bottom of the support pipes under the distribution pipe.

The sizing of PSNDs is based on soil texture, structure and consistence.

DEM shall reserve the right to require additional supporting engineering calculations for the use of PSND on designs with design flows greater than 2000 gpd.

Training and Authority to Design/Install

DEM strongly recommends that all designers and installers receive training on the systems addressed in this guidance as a pre-requisite to performing any work related to these systems. Also, as the specifications for PSNDs have been substantively revised, DEM strongly recommends designers and installers who previously attended training on these, to attend training again.

Acknowledgement

This 2010 revision of this document results from DEM staff review and comment and discussion by the Rhode Island Department of Environmental Management Technical Review Committee (TRC). RIDEM wishes to acknowledge the following individuals: Ken Anderson and Jim Boyd (CRMC), Noel Berg, David Burnham, Joe Frisella, Susan Licardi, George Loomis, Tim Stasiunas, Dennis Vinhateiro and Brian Moore and Deb Knauss (DEM).

RIDEM encourages review and constructive criticism on the contents of the SFGD. The SFGD is on RIDEM's website: from RIDEM home at http://www.dem.ri.gov/, from the left side of the screen select "Permits", then from the center of the screen "Individual Septage Disposal Systems Permits" then from the right side of the screen, "Sand Filter Guidance Document". The listing of approved A/E technologies is also posted on the RIDEM website; the link is available at the same screen as the link to the SFGD. Please convey comments to: Russell J. Chateauneuf, P.E., RIDEM, 235 Promenade Street, Providence, RI 02908 or by e-mail to: mailto:wresourc@dem.ri.gov

Sincerely yours,

Russell J. Chateauneuf, P.E.
Chief, Groundwater and Wetlands Protection

Enclosure

Rhode Island Department of Environmental Management

Guidelines for the Design and Use of Sand Filters and Pressurized Shallow-Narrow Drainfields

April 2000, Revised March 2010

Table of Contents

List of Tables

Guidelines for the Design and Use of Sand Filters and Pressurized Shallow-Narrow Drainfields

Preface

The purpose of this document is to provide an orderly guideline for the design and review of sand filter systems and pressurized shallow-narrow drainfields (PSNDs) for distribution of pre-treated residential strength effluent. This document uses various terms to differentiate between discretionary, required and prohibited design criteria and installation activities. The terms used are:

1. May: Optional, but consider this criterion.
2. Should: Optional, but a well-accepted practice. A wise or advisable choice.
3. Must or shall: Not optional. The wastewater field's present state of knowledge mandates use as described.

A glossary of wastewater terms is included in this document as Appendix A. Figures referenced in the text are located in Appendix B of this document. These guidelines are not intended to be a step-by-step procedure to designing and installing sand filter systems. They are intended to provide general information to the designer, installer and maintenance provider.

Introduction

Sand filters have been used for wastewater treatment for over one hundred years. In the past 20 years, they have been used more frequently for single family home applications. In that time, their design has been refined and treatment levels have become reliable and predictable. Although a relatively new technology for Rhode Island, sand filters have a long and proven performance history in other states throughout the United States (for instance MD, MI, OR, WA, and others). Perhaps the most rigorous and structured performance evaluation studies have occurred on sand filter systems than on any other single treatment technology, lending to the wealth of information on these systems. Sand filters when designed, installed, and operated in accordance to this guidance will provide effluent BOD_5 and TSS levels of less than 10mg/L. Sand filters are efficient nitrifying units, and can reduce septic tank effluent ammonia-nitrogen levels from 35-55 mg/L to less than 5mg/L by passage through a single pass sand filter.

Sand filters can reduce fecal coliform levels from approximately 10^6 colony forming units (cfu)/100ml in septic tank effluent to 10^3 cfu / 100 ml in sand filter effluent. Low rate sand filters may reach even greater fecal coliform reductions. Treatment performance studies from throughout the United States show that single pass sand filters can remove 10 to 60%

of the total nitrogen in septic tank effluent. Research conducted on Rhode Island single pass sand filters, supports nitrogen removals more typically less than 15%.
Literature reviews of pressure dosed recirculating sand filters throughout the nation document total nitrogen removal in the 20 to 60 % range. Rhode Island recirculating sand filters typically meet or exceed total nitrogen removals of 50%.

These representative studies are included for those seeking more reference information about sand filters: USEPA, 1980;, Ronayne et al., 1982; Anderson et al., 1985; Pell and Nyberg, 1989a,b,c; Ball, 1991; Loudon, T.L., 1996; Peebles et al., 1991; Gold et al.,1992; Piluk and Peters, 1994; Emerick et al., 1997).

Different types of sand filters have different design criteria, sand media specifications, and corresponding hydraulic loading rates. The sand media used in the filters, and the microorganisms that colonize and reside in them, are responsible for much of the wastewater treatment. Sand filter media quality is crucial to the operation and longevity of the filter. To assure good wastewater treatment, sand media free of fine particles, with the proper sand uniformity and effective size must be used with the appropriate sand filter type and hydraulic loading rate.

Sand filters will not reach complete removal of all the nutrients and pathogens in domestic wastewater. PSNDs when combined with a sand filter or an advanced treatment system may help produce a treatment train that is cost effective and more efficient. The installation of narrow (12 inches wide) and shallowly placed (within 12 inches of the ground surface) low-pressure drainfields (PSNDs) directly in native soils, without trench stone, have been used successfully in Rhode Island on several State demonstration projects and in over 400 RIDEM permitted OWTS installations.

Types of Sand Filters Covered by this Guidance

This guidance is intended for the design of sand filters receiving residential strength wastewater which should not exceed the following parameters: biochemical oxygen demand (BOD_5) of 300 mg/L; total suspended solids (TSS) of 170 mg/L; fat, oil, and grease (FOG) of 25 mg/L; and total Kjeldahl nitrogen (TKN) of 75 mg/L. Note that influent TKN concentrations higher than 75 mg/L may not be a problem, so long as other parameters are within the specified ranges.

The types of sand filters covered by this guidance document are:

Recirculating Sand Filters (RSF) - Multiple pass sand filter (Figure 1). Sized at a maximum of 5.0 gallons/ square foot /day. With a recirculation rate of 2-4, the actual wastewater loading rate on the sand filter is 3-5 times the forward flow from the dwelling.

RSF Treatment Process Summary - Wastewater, having received primary treatment in a septic tank or equivalent unit, flows by gravity to a recirculation (mixing) tank. In doses controlled by both a programmable timer and float switch, the mixed fresh wastewater and partially treated filter effluent is applied to a bed of sand media (actually of small gravel sized particles). This mixed wastewater is dispersed over the filter surface in a PVC distribution network surrounded in pea stone. Wastewater trickles down through the sand media, where biological treatment occurs.

The treated RSF effluent is collected in an underdrain at the bottom of the filter and discharged back to the recirculation tank. There most of it mixes with incoming wastewater, a small amount gets discharged to the drainfield, and the cycle begins again. Typically, a buoyant-ball check valve is used to control discharge and recirculation. Treated wastewater is discharged to a drainfield for additional treatment.

Single Pass Sand Filter (SPSF) (Figures 2A and 2B).

1. Low Rate single pass filter loaded at a maximum of 1.25 gallons/square foot/day.
2. High Rate single pass filter loaded at a maximum of 2.0 gallons/square foot/day.

SPSF Treatment Process Summary - Wastewater, having received primary treatment in a septic tank or equivalent unit, is pressure dosed to a bed of specified sand media. Wastewater applications to the filter surface are controlled by both a programmable timer and float switch. Wastewater is dispersed over the sand filter surface in a PVC pipe distribution network surrounded in pea stone. Wastewater trickles down in unsaturated thin film-flow through the sand media, where biological treatment occurs.

The treated wastewater (sand filter effluent) is collected in an underdrain at the bottom of the filter and discharged by pressure to a PSND, where additional treatment occurs.

Selecting the Best Sand Filter for a Site

Because of size and space considerations, most single pass sand filters are designed for flows of less than 1,000 gallons per day.

Recirculating sand filters (RSFs), because of the higher hydraulic loading rates, utilize larger sized sand media, but have a smaller size footprint and tend to be more economical for larger flows. With the addition of an anaerobic zone provided by the recirculation tank, nitrogen removal will be greater in the RSF than in a SPSF.

Conversely, pathogen removal efficiency is better in SPSFs. This is due primarily to the finer sand media particles used in a single pass filter that physically screen out larger septic microbes. In addition, the lower hydraulic loading rates in single pass sand filters create longer retention times in the filter for treatment processes to occur. These treatment characteristics should be considered when siting sand filters in critical resource areas.

High rate SPSFs are recommended for sites where space considerations are a primary concern. These filters will produce a high quality effluent, low in BOD_5 and TSS (concentrations of both usually less than 5 mg/L). Pathogen reductions in high rate filters are considerably better than what is possible in many other advanced treatment systems. However, high rate SPSF effluent will still contain residual pathogenic organisms and are not the preferred sand filter design for use in shallow groundwater areas or in areas with "dug" drinking water wells. Under tight lot conditions in these types of locations, a treatment train consisting of a high rate SPSF followed by an ultraviolet disinfection unit and PSND may produce high treatment levels.

Low rate SPSFs are recommended for sites where maximum removal of pathogenic organisms is desired. Applicable locations are: critical resource areas such as drinking water reservoir watersheds, pathogen sensitive poorly-flushed coastal ponds, shallow water table soil locations where shallow dug wells provide potable water, sites in close proximity to shellfishing grounds, and areas where recreational water contact issues are a concern.

Tank Specifications

All tanks and containers used in a sand filter system **must be watertight**, otherwise the sand filter systems will not function properly. Leaks will allow groundwater to infiltrate into tanks and be pumped onto filters, subsequently overloading them. Similarly, under deep groundwater conditions, wastewater leaking out of a septic tank will not be dosed to the sand filter and treatment will be short circuited.

All septic, recirculation and pump tanks should be either vacuum tested or water tested with their access risers in place before use. It is recommended that any tank used in a sand filter system be guaranteed watertight by the tank manufacturer, the installer, or the designer doing construction oversight. All tanks shall have a watertight riser to grade at both the inlet and outlet end for servicing. All seams or joints in, and between, the septic tank and riser shall be watertight. The risers should be mechanically bonded to the tank in a way that provides both structural integrity and watertightness. All inlet and outlet pipes to the tank shall also have strong mechanical bonds that are watertight.

To water test a tank, seal the tank inlet and outlet. Next, fill the tank with tap water to 2 to 4 inches above the joint between the riser and tank and let stand for 24 hours. If there is a water loss, refill, mark the water level and let stand for two more hours. There should be no additional water loss.

Vacuum testing of tanks should be done by a qualified contractor or tank manufacturer experienced in performing this procedure. It is recommended that the tanks be constructed, installed and tested in accordance with American Society for Testing and Materials (ASTM) Standard C-1227-97A.

To help achieve the maximum level of **primary treatment**, two compartment septic tanks (divided in a 2/3 and 1/3 configuration) shall be used with all sand filter systems (Figures 3B, 4). A typical recirculation tank for a recirculating sand filter is shown in Figure 5. Tank volume requirements are shown in Table 1.

Table 1. Tank size requirements for sand filters receiving domestic strength wastewater

# of Bed-rooms	Design Loading Rate (gal/day)	SPSF* Septic Tank (gallons)	RSF* Septic Tank (gallons)	RSF* Recirculation Tank (gallons)
2	230	1250	1000	1000
3	345	1500	1250	1000
4	460	1500	1500	1250
5	575	1750	1750	1250
6	690	2000	2000	1500
7	805		2250	1500
8	920		2500	1750
9	1350		2750	2000
10	1500		3000	2250

*SPSF= single pass sand filter; RSF = recirculating sand filter

For RSFs with design flows in excess of 1500 gpd, septic tanks shall be sized at 2.0 X daily design flow; recirculation tanks shall be sized at 1.5 X daily design flow.

Routine hydraulic surge storage capacity in septic tanks housing sand filter pumps shall be a minimum of 10% of the septic tank volume. In addition to this, a minimum **emergency hydraulic storage** volume capacity in septic tanks housing sand filter pumps shall be a minimum of 10% of the septic tank volume.

In situations where sand filters are being designed for seasonally-used vacation homes and summer rental homes, where daily design flows may often be exceeded, it is strongly recommended that tank sizes be increased by a minimum of thirty (30) percent.

If sand filters are being designed for high strength wastewater (exceeding the waste strength concentrations mentioned above), careful consideration must be paid to reducing wastewater strength to within domestic waste strength ranges and to increase tankage volumes to assure protection of the sand filter. Wastewater from kitchen and food processing facilities must first pass through a grease tank with at least a 3 day, and preferably a 5 day hydraulic retention time, before mixing with the main blackwater stream. A three day hydraulic retention time may be adequate to trap fats, oil and grease. However, peak flows, wash water temperature, and detergents can influence fat, oil, and grease removal efficiency. In high risk installations, tankage volume should be increased appropriately to allow for maximum fat, oil and grease removal.

Pumps and Effluent Screens

Sand filters submitted under this guidance shall be pressurized utilizing programmable timers. Intermittently pressure dosing effluent provides uniform distribution of wastewater over the filter surface, minimizing the chance of localized saturation in the filter, and promotes better wastewater treatment. Several small incremental wastewater doses promote better treatment potential than a few larger doses. Likewise, storing peak flows in the system's tankage and time dosing wastewater (using a programmable timer in a control box, see Figure 6) to a sand filter surface over a 24 hour clock also promotes better wastewater treatment.

Pumps should be sized to provide a minimum of five (5) feet of head (i.e. pressure) at the distal end of each distribution lateral in the sand filter. Most pump manufacturers will provide pump calculations for individual sand filter designs and requirements.

All effluent should be prescreened using an effluent filter/screen before it is dosed onto the sand filter. This screen/filter assembly helps protect the pump and sand filter surface from excessive solids.

When designing a SPSF without a separate pump tank, dosing pumps delivering wastewater to the filter surface shall be located in a screened pump vault (Figure 7) placed directly in the second compartment of a two compartment septic tank (Figure 2A, 4). The screened pump vault and the two compartment tank help protect the pump and sand filter from solids.

An alternate design approach for a SPSF, may include a pump located in a separate pump chamber/tank following the septic tank (Figure 2B). In this case, flow from the septic tank to the pump chamber is by gravity. When using this configuration, an effluent filter or screen shall be placed on the outlet of the septic tank (i.e. the primary treatment tank). Any pump located in a separate pump chamber/tank preceding a sand filter shall be positioned above the bottom of the chamber/tank a minimum of six (6) inches. When using this alternate configuration, a minimum pump chamber/tank size of 1000 to 1250 gallons is recommended, with higher design flows requiring larger tanks.

When a RSF is used, the pump dosing the sand filter should be located in the recirculation tank that follows the septic tank (Figure 1). Flow from the septic tank to the recirculation tank is by gravity. An effluent filter/screen shall be placed on the outlet end of the septic tank to help trap solids, keeping solids carryover to the recirculation tank to a minimum (Figure 3B). The sand filter dosing pump located in the recirculation tank shall be placed in a screened pump vault.

In the tank housing the pump that doses all sand filters, a hydraulic storage capacity above the working level of the tank shall be provided to accommodate power outages or servicing of the system. This emergency storage capacity volume shall be a minimum of 100 gallons or 10% of the septic tank volume (whichever is greater), and shall be positioned above the pump high-water alarm but below the tank inlet invert.

The effluent transport line shall be a 1 ¼ to 2 inch PVC (Class 200 minimum) pipe, the actual size depending upon such factors as distance, pump head, friction loss, and desired pressure at distal orifices. This pipe should be sloped either back to the pump tank or towards the sand filter to clear the line after each dose. This is done to prevent freezing in cold weather. If the transport pipe slopes towards the filter and the sand filter distribution piping is at a lower elevation than the maximum water level in the tank, an anti-siphon device should be used on the pump discharge assembly to prevent siphoning.

Sand Filter Specifications (see Figures 8A through 8F and Figure 9)

Filter Enclosure

A. It is essential that the enclosure containing the sand media is watertight to prevent groundwater from flooding the system and to prevent untreated effluent from leaking out of the filter. The enclosure shall be a monolithic concrete slab and walls or a 30 mil PVC liner with all boots, patches, repairs and seams having the same physical properties as the parent material. If using PVC liners all seams shall be factory welded or secured with the appropriate resilient sealant.

B. Any penetrations in concrete enclosures must be formed with the appropriate precast knockout. To assure a watertight connection it is recommended that an appropriately-sized PVC coupling or watertight rubber boot be cast into the concrete wall and the underdrain pipe be glued or clamped into the coupling/boot. An alternate method would be to utilize a core and flexible rubber expansion seal. Likewise, all transport pipes delivering wastewater to the filter should also be glued. Gasketed PVC pipe may be used to minimize thermal expansion and contraction problems on long pipe runs of over 300 feet.

C. Any penetration through the PVC liner wall shall be done with a PVC boot attachment glued to the liner with the appropriate resilient sealer. Two (2) inches of fine sand shall be placed beneath the bottom of the liner to bed and protect it against sharp objects.

D. When using a PVC liner, the support walls shall be rigid and made of plywood (or equivalent) and 2x4 construction to hold the liner in place during installation. The points of all screws and fasteners used in construction shall face away from the liner. Alternately, if the soil on site will support vertical walls of an excavation, wooden support walls may not be needed. However, a wooden top frame structure (such as landscape timbers) is still needed to hang and hold the liner while sand is placed in the filter. Care is needed not to stretch the liner during the filling procedure.

E. The outside of the liner walls shall be backfilled evenly as the filter sand is placed into the enclosure. This will prevent the walls from bowing outward as the filter is filled with sand media. When backfilling the enclosure, avoid fill material with sharp stones which can penetrate the PVC liner after the plywood rots away. Overdigging the hole should be avoided; minimal backfilling on bottom and sides provides a more stable enclosure.

Underdrains (see Figures 8A-F, 9)

A. A four (4) inch diameter PVC Schedule 40 slotted underdrain collection pipe shall be placed directly on the bottom of the enclosure. Underdrain slots should be ¼” wide, 2 ½” deep and spaced 4” apart. To avoid the slots being pushed down into the liner and covered by liner material, the slots shall be faced upwards (vertical). The distal end of the pipe shall be brought to grade and covered with a removable cap. This shall serve as a vent/cleanout and observation port. In a filter with a pump basin located in the center of the sand filter where two underdrain pipes converge, only one (1) of the underdrain pipes needs to be brought to the surfaced and capped. The underdrain pipe can lay level or have no more than a 0.5% grade towards the drainfield or separate or incorporated pump chamber. In larger filters, underdrain pipes shall be spaced apart a maximum of ten (10) feet on center.

B. The underdrain pipe shall exit the enclosure through a precast exit hole when using a concrete container. The interface between pipe and exit hole shall be sealed and made watertight. A cast-in place PVC coupling is recommended (see Filter Enclosure section above). Appropriate stainless steel clamps (two clamps are recommended) shall seal the PVC boot around the underdrain pipe when using a PVC liner.

C. A minimum of four (4) inches of ½” to ¾” clean washed stone is placed over and immediately around the underdrain pipe only. Avoid angular and sharp stone which could damage a PVC liner.

D. Eight (8) inches of 3/8” clean washed pea stone shall be placed at the inside bottom of the enclosure. This should be mounded over the washed stone covering the underdrain.

E. Care should be taken to make certain that the above mentioned layers are installed properly. This layering sequence will prevent sand filter media from washing into the underdrain pipe of the filter.

F. Install an observation port consisting of a vertical four (4) inch perforated or slotted PVC pipe wrapped in filter fabric with a fixed cap on the bottom end. This shall be brought to finished grade and have a removable cap to facilitate observation of water level in the filter. The bottom cap shall be placed directly on the filter liner. This observation port shall be located approximately two (2) feet in from the filter perimeter.

Installation of Sand Filter Media

A. Sand media shall be selected for the appropriate application based on the enclosed sand filter media guidelines (see Table 2).

B. No filter fabric of any kind shall be placed around the filter underdrain pipe(s) or between the 3/8” pea stone covering the filter base and the overlying sand media (Figure 9, Underdrain Detail).

C. Sand should be a minimum of twenty-four (24) inches deep and be thoroughly washed and as free of fines as possible.

D. It is recommended that the sand media be placed in level eight (8) inch lifts in the filter and wetted slightly during installation to promote even settling. It is important not to wet the sand too much because particle stratification may occur.

E. As the filter is filled with sand, the edges of the filter should be "walked down" by installer to make sure sand is tight along filter perimeter, and no voids exist. The installer should watch that the liner is not stretched during the filling process.

F. After the required amount of filter sand has been added to the filter, place three (3) inches of 3/8" washed pea stone over the filter sand. After the distribution laterals have been installed atop the pea stone and pressure tested, install shields on each orifice on the distribution laterals, add two (2) more inches of pea stone to cover the distribution laterals. No filter fabric of any kind should be placed between the sand and overlying pea stone layers.

Distribution Laterals

A. Septic tank effluent applied to a sand filter is distributed over the sand surface using small diameter, pressure rated PVC pipe. Generally, for the sand filters in this guideline the distribution manifold is typically 1 to 1 ½ inch PVC (Class 200 minimum) and the distribution laterals are usually ¾ to 1 inch Schedule 40 PVC. Size will vary depending on design and site conditions. (Note: Small lateral and orifice diameters are recommended to provide the highest possible scouring velocity in the laterals, minimize orifice clogging, and provide as even distribution of wastewater as possible.)

B. A series of 1/8 inch diameter holes (orifices) shall be made in the top of the distribution laterals (12 o'clock position) and spaced according to the dosing requirements of the system (see Figure 9). Generally, the orifice spacing is based on a 2 to 2 ½ foot grid pattern to best utilize the filter surface. This grid will be smaller (typically 14 inches to 18 inches) when using the high rate filters. Holes should be drilled downward through both the top and bottom of the pipe (12 and 6 o'clock positions) **at every fifth orifice** along a lateral to allow drainage after a dose and to prevent lateral freezing in cold weather. Alternately, the laterals can be installed with all orifice holes pointing down (6 o'clock position) using orifice shields with slots or holes to provide free draining (usually referred to as cold weather orifice shields).

C. Designs should account for a minimum of five (5) feet of head (pressure) at the distal end of each sand filter distribution lateral.

D. The high rate SPSF should be dosed a maximum of 0.25 gallons per orifice per dose. SPSFs should receive 18-24 equal wastewater doses per day. RSFs should receive 24-

48 equal wastewater doses per day. Pump manufacturers will usually help provide pump calculations to assist with this design requirement.

E. Orifice shields, placed over each of the orifices, shall be used to protect the orifices from being blocked by pea stone. Alternately, distribution pipes can be placed in a continuous perforated, drilled, or slotted sleeve (3 to 6 inch PVC or corrugated agriculture or foundation drainage pipe). If orifice shields are used with orifices in the 6 o'clock position (facing down), the shields must be free draining.

F. Schedule 40 PVC or equivalent sweep elbows (also called turnups) shall be attached to the distal end of each buried SPSF lateral to facilitate maintenance and inspection. A standard ninety (90) degree elbow **should not** be used here. The sweep elbow end should be closed off with either a ball valve or a threaded cap. The threaded end should accommodate attachment of a ten foot length of clear PVC pipe to be used to determine initial head at the distal lateral ends and subsequent head measurement during routine future inspection/maintenance visits. Difference in head relative to the initial reading will signal maintenance requirements during subsequent visits. The sweep end is also the location through which lateral maintenance will occur (see Operation and Maintenance section).

G. In the case of buried SPSFs, the ends of the sweep elbows shall be readily accessible by means of an access box or port brought to the ground surface. High density plastic irrigation valve access boxes/ports are often used for this purpose.

H. The distal ends of laterals in a RSF, which are readily accessible by pushing aside a small amount of pea stone, do not need sweep elbows (turnups). These lateral ends should have threaded ball valves onto which a distal head measurement pipe can be attached. This ball valve will also be the location through which lateral cleaning will occur (see Operation and Maintenance section).

Cover Material

A. For **buried SPSFs**, a light-duty non-woven filter fabric shall be placed on top of the uppermost layer of pea stone, between the pea stone and the topsoil cover material. This will eliminate fine soil particles from clogging the pea stone. Do not use heavy weight filter fabrics because they can limit gas/oxygen movement into and out of the sand filter.

B. A maximum of eight (8) inches around the center pump basin and six (6) inches on the filter edges of loamy sand or sandy loam topsoil and a grass cover are recommended to complete the **buried SPSF** installation. The finished grade for any sand filter should be slightly higher than the surrounding grade and crowned, if possible, to prevent surface water from flowing onto the filter.

C. When using a **RSF**, cover the filter with pea stone to two (2) to four (4) inches over the top of the lateral end ball valve. **RSFs have a pea stone surface and do not get covered with topsoil.**

<u>Precautionary Notes:</u>

D. **Sand filters should not be placed in a depressional area on a property, where stormwater is likely to collect during rainfall events.**

E. **Care should be taken to not bury the filter too deeply or cover the filter top with soil material that could compact excessively (especially when moist). This could limit the gas/oxygen diffusion through the filter surface and cause filter hydraulic failure.**

F. **Avoid placing buried single pass sand filters in a traffic area where they would receive excessive foot traffic.**

G. **A minimum buffer of ten (10) feet should be maintained between sand filters and neighboring trees and shrubs. Water-loving trees and shrubs shall not be placed adjacent to sand filters, because their root systems can cause system damage.**

H. **Under no circumstances should heavy equipment, vehicles, or impermeable surfaces/materials be allowed over a finished sand filter. At a minimum, this would result in poor treatment. More likely system failure, broken components, and financial expense to the homeowner will result.**

I. **Under wet site conditions, it is recommended that the sand filter elevation be raised to avoid having the filter enclosure sitting directly in groundwater. A raised filter can be crowned at the surface and blended into the surrounding surface grades, which will help keep the filter isolated from surface water runoff also.**

Sand Filter Media Specifications

Sand filter media specifications are shown in Table 2 and Figures 10, 11, and 12. **It is important to remember that using good quality sand media is essential. Not all sand and gravel operations will have the ability to produce sand with these specifications.** A sieve analysis of the sand media to be used should be conducted to assure that its effective size and uniformity coefficient (UC) are appropriate for the intended use. When sampling the stock piled sand media, samples should be taken from several locations within the pile to assure a representative sample for analysis. The standard method to be used for performing particle size analysis should comply with one of the following:

1. The sieve method specified in ASTM D-136 and ASTM C-117.

2. The method specified in Soil Survey Laboratory Methods and Procedures for Collecting Soil Samples, Soil Survey Investigation Report #1, U.S. Department of Agriculture, 1984.

Important Note: To prevent clogging in the filter, all sand media must be well washed and as free of fine particles and dust as possible.

Table 2. Sand filter loading rates and media specifications

Sand Filter Type	Design Loading[1] Rate (gal/ft^2/day)	Uniformity Coefficient ($D_{60} \div D_{10}$)	Effective Size (D_{10}) mm	Acceptable Sand Specifications
Single pass low rate	1.25	<3	0.33	(Figure 10))
Single pass[2] high rate	2.0	<2.0	0.65	(Figure 11)
Recirculating [3]	5.0	1.3-2.5	1.5-3.0	(Figure 12)

[1] Based upon forward flow.
[2] Dosing rate equals ¼ gallon/orifice/dose.
[3] Recirculation rate equals 3-5 times forward flow/day; dosing rate shall be adjusted to provide for this recirculation rate. It is recommended that the filter be dosed once every half hour (frequent small doses promote better treatment).

Requirements for All Sand Filters:

1. A programmable timer, to control and adjust the number of doses per day, length of dose time, and the duration of time between doses.

2. A high water alarm, pump, and float switch(s) set to override the programmable timer in the event of timer malfunctions or temporary excessive water use.

3. A pump control panel with an elapsed time run meter and a dosing event counter (pump event counter) for each pump in the system.

4. An event counter on the timer override or high water alarm float (whichever is most applicable to the expected daily flow). This counter would indicate how often the system is working in override or high water situations.

5. A routine hydraulic surge storage capacity in the septic tank from which effluent is pumped onto the sand filter. This surge storage capacity shall be a minimum of 10% of the septic tank volume capacity, and shall be positioned between the elevation of the timer operating float switch and the high water alarm/timer override float switch.

6. An emergency storage capacity in the septic tank from which effluent is pumped onto the sand filter. This zone shall be positioned above the elevation of the high water alarm/timer override float switch and below the tank inlet invert. This storage volume shall be a minimum of 10% of the septic tank volume capacity.

Requirements for Recirculating Sand Filters:

1. A separate recirculation tank with a hydraulic capacity (in gallons) as noted in Table 1.

2. A recirculation buoyant-ball check valve (or other approved flow splitting device) to split the return flow from the sand filter. The ball when seated should maintain the liquid level in the recirculation tank at 80% of tank liquid capacity. The liquid capacity is determined by the elevation of the timer operating float switch.

3. A recirculation ratio from 3:1 to 5:1. Note that a 4:1 recirculation ratio returns 3 parts (3/4) of the sand filter effluent back to the recirculation tank, while discharging 1 part (1/4) of the sand filter effluent to the drainfield.

Operation and Maintenance Requirements for Sand Filter Systems

WARNING - Before doing any work on either the wiring to the level control floats and pumps in the vault, tanks, or on the control panel, pull the fuse and switch the circuit breakers in the control panel to the OFF position (see Figure 6). Do not enter a confined space without using proper equipment and following standard confined space safety precautions.

A. Immediately after any sand filter system has been installed, the head or "squirt height" of the distribution laterals needs to be determined, recorded in the maintenance record and left on site (usually in the system electrical control box). Measuring the head is done by attaching a graduated length of clear PVC pipe to the end of the sweep elbow accessed by removing the inspection port cover (in a RSF, the straight end of the lateral can be accessed by pushing aside the pea stone, and attaching a 90 degree elbow). The pump is turned on, the sweep end opened, and the wastewater height in the clear pipe is measured and recorded.

B. A minimum of five (5) feet of distal head pressure is recommended to discourage orifice clogging.

C. Orifice blockage will occur in all systems. A bottle brush (appropriately sized for the lateral) attached to a plumbers snake is pushed down each lateral to unplug the orifices.

D. With the bottle brush removed, the pump should be manually engaged and each lateral line can be flushed out through the lateral end onto the sand filter.

E. Alternatively, a pressure power washer with appropriately sized tubing can be sent down each lateral to flush accumulated solids.

F. Usually a sand filter in continuous use will require lateral flushing / bottle brush treatment once a year. Sand filters operating above their daily design flow or systems in need of a septic tank pumpout, may require more frequent lateral flushing; the frequency based upon the results of the distal lateral head pressure test. Seasonally-used sand filters may not need yearly lateral flushing, but their lateral head (pressure) should be checked once per year, and maintenance performed as needed.

G. The lateral "squirt height" (which approximates, but is somewhat less than, the head) in RSFs can be determined by spreading aside the pea stone surface covering one of the distribution laterals, removing an orifice shield, and measuring the squirt height with a tape measure placed next to the stream. Alternately, a 90 degree elbow can be attached to the lateral end and head visually measured in an attached clear pipe.

H. The surface of all sand filters should be kept free of debris. If the sand filter is an "open" filter covered with pea stone instead of turf, the sand filter surface should be kept free of weeds and grasses. This surface can be lightly raked to remove leaves, etc. and weeds and grasses should be removed when they first appear.

I. Once a year all electrical components should be checked for function. All float switches should be activated and timers should be checked against the desired setting. All float switches should be hosed down to prevent scum accumulation. All wiring should be neatly bundled and placed out of the operating path of the float switches.

J. The septic tank and pump tanks should be measured for sludge and scum accumulation. This should occur every 1-3 years, the frequency depending on household usage and occupancy. More actively-used systems should be placed on the more frequent sludge/scum measurement schedule. This can easily be done as part of the annual maintenance. If sludge and scum levels warrant, have those tanks pumped.

IMPORTANT! If fiberglass or polyethylene tanks are used, it is important to monitor groundwater levels before pumping septage or to schedule pumping of tanks for late Summer or early Fall to avoid tanks floating (this time period may differ depending upon weather conditions). Pumping concrete tanks during periods of high groundwater may also cause tank floatation problems. The yearly inspection process will facilitate the scheduling of tank pumping to avoid emergency pumping situations. All tanks should be filled with tap water immediately after septage pumping is completed.

K. The effluent filter in the septic tank should be hosed off on a yearly basis, and whenever the septic tank is pumped. Systems operating above their design flows may require more frequent effluent filter cleaning.

L. **Effluent filters located in a recirculation tank should be checked a minimum of every six months for accumulation of slime growth.** If the pump is located in a pump vault, this slime growth may necessitate the removal and cleaning of the vault, pump and the effluent filter, if so equipped. If inspections determine that slime growth is not a problem, then this particular inspection item schedule may be reassessed.

M. If the pump vault is removed, the cleaned vault should be filled with clean water from a garden hose as it is being lowered back into the septic tank. This will prevent the screen from being fouled with solids in the tank and will also make it easier to submerge.

N. All slime material hosed off of filters, pumps and vaults should be placed into the **inlet end of the septic tank**, accessible through the tank inlet access riser / manhole**.**

O. All tanks should be visually inspected for watertightness and structural soundness when maintenance is performed.

P. In the event of an audible alarm, the alarm can be silenced by pushing the red button on the outside of the control panel. In most cases the alarm will be due to a temporary high water situation caused by too much water entering the system at a particular time. This will be self-correcting in most cases. If the alarm keeps coming on or if the red light on the outside of the panel stays on for a prolonged period of time after the alarm is silenced there may be a more serious problem such as a clogged effluent filter, "full" septic tank, or mechanical malfunction.

Q. The high water alarm will come on if the volume of water used at a particular time is more than what is accommodated for discharge in the usual dosing process. An alarm may go on if the occupancy or water use of the house or facility is more than typical. These are referred to as "nuisance alarms" and do not mean there is a system problem. If the nuisance alarm persists, the dosing schedule and amounts can be changed to help correct the problem. In some cases, persistent alarms may indicate a more serious problem that needs to be addressed.

R. At each visit, readings from elapsed run time meters, event counters, and water meters should be recorded on the data cards (usually stored in the electrical control panel).

S. At each site visit, a sample of the sand filter effluent should be collected to visually check for effluent clarity. This sample should be clear and odor-free.

Sizing PSNDs Receiving Sand Filter Effluent or Advanced-treated Residential-strength Wastewater

Because all three sand filter designs in this guide are capable of reducing waste strength to well below secondary treatment levels (i.e. BOD and TSS well below 30 mg/L), they may be allowed a reduction in conventional drainfield size. To gain additional reductions of nutrients and pathogenic organisms in critical resource areas, PSNDs are the preferred leachfield for use with the sand filters and other advanced treatment systems illustrated in this guide. Loading rates for soils receiving sand filter and other advanced treatment systems' effluent shall follow the criteria shown below.

Sizing of PSNDs is dependent on consistency and quality of treated effluent. This guide divides treatment systems into two categories as follows.

Category 1 systems are advanced treatment systems that incorporate time-dosing and that have been classified by the RIDEM as meeting treatment standards of less than or equal to 20 mg/L for both BOD and TSS and FOG of less than or equal to 5 mg/L. This timer provides de facto time-dosed application of treated effluent to the PSND (See Figures 13 and 14).

A Category 2 System is **a**ny advanced treatment system that is **not time dosed,** and has been classified by the RIDEM as meeting treatment standards of 30 mg/L or less for both BOD and TSS and FOG of less than or equal to 5 mg/L. Routine hydraulic surge storage capacity in the tank from which the treated effluent is pumped to the PSND is required. The surge storage capacity shall be positioned between the elevation of the timer operating float switch and the high water alarm/timer override float switch (See Figures 15, 16A, 16B and 16B).

Table 3. Hydraulic loading rates for PSNDs.

Soil Category	Soil Texture* [4]	Soil Structure	Soil Consistence In-hand Using Soil Clods	Typical Soil Class	Category 1 Systems[1] PSND Loading Rates[3] (gal/ft^2/day)	Category 2 Systems[2] PSND Loading Rates[3] (gal/ft^2/day)
1	cos, s, lcos, ls, cosl, fs	structureless-single grain subangular blocky	loose friable	Outwash (Class C), ice contact (Class D) and coarse ablation till (Class B) deposits	2.3[4]	1.5[4]
2	vfs, lvfs	structureless-single grain	loose	Outwash (Class C) and ice contact (Class D) deposits	2.7	1.9
3	ls, sl, l	granular, subangular blocky	very friable to friable	Lodgement Till (Class A), Ablation Till (Class B), Outwash (Class C), or Ice Contact (Class D)	3.5	2.3
4	lfs, lvfs, fsl, vfs	granular, subangular blocky	very friable to friable	Lodgement Till (Class A), Ablation Till (Class B), Outwash (Class C), or Ice Contact (Class D)	3.1	2.0
5	sil, si, vfsl	subangular blocky	very friable to friable	Typically Eolian deposits (Class G)	2.7	1.9
6	lcos, cosl, lfs, ls, sl, l,	structureless massive	very friable to friable	Ablation till (Class B)	2.3	1.5
7	fsl, vfsl, sil, si, vfs	structureless-massive	very friable to friable	Ablation till (Class B)	2.1	1.5
8	all textures	structureless-massive	firm to very firm	Lodgement till (Class A)	1.9	1.3
9	all textures	platy, structureless-massive	firm to very firm	Lodgement till (Class A)	1.5	1.0
10	all textures	platy, structureless-massive	extremely firm	Lodgement till (Class A)	Not Allowed	Not Allowed

* Soil textures defined in the glossary.
[1] Category 1 Systems = Any advanced treatment system that is **time dosed** according to the specifications of this guide and has been classified by the Department as meeting treatment standards of less than or equal to 20 mg/L for both BOD and TSS and FOG of less than or equal to 5 mg/L.
[2] Category 2 Systems = Any advanced treatment system that is **not time dosed** according to the specifications of this guide and has been classified by the Department as meeting treatment standards of 30 mg/L or less for both BOD and TSS and FOG of less than or equal to 5 mg/L. Time dosing and an in-line screen filter or a screen pump vault must be used on the pump dosing the PSND.
[3]Drainfield loading rates shall be based upon texture, structure, and consistence of most restrictive horizon.
[4] PSNDs placed in cos, vcos, gravelly or very gravelly soils shall have a leveled-off 6-inch ASTM C-33 sand layer.

Pressurized Shallow-Narrow Drainfields (PSNDs) (Figures 17 and 18)

Remember to follow these basic rules when designing and installing PSNDs:
1) Minimum invert perimeter shall be five-feet, provided a 3:1 slope is maintained beyond the five-feet to original grade; the invert and bottom bed of the PSND shall be held to be the same, equal to the elevation of the bottom of the support pipes and under the distribution pipe;
2) Preservation of the native soil between trenches and minimizing its disruption and compaction during construction is essential to maintaining soil structure and therefore water and gas movement in the soil around the trenches. For this reason construction is to be trench-by-trench (relief from this requirement may be granted by the RIDEM on a

case-by-case basis when informed of unanticipated site conditions encountered during construction);

3) Keep the bottom bed shallow (8-12 inches below existing and finish grades);
4) Separation to the seasonal high water table is two (2) feet statewide unless otherwise specified by permit;
5) Separation to impervious layer shall be four (4) feet statewide unless otherwise specified by permit;
6) Keep the bottoms of the individual trenches level;
7) Do not over-dig the width or depth of the drainfield trenches;
8) Provide for lateral pipe drainage and maintenance access;
9) Avoid working soils that are moist or wet because they can easily smear and compact; and
10) Scarify the drainfield base well before installing components.

When first reviewing a construction site and developing a design, it is best to position PSNDs parallel to ground surface contours. This will help make it easier to keep drainfield base elevations uniform. Designing perpendicular to a surface contour will mean that the down gradient end of the drainfield trench will be shallow-placed, whereas the up gradient end will be much deeper.

Small frequent doses of effluent to a PSND are preferred over fewer larger doses. Drainfield pump basins/chambers should be designed with float switches controlling high water alarm, pump on/off, and low water alarm/redundant off. An event counter and elapsed time run meter shall also be used on the drainfield pump.

PSND Construction

The soil between the dispersal trenches shall remain undisturbed. If the presence of boulders or other obstacles make trench construction impractical, the entire leachfield area may be excavated as necessary, backfilled with ASTM C-33 sand to the design elevation of the bottom bed (Figure 18), the PSND constructed and backfilled with native soil material.

Transport Lines

Sand filter effluent applied to PSNDs is typically done using small diameter, pressure rated PVC pipe. Generally, for this guideline the effluent transport line from the sand filter to the PSND is usually a 1¼ to 2 inch PVC (Class 200 minimum) pipe; the actual size depending upon such factors as distance, pump head, friction loss, and desired pressure at distal orifices. This pipe should be sloped either back to the pump basin or towards the drainfield to clear the line after each dose. In some cases it may be better to slope the transport line in both directions. In all cases, this is done to prevent freezing in cold weather. If the transport pipe slopes towards the filter and the sand filter distribution piping is at a lower elevation than the maximum water level in the tank, an anti-siphon device should be used on the pump discharge assembly to prevent siphoning.

Distribution Manifolds and Laterals

PSND distribution manifolds typically are 1 ¼ to 2 inch PVC (Class 200 minimum) and the distribution laterals are usually 1 to 1 ¼ inch Schedule 40 PVC. Size will vary depending on design and site conditions. (Note: Small lateral and orifice diameters are recommended to provide the highest possible scouring velocity in the laterals, to minimize orifice clogging, and to provide as even distribution of wastewater as possible.) In addition the following criteria shall also be observed: A series of 1/8 inch diameter holes (orifices) shall be made in the top of the distribution laterals (12 o'clock position) and spaced according to the dosing requirements of the system (see Figure 9). During construction/fabrication a new drill bit should be used to assure as smooth an orifice as possible. Generally, the orifice spacing is every 18 to 24 inches to best distribute wastewater to the drainfield surface. Along a lateral, holes should be drilled downward through both the top and bottom of the pipe (12 and 6 o'clock positions) **at every fifth orifice** to allow drainage after a dose and to prevent lateral freezing in cold weather. Cold weather orifice shields that are used in sand filters **are not used in shallow and narrow drainfield applications**. Designs should account for a **minimum** of two (2) feet of head (pressure) at the distal end of each drainfield distribution lateral.

Schedule 40 PVC or equivalent sweep elbows (also called turnups) shall be attached to the distal end of each drainfield lateral to facilitate maintenance and inspection. A standard ninety (90) degree elbow **should not** be used here because it will interfere with maintenance activities. The sweep elbow end should be closed off with either a ball valve or a male threaded adapter and threaded cap. The threaded end should accommodate attachment of a ten foot length of clear PVC pipe to be used to determine initial head at the distal lateral ends and subsequent head measurement during routine inspection and maintenance visits. A difference in head relative to the initial reading will signal maintenance requirements during subsequent visits. The sweep end is also the location through which lateral cleaning will occur (see Operation and Maintenance section).

The ends of the sweep elbows shall be readily accessible by means of a 6 to 8 inch diameter access box or port brought to the ground surface. Access ports should also be placed every twenty feet along the drainfield trenches. High-density plastic irrigation valve access boxes/ports are often used for this purpose.

Drainfield Cover

The dome-like covering over the PSND should be made of 12 inch diameter PVC pipe, or high-density polyethylene (HDPE) pipe cut lengthwise or ADS N-12 IB ST or an approved equivalent (Figures 17 and 18). One (1) inch diameter Schedule 40 PVC support pipes should be used to support the dome (and pressure pipe), to act as a spreader device for the dome, and to provide a greater bearing surface for the dome. These support/spreader pipes should be spaced approximately four (4) feet apart or whenever a drainfield cover joint occurs. Notches should be cut into either end of the support pipes for the cover to fit into. This will help provide greater structural strength for the cover.

Filter fabric should be placed over or wrapped around any joint or inspection port. This will keep migration of fine soil particles into the drainfield trench to a minimum. The ends of the drainfield cover should be wrapped with filter fabric or capped with a suitable end cap.

Trench Spacing and Maximum Length

A minimum two and one-half (2.5) foot on-center (one and one-half foot edge-to-edge) trench spacing shall be used. Maximum trench length should not exceed fifty (50) feet. Actual lengths will vary between locations and will be influenced by site conditions and the need to maintain the required minimum two foot of distal head pressure on drainfield laterals.

Trenches at Different Elevations and Zoned Drainfields

Smaller sized pumps can be used on larger drainfields and still maintain distal head pressure by utilizing automatic sequencing valves. These valves automatically direct flow to two or more final treatment and dispersal components, one or more at a time, and in a prescribed order sequentially redirect flow to separate zones within the drainfield.

Site conditions may not facilitate installing drainfield trenches at the same elevation. In these situations, gate valves can be used to provide uniform wastewater distribution; gate valves also help facilitate cleaning of laterals. Access ports must be installed at the locations of gate valves. Alternately, orifice plates may be used to help equalize flow to trenches that are not at the same elevation.

Maintenance

Sand filter effluent and other RIDEM approved advanced treatment systems' effluent is low in BOD and TSS, accumulation of biosolids or slime material in drainfield lateral pipes is fairly minimal. Over time, however, biosolids will accumulate, blocking orifices and creating uneven wastewater distribution along the trench. To unclog the orifices locate the trench access port and open the lateral sweep end. Open each lateral end, manually engage the pump and purge any loose solids out the lateral end into the access port. A bottle brush (appropriately sized for the lateral) attached to a plumbers snake is then pushed down each lateral to unplug the orifices. With the bottle brush removed, the pump should be manually engaged and each lateral line can be flushed out through the lateral end onto the drainfield surface. This minimal amount of biosolids will usually decompose within two days. Alternatively, a pressure power washer with appropriately sized tubing can be sent down each lateral to flush accumulated solids.

Usually a PSND following a sand filter in continuous use will require lateral flushing/bottle brush treatment once a year or every two years. Systems operating above their daily design flow may require more frequent lateral flushing; the frequency based upon the results of the distal lateral head pressure test. Seasonally-used systems may not need yearly lateral flushing, but their lateral head (pressure) should be checked once per year, and maintenance performed as needed.

Precautions

The home landscape immediately above and adjacent to any septic drainfield should be protected from heavy vehicle traffic and excessive weight loads, before, during and post-construction. This is especially important when using PSNDs, because they are located close to the ground surface and especially susceptible to damage after construction. It is recommended that the proposed drainfield location be staked and flagged/fenced to prevent encroachment during home construction. If vehicle encroachment is expected to be a problem after construction, some structure such as garden timbers, fences, or walls should be used to protect the drainfield area.

The drainfield area should be kept debris free and planted to grass. Impermeable materials should not be installed or stored over the PSND. Trees and shrubs should be kept a minimum distance of ten (10) feet from the drainfield. Roots from nearby moisture-loving trees such as willows, black locust, and red maple may cause problems with root clogging drainfield lateral orifices. Greater setback distances are recommended from these tree species.

Appendix A

Glossary of Wastewater Terms

Advanced Treatment System: An OWTS which is designed to meet ***minimum treatment standards of 30 mg/L or less for both BOD and TSS and FOG of less than or equal to 5 mg/L***; *see also* **Category 1 System** and **Category 2 System.**

Advanced-treated Wastewater: Wastewater which has been treated by an **Advanced Treatment System**.

Biochemical Oxygen Demand - Five Day (BOD_5): A five day laboratory test which determines the amount of dissolved oxygen used by microorganisms in the biochemical oxidation (breakdown) of organic matter. BOD concentrations are used as a measure of the strength of a wastewater.

Category 1 System: Any advanced treatment system that is **time dosed** according to the specifications of this guide and has been classified by the Department as meeting treatment standards of less than or equal to 20 mg/L for both BOD and TSS and FOG of less than or equal to 5 mg/L.

Category 2 System: Any advanced treatment system that is **not time dosed** according to the specifications of this guide and has been classified by the Department as meeting treatment standards of 30 mg/L or less for both BOD and TSS and FOG of less than or equal to 5 mg/L.

Dosing Tank: A tank that collects wastewater and from which wastewater is discharged into another treatment or dispersal step; equivalent to a dosing chamber.

Drainfield (conventional): An area in which perforated piping is laid in drain rock-packed trenches for the purpose of distributing the effluent from a wastewater treatment unit.

Distribution Laterals (pressure dosed): Usually small diameter PVC pipe with orifices evenly spaced, used to uniformly distribute wastewater over a treatment zone in an enclosed component or drainfield.

Effective (Particle) Size, ($ES= D_{10}$): The size of a sand filter media grain in millimeters, such that 10% by weight of the media sample is smaller.

Effluent: Liquid that is discharged from a septic tank, filter, or other on-site wastewater system component.

Fecal Coliform (bacteria): Coliform bacteria specifically originating from the intestines of warm-blooded animals, used as an indicator of pathogenic bacterial contamination.

Filter: A device or structure for removing suspended solid, colloidal material, or BOD from wastewater.

Filter Fabric: Any man-made permeable textile material used with foundations, soil, rock, or earth.

Filter Media: The material through which wastewater is passed for the purpose of treatment.

Particle Size: The diameter (in millimeters) of a soil or sand particle, usually measured by sedimentation or sieving methods.

Particle Stratification: Separation of particles according to size due to movement of particles in either air or water.

Pressurized shallow-narrow drainfield: Drainfield for final treatment and dispersal of pre-treated effluent by low-pressure distribution laterals installed in dome-covered trenches installed in the upper portion of the soil surface (see Figure 17 and 18).

Pre-Treated Effluent: Effluent which has been treated by a SPSF, RSF, Category 1 or Category 2 System that is approved for use by the RIDEM.

Recirculating Sand (Gravel) Filter: A sand (gravel) filter which processes liquid waste by mixing sand filter filtrate with incoming septic tank effluent and recirculating it several times through the sand filter media before discharge to a final treatment/dispersal unit.

Residential Strength Wastewater: effluent from a septic tank or other treatment device with a BOD5 less than 300 mg/L; TSS less than 170 mg/L; and fats, oils, and grease less than or equal to 25 mg/L.

Sand Filter: A biological and physical wastewater treatment unit consisting (generally) of an underdrained bed of sand to which primary treated effluent is periodically applied. Filtrate collected by the underdrain(s) is then transferred from the filter to an approved soil absorption system or other treatment step. Pretreatment of wastewater prior to the sand filter step, can be provided by either a septic tank or another approved treatment device.

Sandy Loam: Soil in which the sand fraction is still quite obvious, containing 25% or more medium sand. It is dominantly a loam, which is composed of sand, silt, and clay particles.

Sequencing Valve: valve used to automatically direct flow to two or more final treatment and dispersal components, one or more at a time, and in a prescribed order.

Single Pass Sand Filter: A sand filter in which primary treated wastewater is applied periodically, providing intermittent periods of wastewater application, followed by periods of drying and oxygenation of the filter bed. Wastewater applied to the surface of a single pass sand filter flows through that filter media once before going onto the next treatment step.

Soil Texture: The relative proportions of soil separates (sand, silt, and clay particles) in a particular soil. USDA soil texture abbreviations illustrated in Table 3 are defined as: cos = coarse sand; vcos = very coarse sand; fs = fine sand; lfs = loamy fine sand; ls = loamy sand; fsl = fine sandy loam; sl = sandy loam; l= loam; vfs = very fine sand; lvfs = loamy very fine sand; vfsl = very fine sandy loam; sil = silt loam; vfsl = very fine sandy loam; si = silt; sicl = silty clay loam.

Total Suspended Solids (TSS):, measure of solids that either float on the surface of, or are in suspension in, water or wastewater. A measure of wastewater strength, often used in conjunction with BOD_5.

Uniformity Coefficient (UC): A numeric quantity which is calculated by dividing the size of a sieve opening which will pass 60% by weight of a sand media sample by the size of the sieve opening which will pass 10% by weight of the same sand media sample. Note that 50% of the sample is retained between the two. The uniformity coefficient is a measure of the degree of size uniformity of the sand particles in sand media sample. As the UC value approaches one (1), the more uniform in particle size the sand media is. The larger the UC, the less uniform the particle size.

$$UC = \frac{\text{Particle Diameter}_{60\%} = D_{60}}{\text{Particle Diameter}_{10\%} = D_{10}}$$

Wastewater: Water-carried human excreta and/or domestic waste from residences, buildings, industrial establishments or other facilities.

Acknowledgments

This 2010 revision of this document results from review, comments and discussion by the Rhode Island Department of Environmental Management Technical Review Committee (TRC), Ken Anderson and Jim Boyd (CRMC), Noel Berg, David Burnham, Russell Chateauneuf (DEM), Joe Frisella, Susan Licardi, George Loomis, Tim Stasiunas and Dennis Vinhateiro and Brian Moore (DEM) and Deb Knauss (DEM).

The principal authors of the original version of this document, adopted April 2000 are George Loomis and David Dow of the University of Rhode Island On-site Wastewater Training Center. URI Coastal Fellows Gary Fullerton, Peter Constantine, and Jamie Coolen produced the figures for this document. Arthur Gold and Mark Stolt at the URI Department of Natural Resources Science provided careful reviews of this guide. This document is contribution number 3766 of the Rhode Island Agricultural Experiment Station and the Rhode Island Cooperative Extension, who provided funding to develop this guide.

This document was based on the regulations and guidelines developed for the states of Washington and Oregon. Those documents are *"On-Site Sewage Disposal Rules*", State of Oregon, Department of Environmental Quality, April 1, 1995 and *"Guidelines for Sand Filters"*, Washington State Department of Health, Technical Review Committee, June, 1996. The publication entitled "*Pressure-Dosed Sand Filter Pretreatment Systems*" North Carolina Innovative Wastewater System No. IWWS-97-1, dated May 1, 1997 by Michael Hoover was also used as a source.

The media sizing criteria, as used in Figures10-12, was adapted from information provided by Orenco Systems, Inc., Sutherlin, OR, from the Washington *"Guidelines for Sand Filters"* and from information provided by Nick Hill of Holliston Sand Company, Inc., Slatersville, Rhode Island.

Early drafts of this document were reviewed and approved by the Technical Advisory Committee of the University of Rhode Island Cooperative Extension On-Site Wastewater Training Program, who recommended forwarding this document to the Rhode Island Department of Environmental Management Technical Review Committee (TRC). Brian Moore and Russell Chateauneuf (DEM) and TRC members Jim Boyd and Ken Anderson (CRMC), Noel Berg, David Burnham, Joe Frisella, Ray Nickerson, Calvin Poon, Tim Stasiunas, and Dennis Vinhateiro provided helpful comments to drafts of this document. Mike DelRossi and Gary Fullerton of MDR Engineering in Cranston, Rhode Island assisted with CAD drawings for this guide.

The authors thank the following Consortium of Institutes for Decentralized Wastewater Treatment outside reviewers for their helpful comments to drafts of this document:

Terry Bounds – Orenco Systems, Inc., Sutherlin, OR.
James Converse – Biological Systems Engineering, Univ. of Wisconsin, Madison, WI.
Mark Gross – Civil Engineering, Univ. of Arkansas, Fayetteville, AR.
David Gustafson – Agricultural Engineering, Univ. of Minnesota, St. Paul, MN.
Ted Loudon – Agricultural Engineering, Michigan State Univ., E. Lansing, MI.
Jerry Stonebridge – Stonebridge Construction Company, Inc., Freeland, WA.
E. Jerry Tyler - Department of Soil Science, Univ. of Wisconsin, Madison, WI.
Steve Wert – Wert and Associates, Inc., Bend, OR.

References

Anderson, D.L., R.L. Siegrist and R.J. Otis. 1985. Technology assessment of intermittent sand filters. USEPA-Municipal Environ. Res. Lab. Cincinnati, OH.

Ball, H. 1991. Sand filters: state of the art and beyond. Proceedings of the 6th National Symposium on Individual and Small Community Sewage Systems. ASAE, St. Joseph, MI.

Emerick, R.W., R. Test, G. Tchobanoglous, and J. Darby. 1997. Shallow intermittent sand filtration: microorganism removal. The Small Flows Journal, 3 (1): 12-22.

Gold, A.J., B.E. Lamb, G.W. Loomis, J.R. Boyd, V.J. Cabelli, and C.G. McKiel 1992. Wastewater renovation in buried and recirculating sand filters. J. Environ. Qual., 21:720-725.

Loudon, T.L.. 1996. Design of recirculating sand filters. Proceedings, 8th Northwest On-Site Wastewater Treatment Short Course. Seattle, WA.

Peeples, J., K. Mancl, D. Widrig. 1991. An examination of the role of sand depth on the treatment efficiency of pilot scale intermittent sand filters. Proceedings of the 6th National Symposium on Individual and Small Community Sewage Systems. ASAE, St. Joseph, MI.

Pell, M., and F. Nyberg. 1989a. Infiltration of wastewater in a newly started pilot sand filter system: I. Reduction of organic matter and phosphorus. J. Environ. Qual. 18:451-457.

Pell, M., and F. Nyberg. 1989b. Infiltration of wastewater in a newly started pilot sand filter system: II. Development and distribution of the bacterial populations. J. Environ. Qual. 18:457-462.

Pell, M., and F. Nyberg. 1989c. Infiltration of wastewater in a newly started pilot sand filter system: III. Transformation of nitrogen. J. Environ. Qual. 18:463-467.

Piluk, R.J. and E.C. Peters. 1994. Small recirculating sand filters for individual homes. Proceedings of the 7th National Symposium on Individual and Small Community Sewage Systems. ASAE, St. Joseph, MI.

Ronayne, M.P., R.C. Paeth, T.J. Osborne. 1982. Intermittent sand filter design and performance- an update. Proceedings of 47th Northwest On-site Wastewater Short Course. Seattle, WA.

USEPA. 1980. Design manual: Onsite wastewater treatment and disposals systems. USEPA Cincinnati, OH.

Appendix B
Sand Filter Figures and Schematics

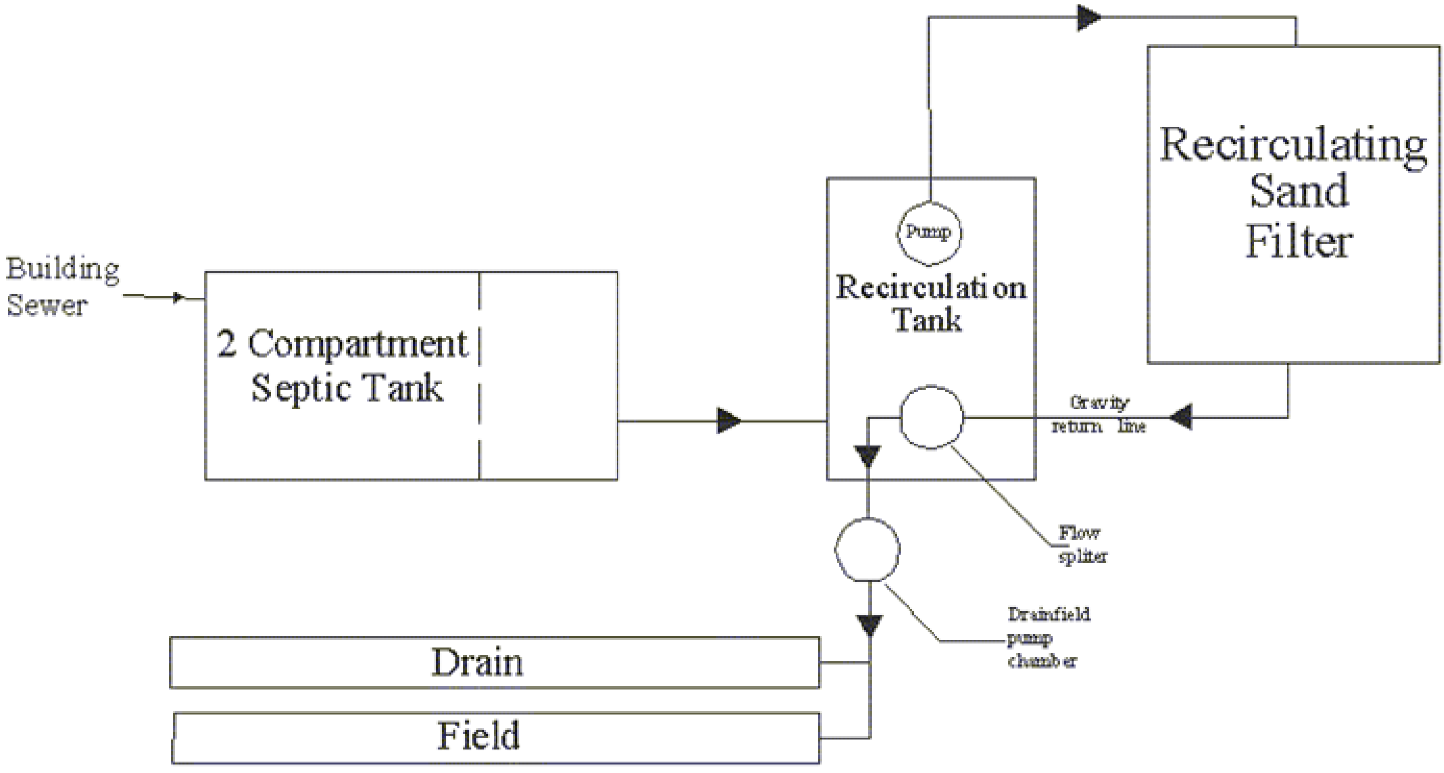
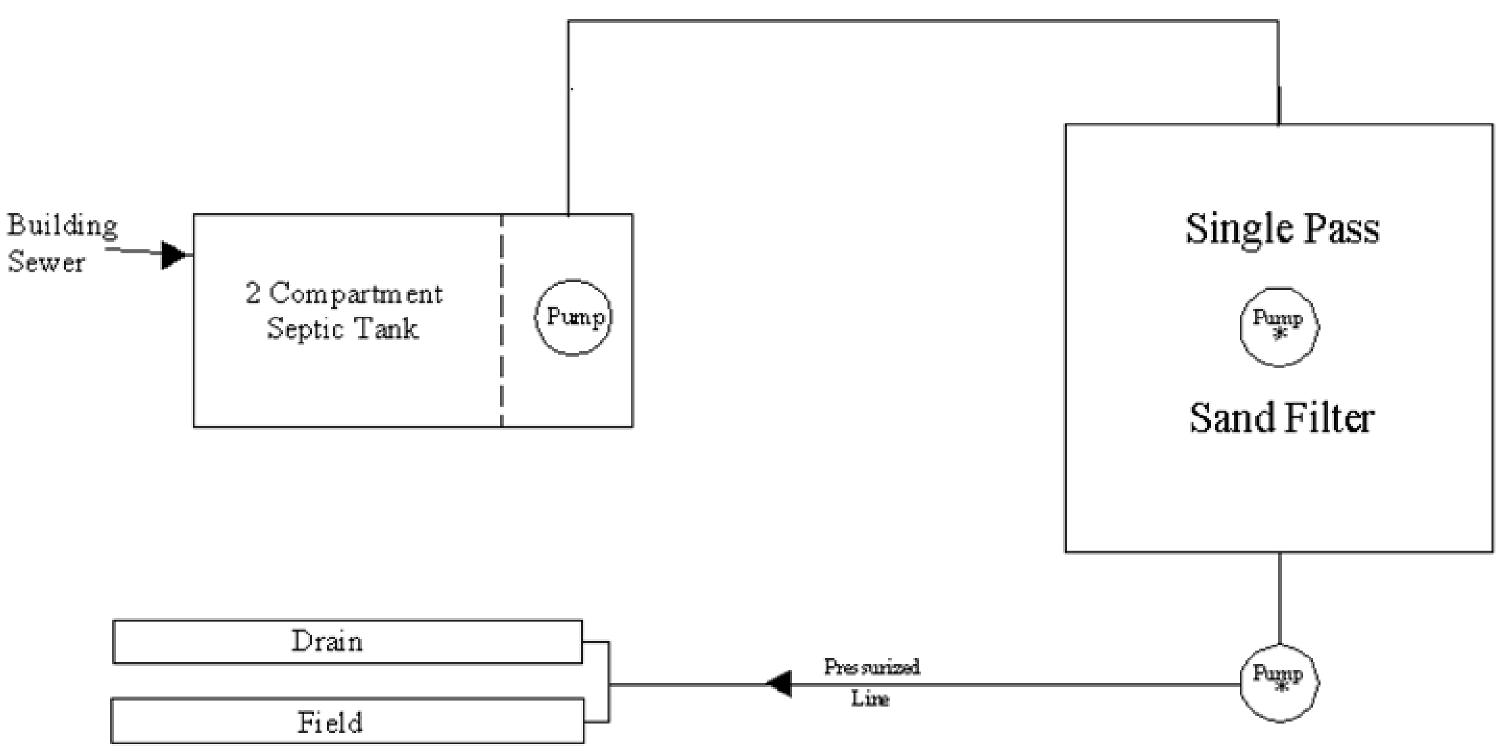
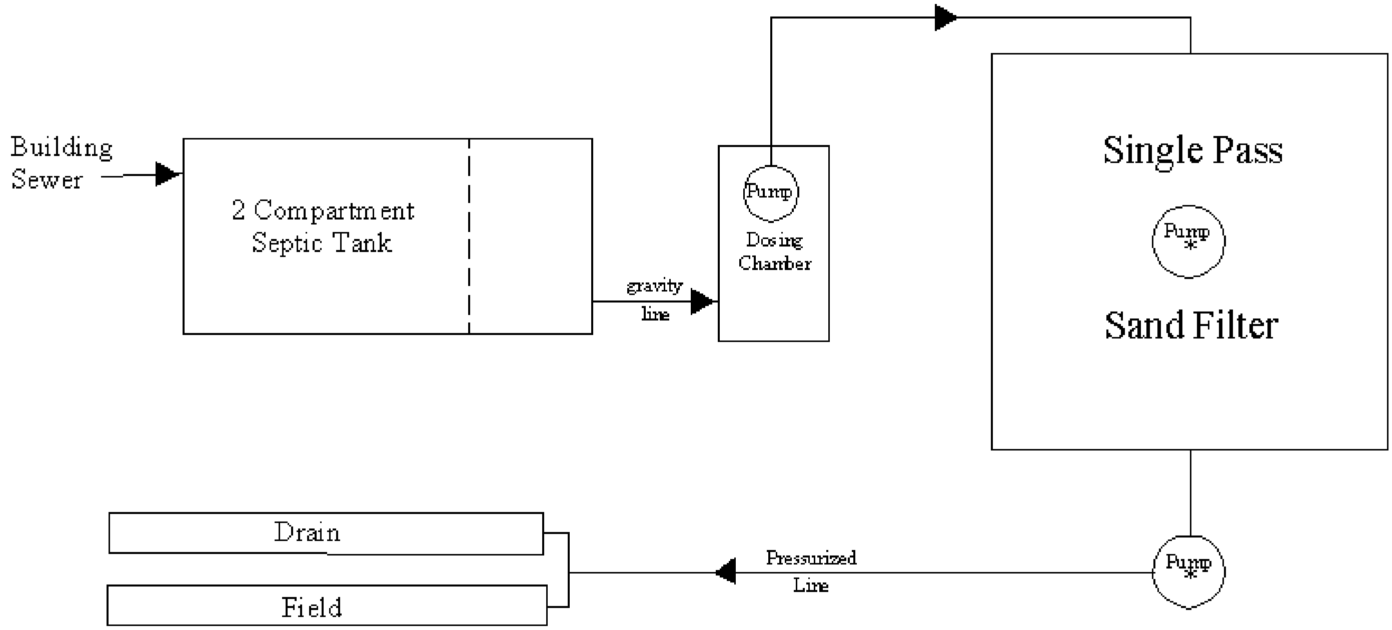


Figure 1: Schematic of a recirculating sand filter



*Possible pump basin locations for pressurized drainfield

Figure 2A: Single pass sand filter and pressurized discharge to drainfield



*Possible pump basin locations for pressurized drainfield

Figure 2B: Single pass sand filter with separate dosing chamber and pressurized discharge to drainfield

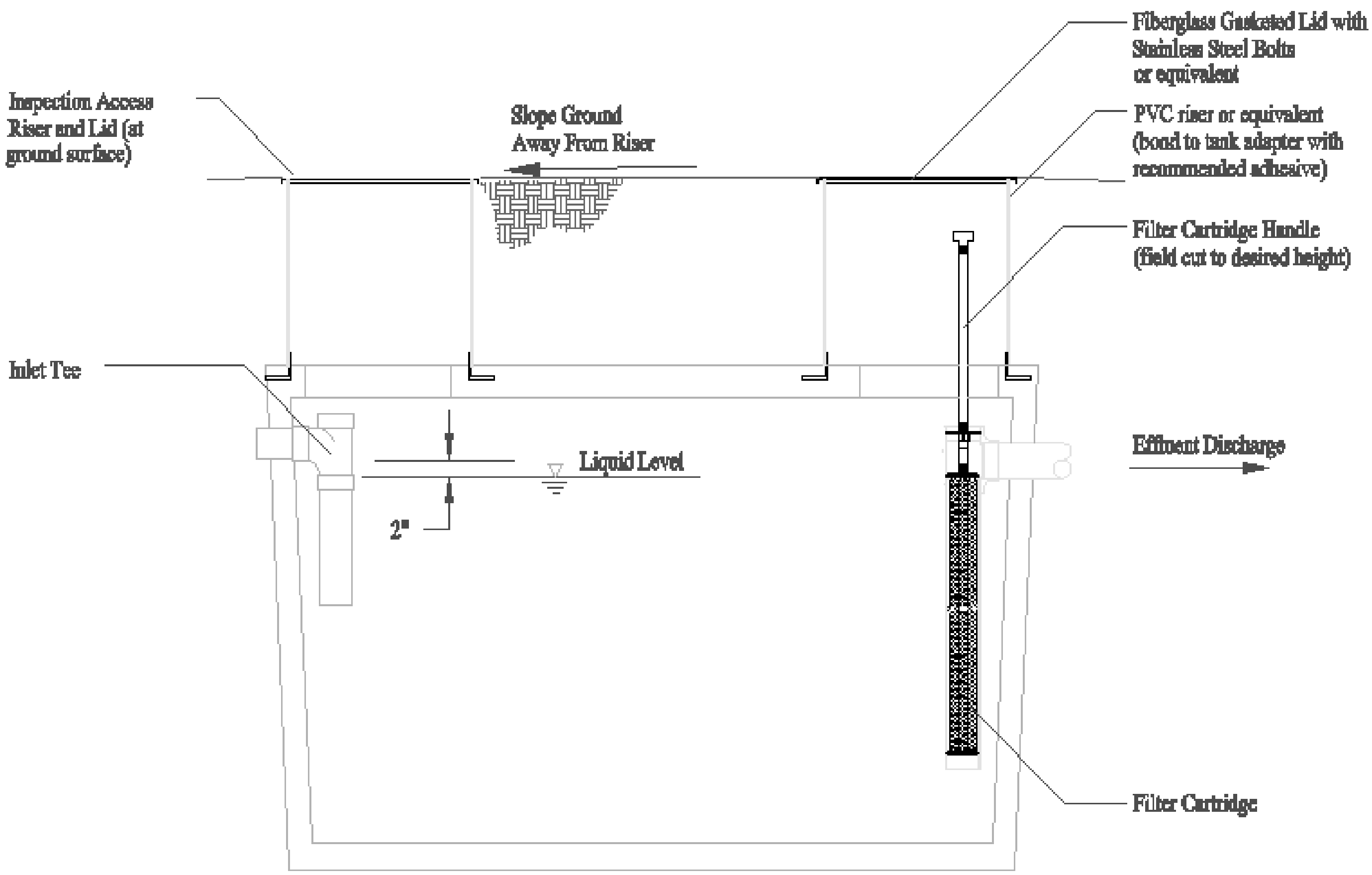


Figure 3A: Single compartment septic tank with effluent filter

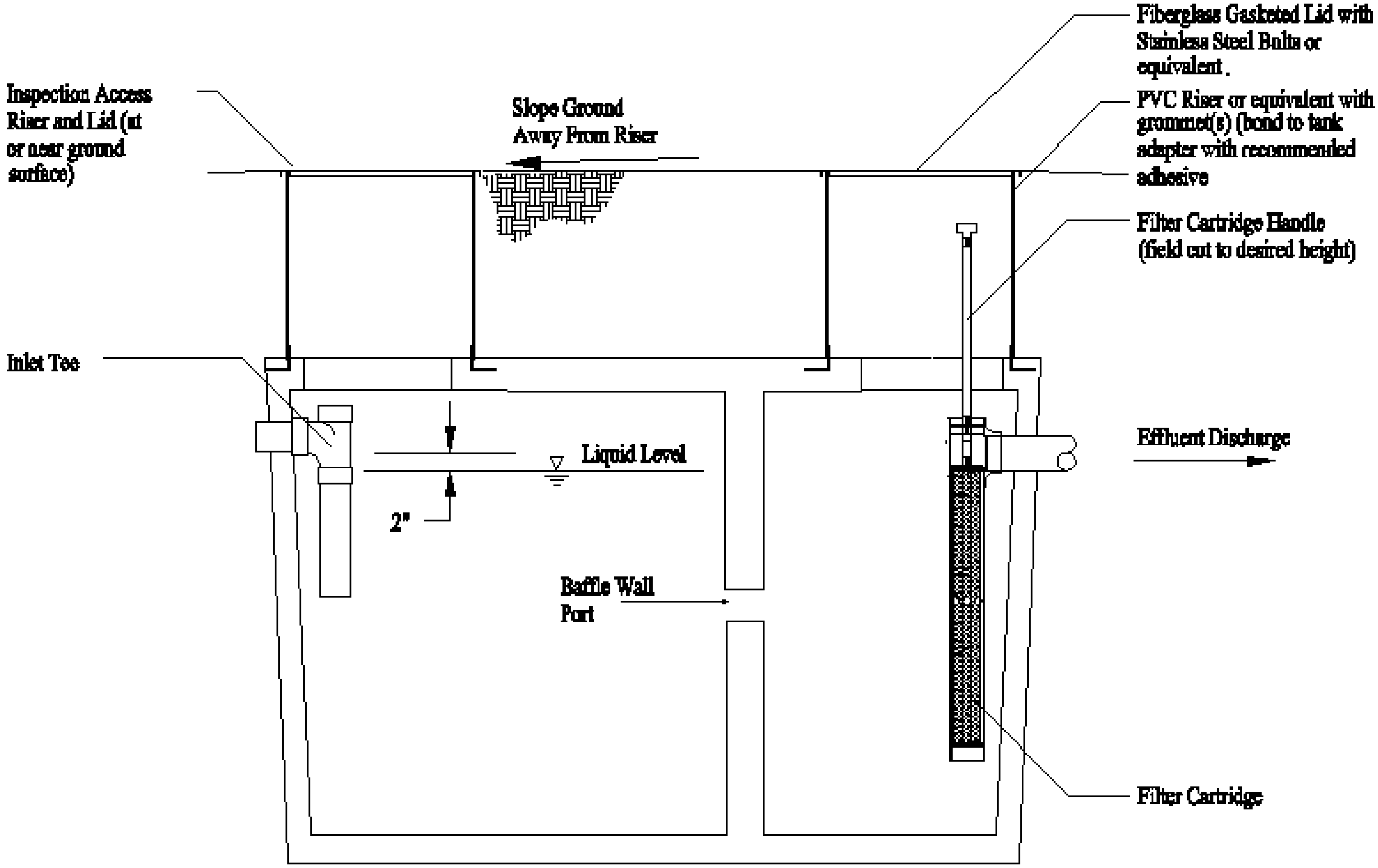


Figure 3B: Two compartment septic tank with effluent filter

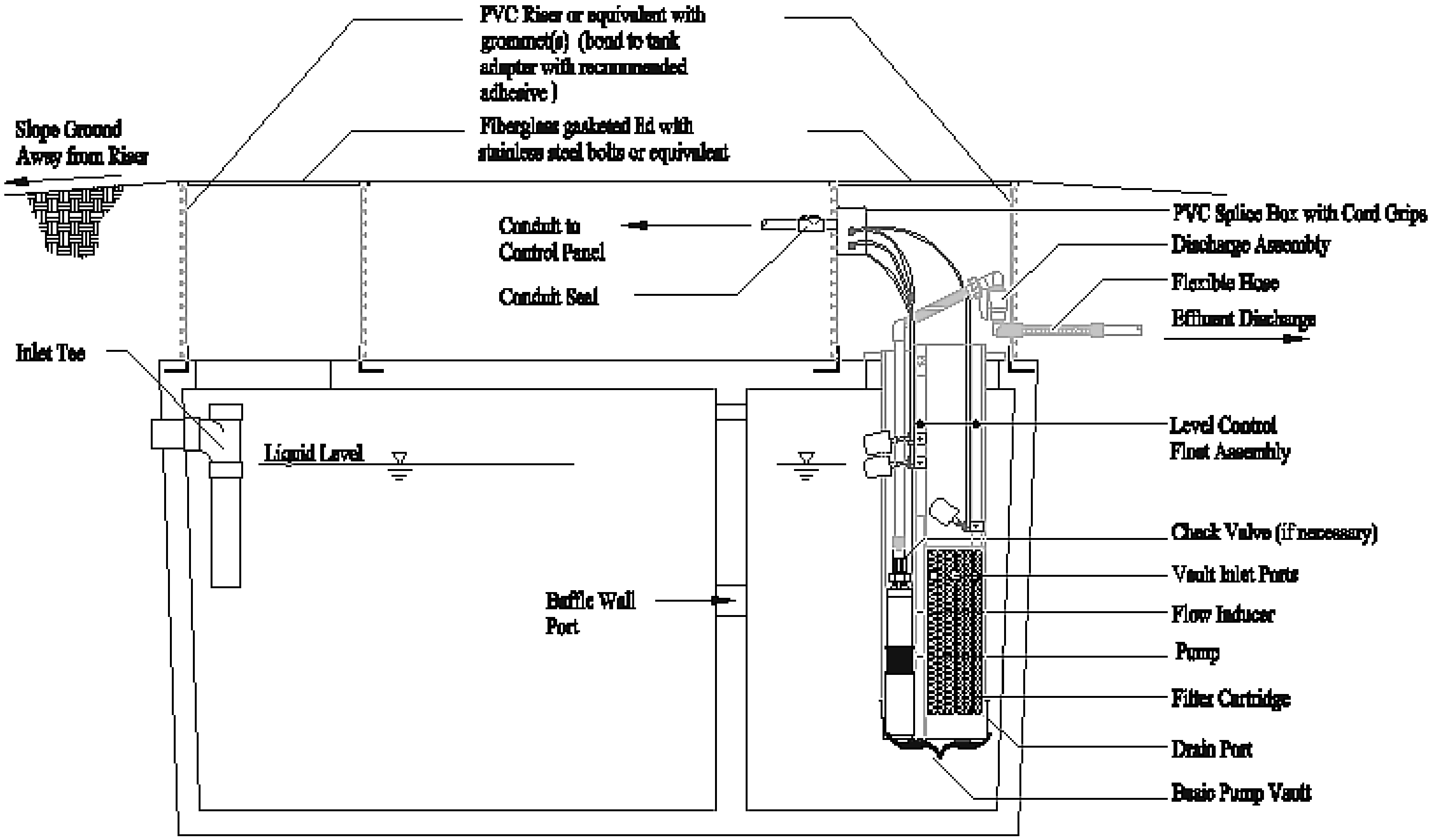


Figure 4: Two compartment septic tank with pump vault

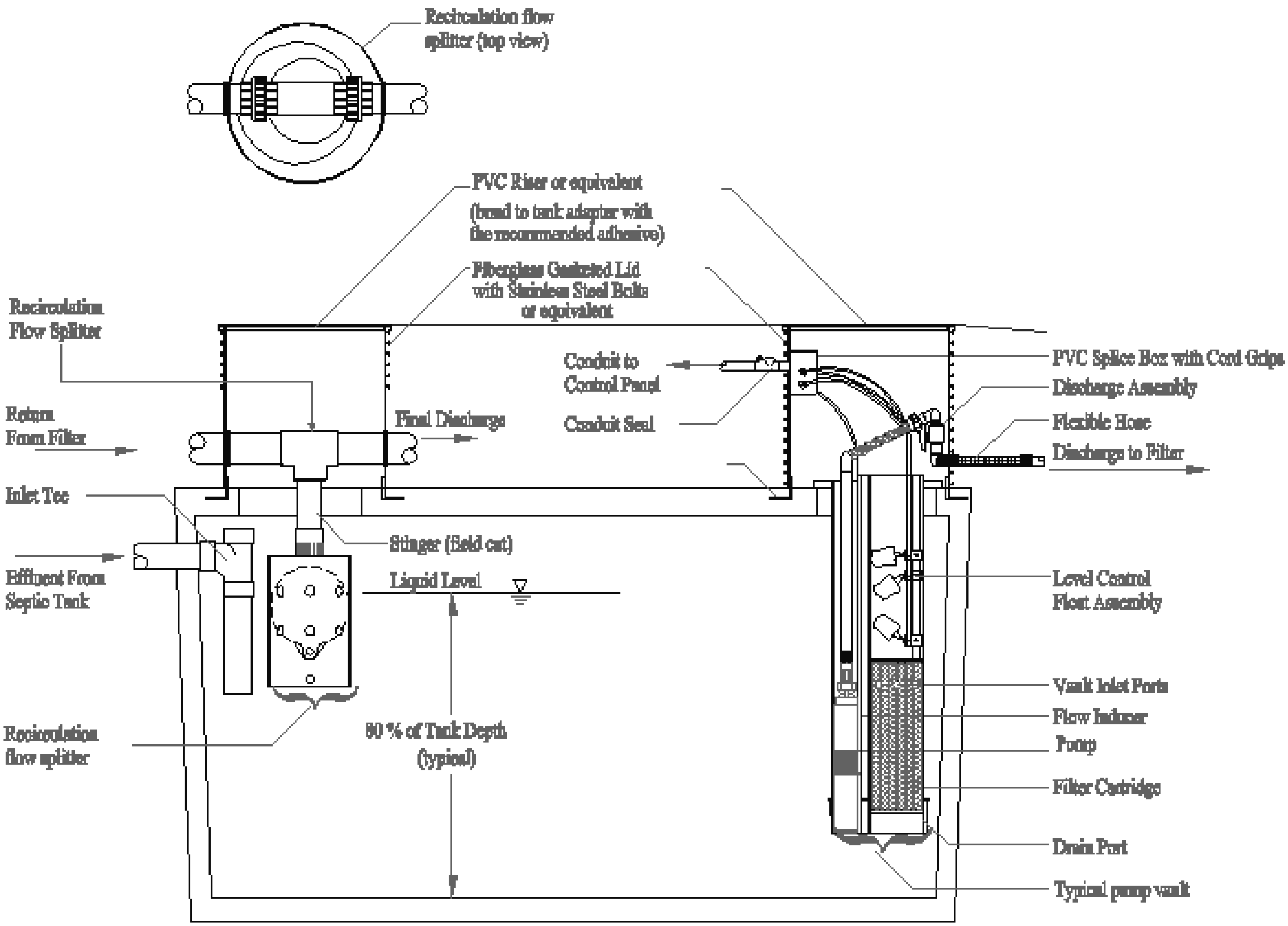


Figure 5: Recirculation tank

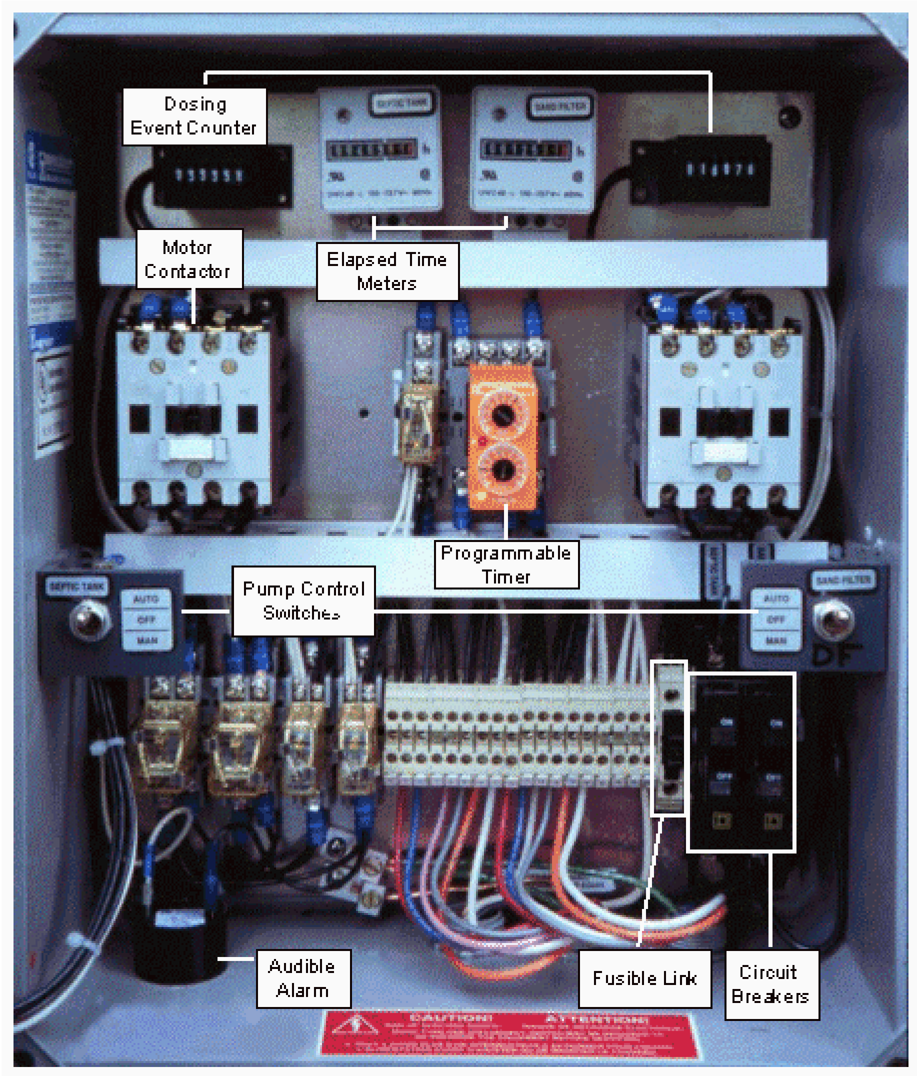


Figure 6: Electrical control panel box

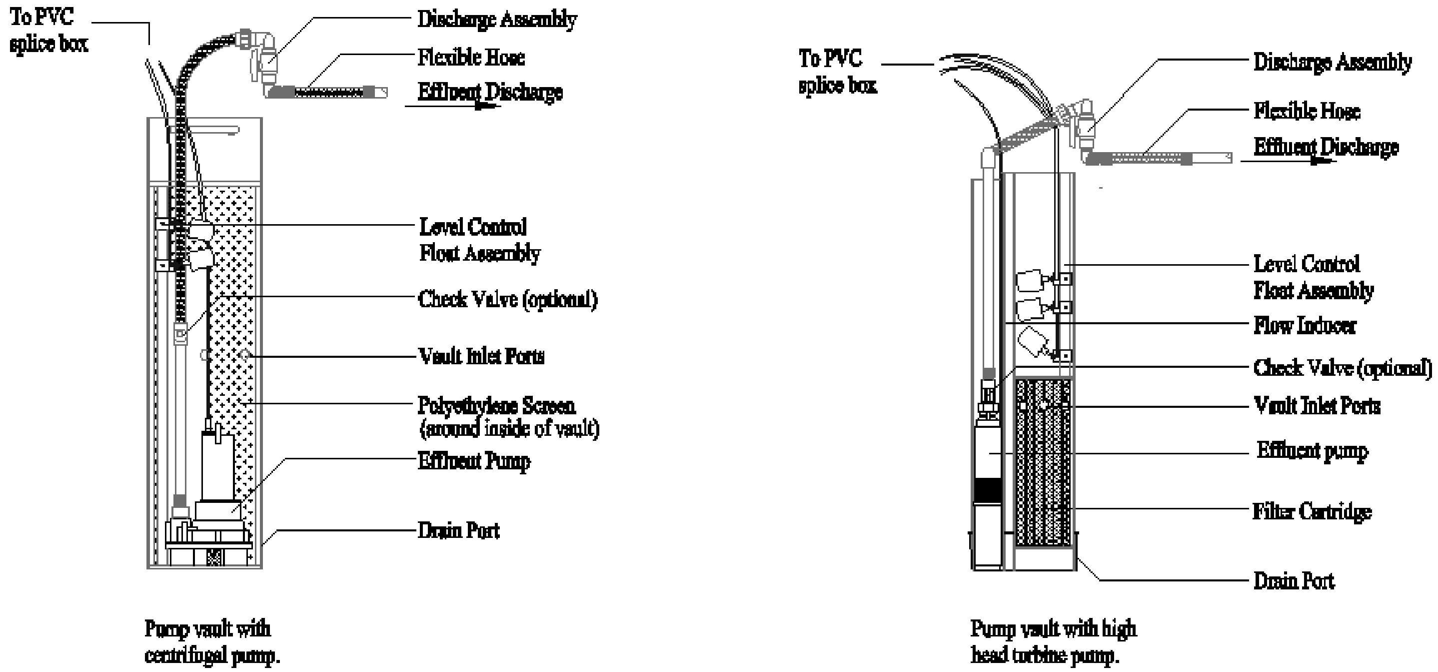


Figure 7: Typical pump vault assemblies

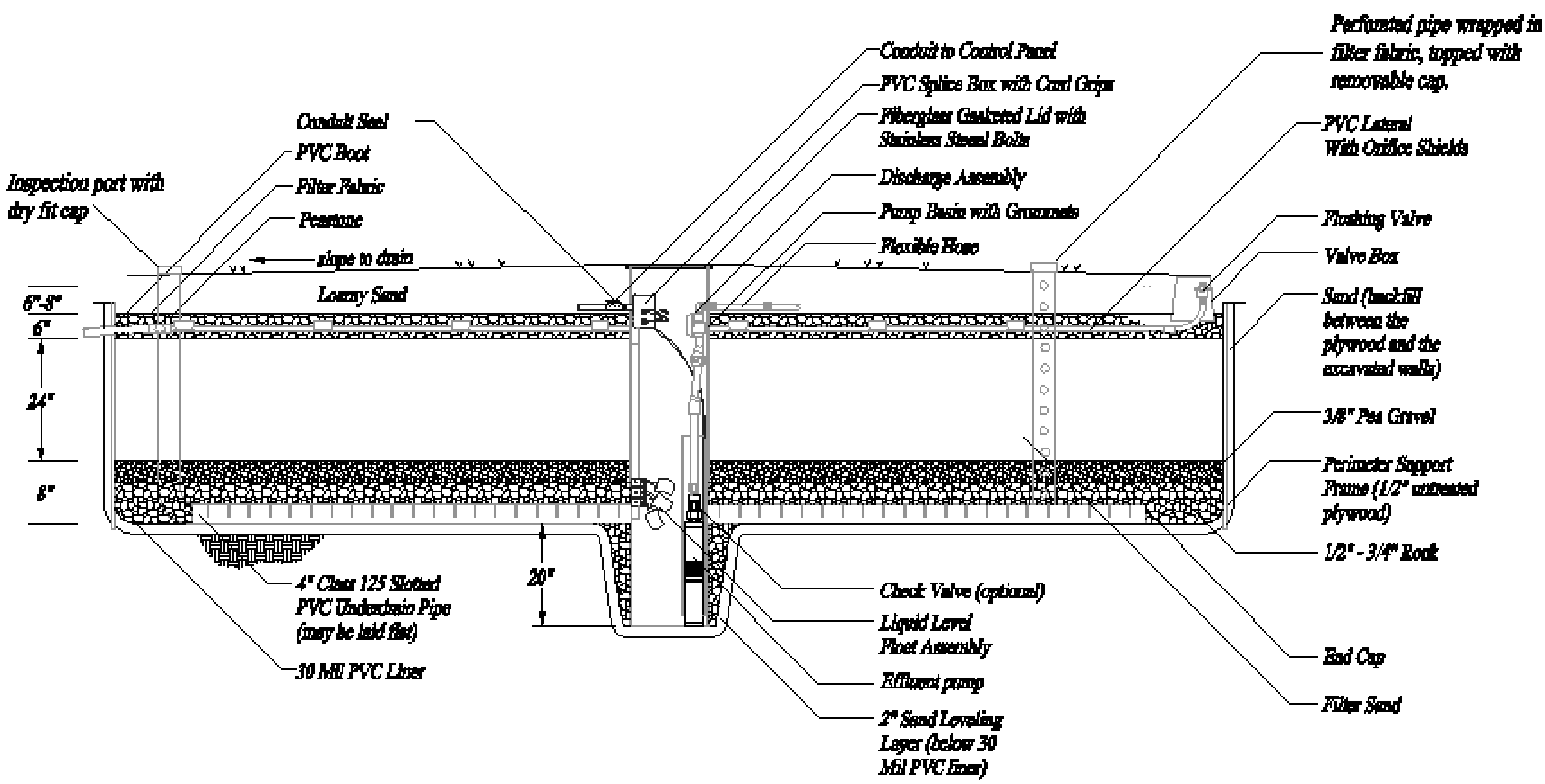


Figure 8A: Single pass sand filter with pump discharge (cross section)

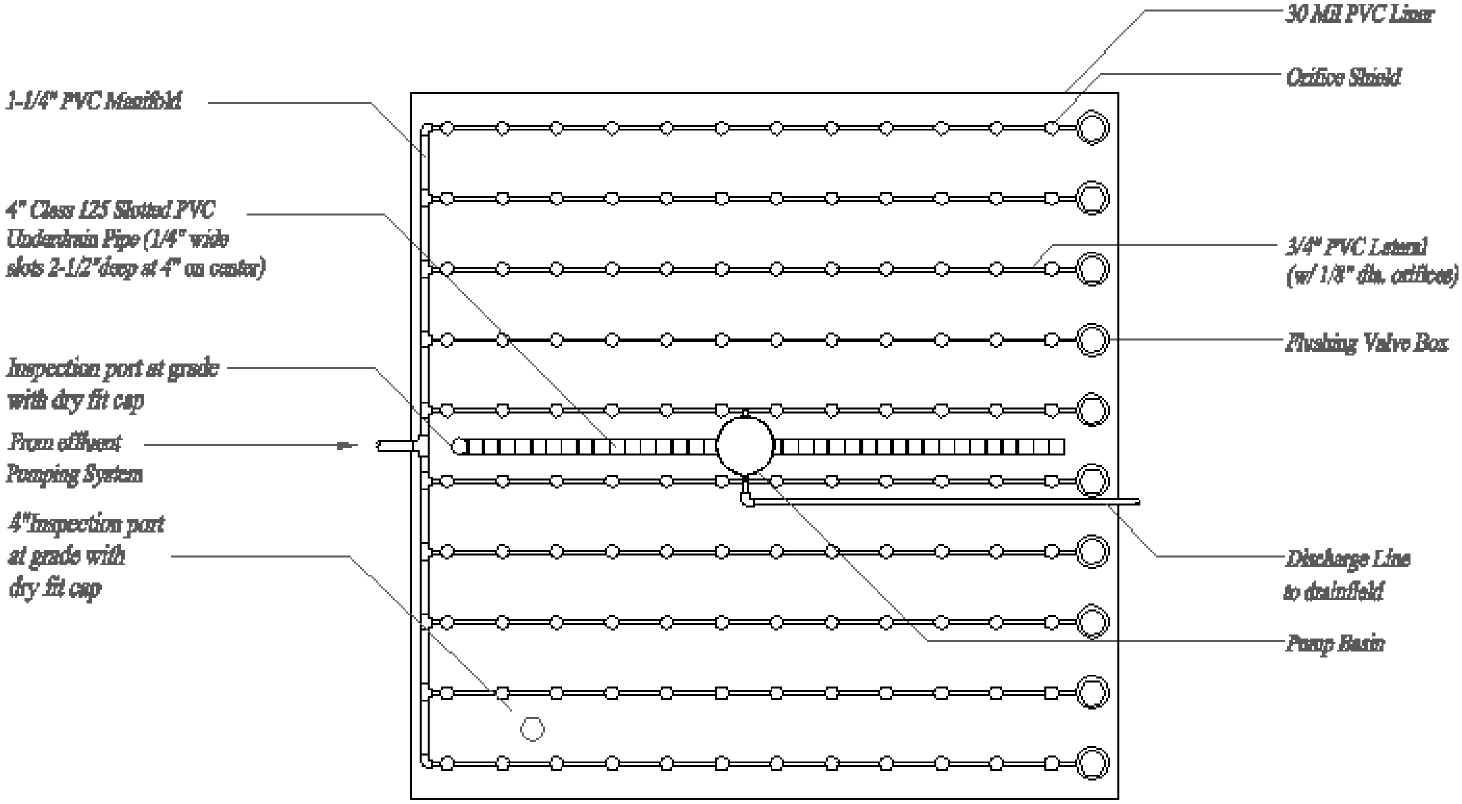


Figure 8B: Single pass sand filter with pump discharge (plan view)

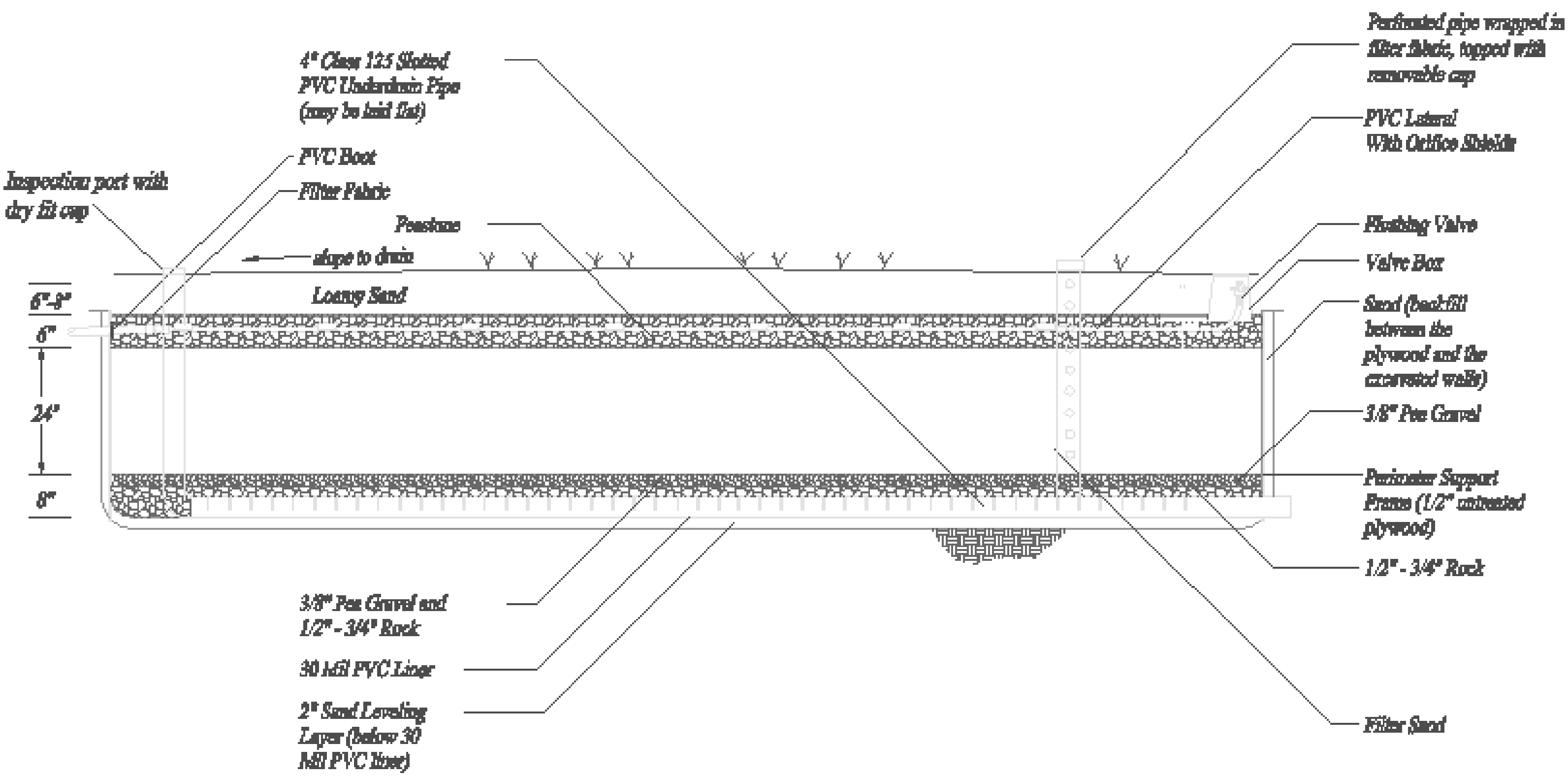


Figure 8C: Single pass sand filter with gravity discharge to drainfield pump basin (cross section)

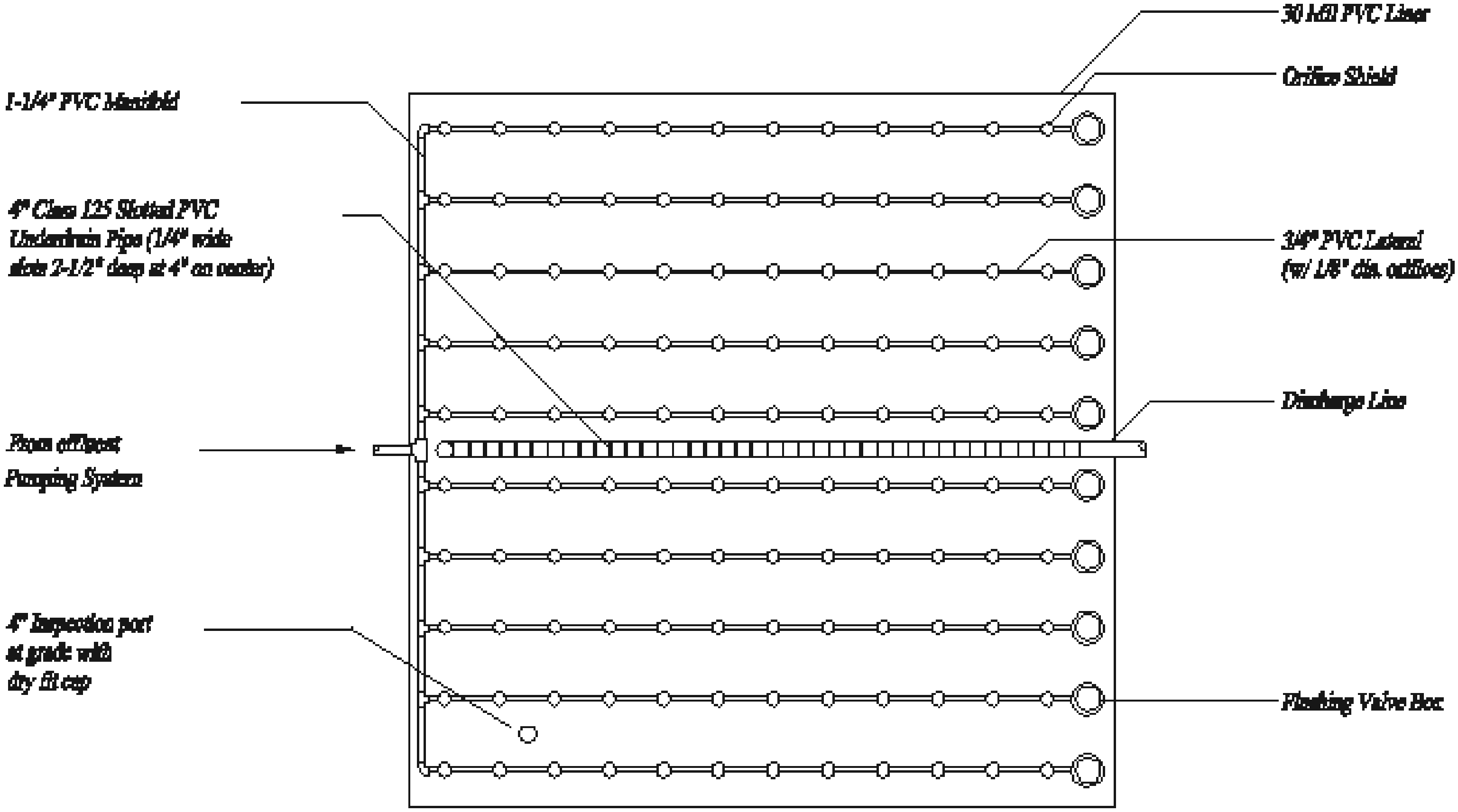


Figure 8D: Single pass sand filter with gravity discharge to drainfield pump basin (plan view)

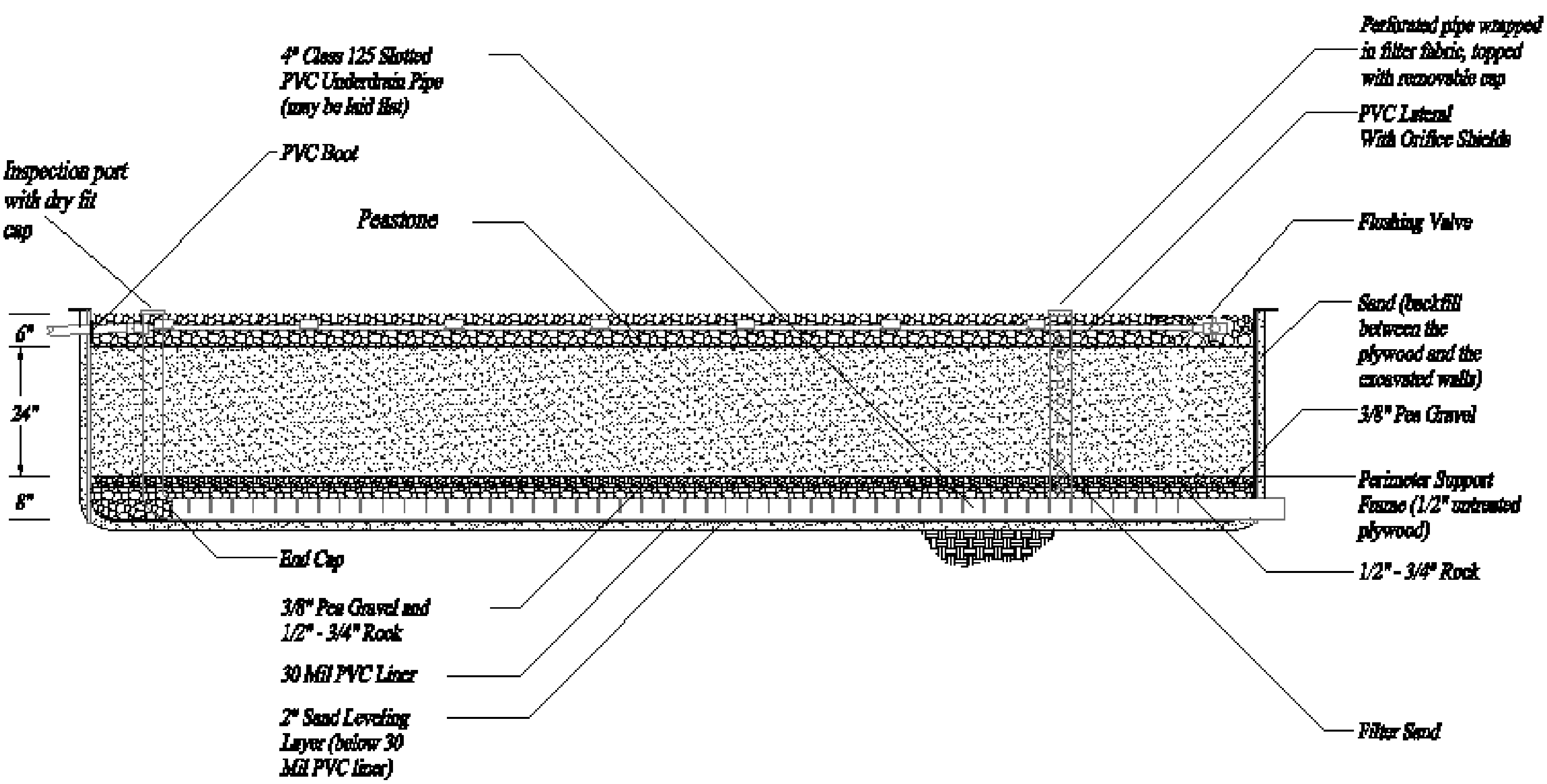


Figure 8E: Recirculating sand filter with gravity discharge (cross section)

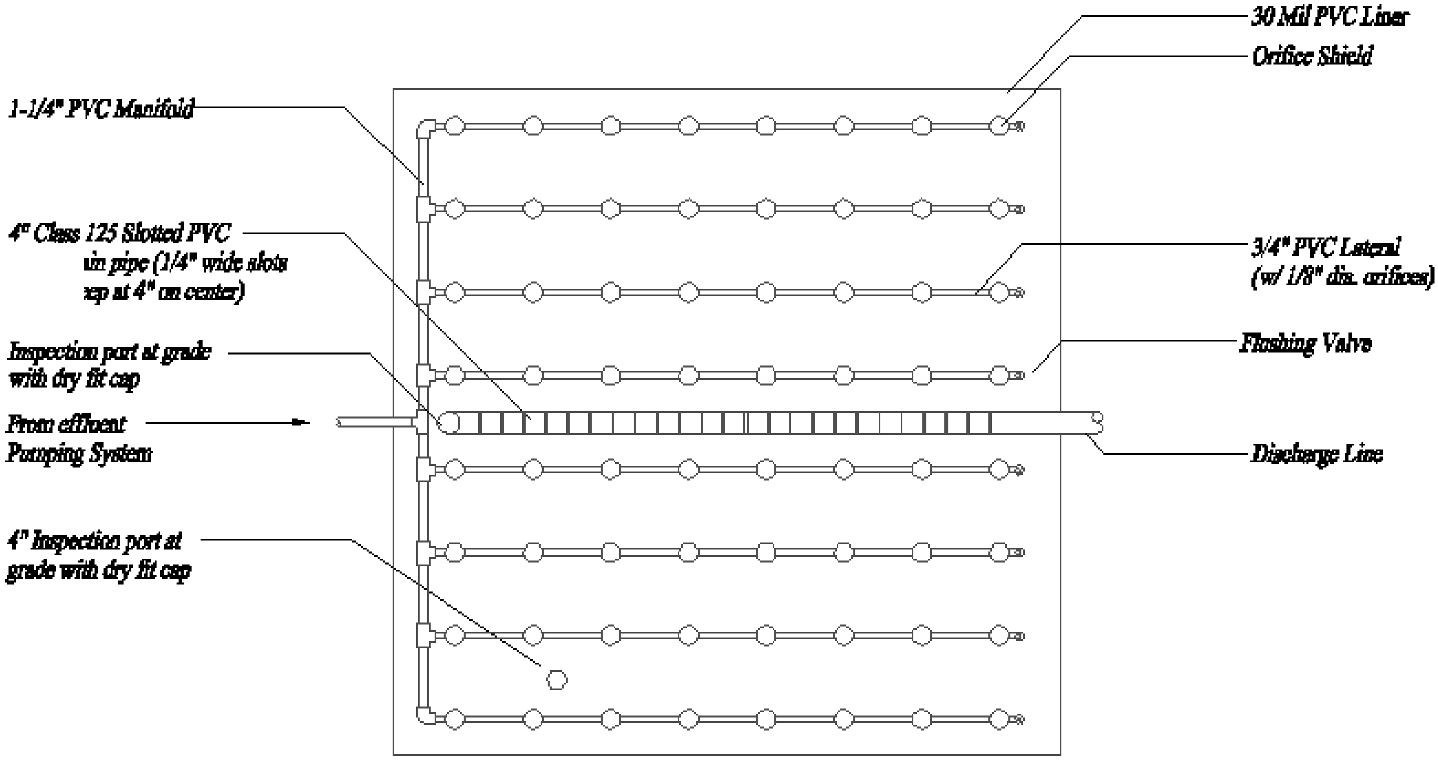


Figure 8F: Recirculating sand filter with gravity discharge (plan view)

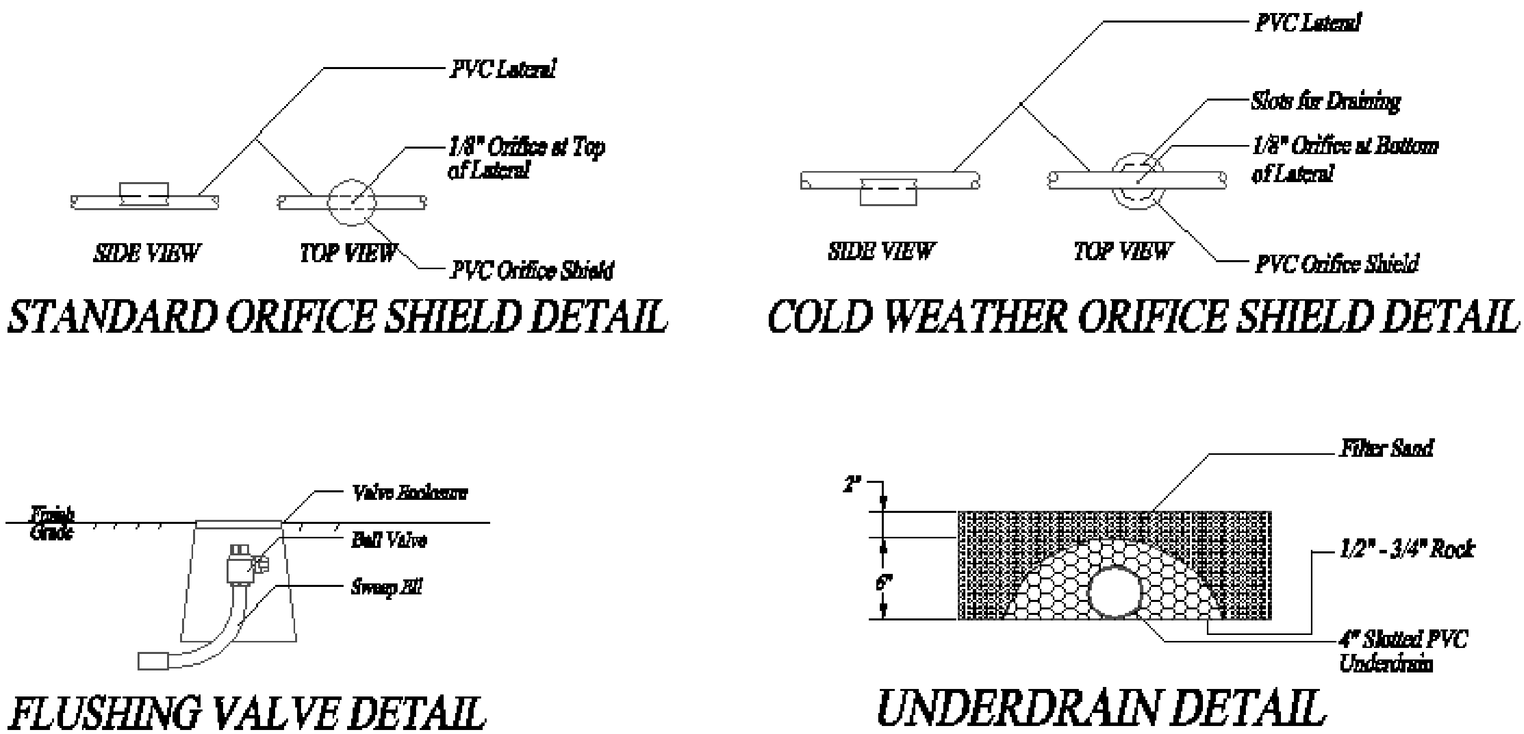


Figure 9: Schematic of sand filter components

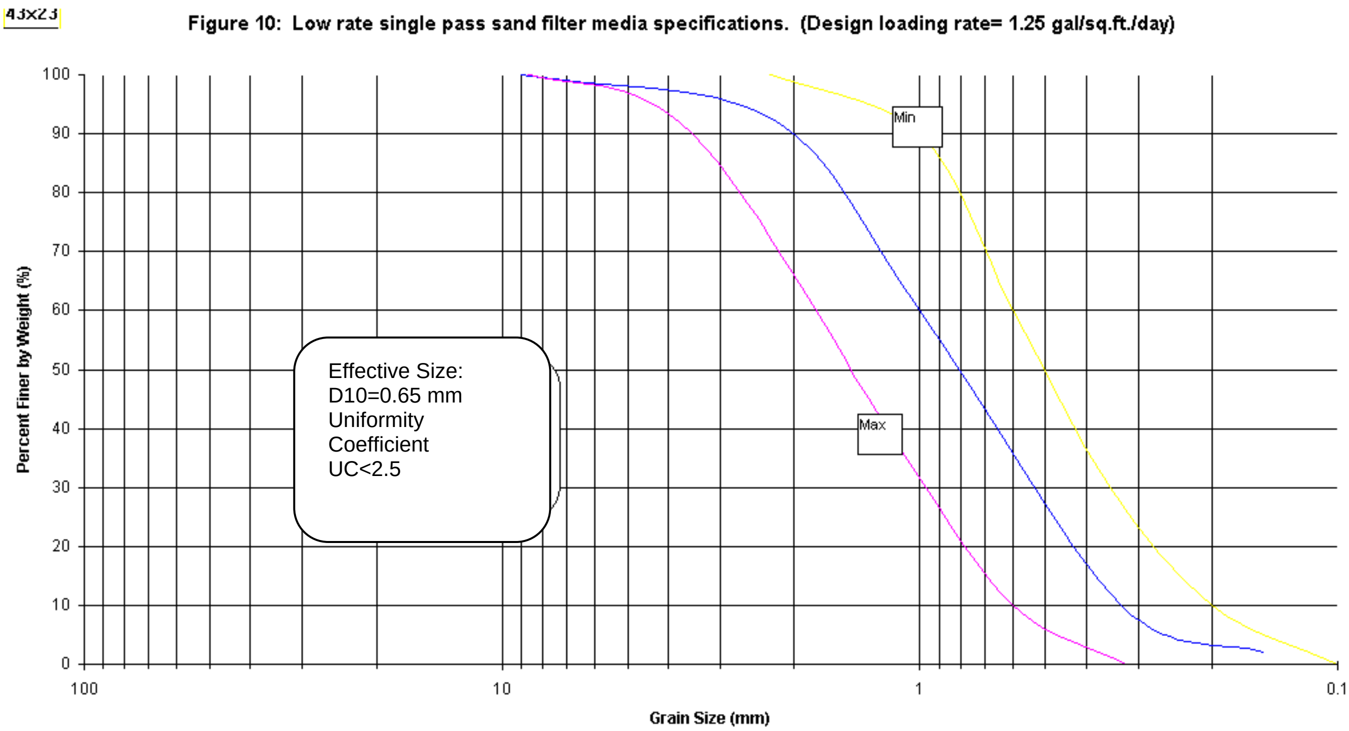


Figure 10: Low rate single pass sand filter media specifications
(Design loading rate = 1.25 g/sf/d)

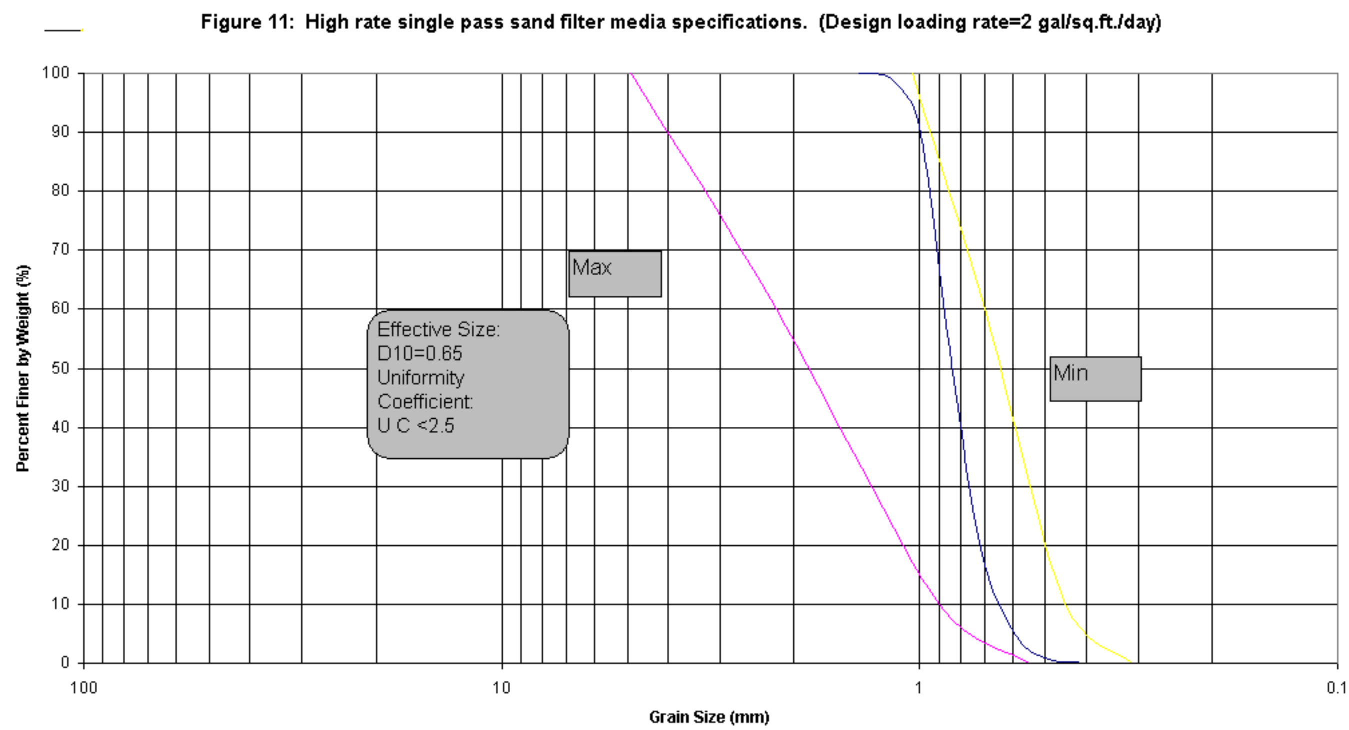


Figure 11: High rate single pass sand filter media specifications
(Design loading rate = 2 g/sf/d)

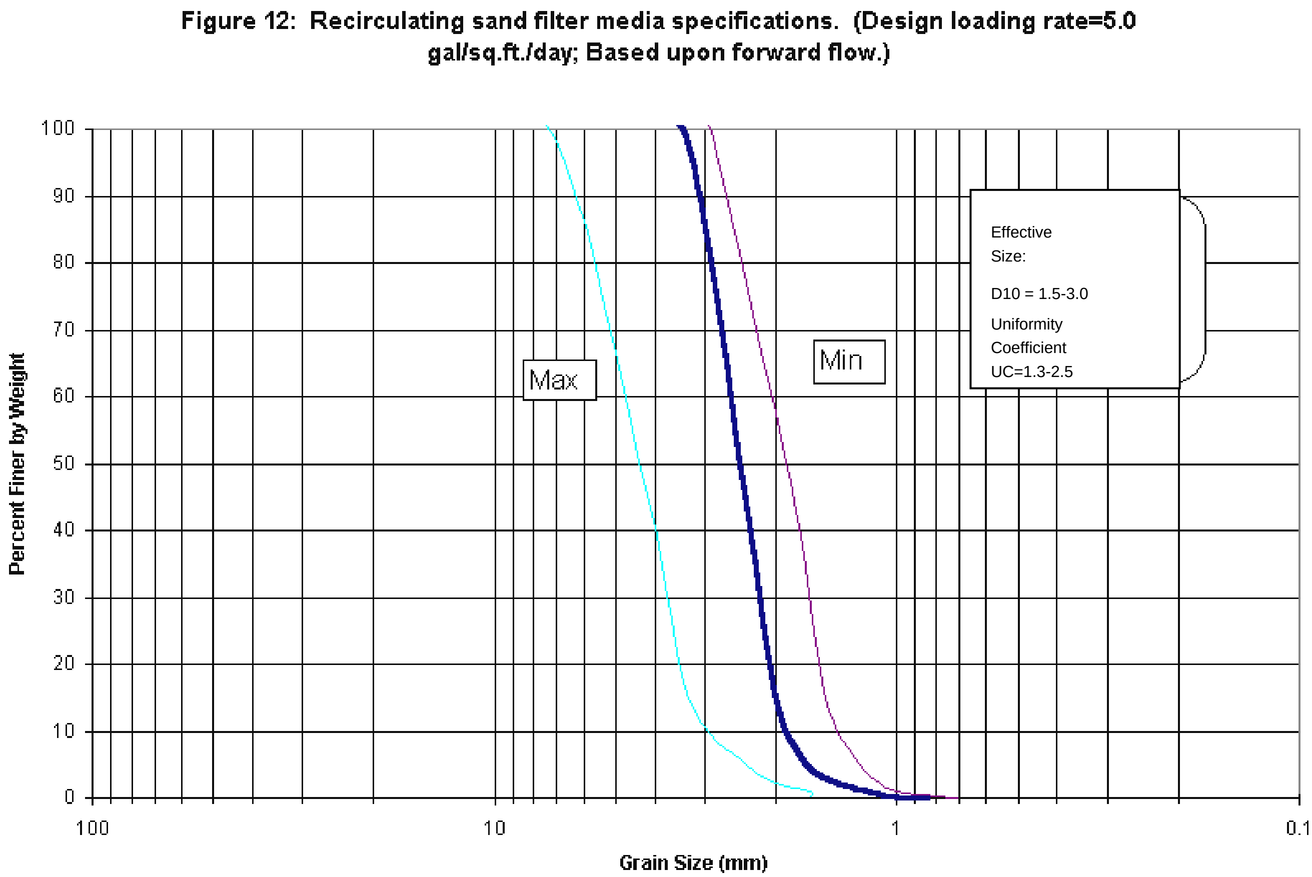


Figure 12: Recirculating sand filer media specifications
(design loading rate=5.0 g/sf/d; based upon forward flow)

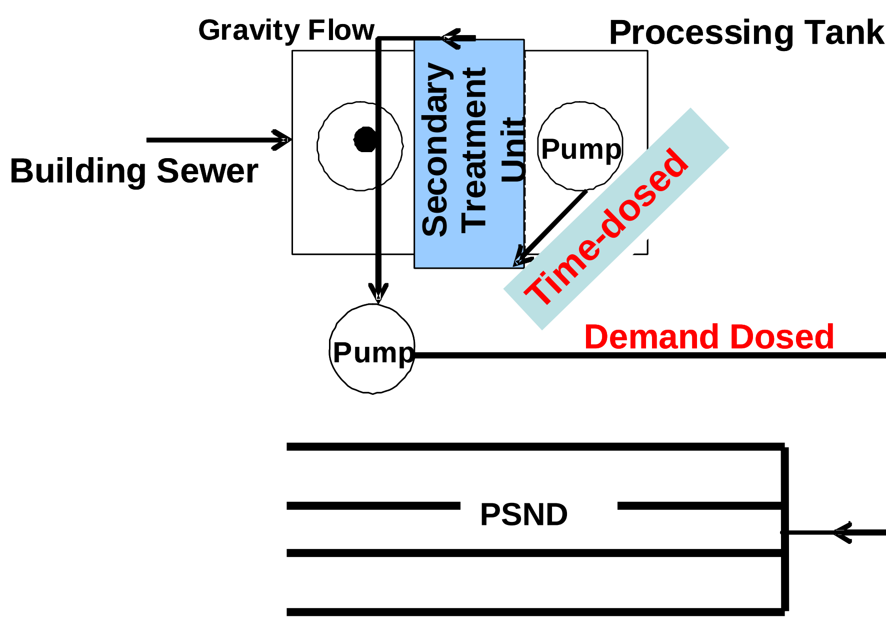


Figure 13: Category 1 System and PSND – Typical Treatment Train

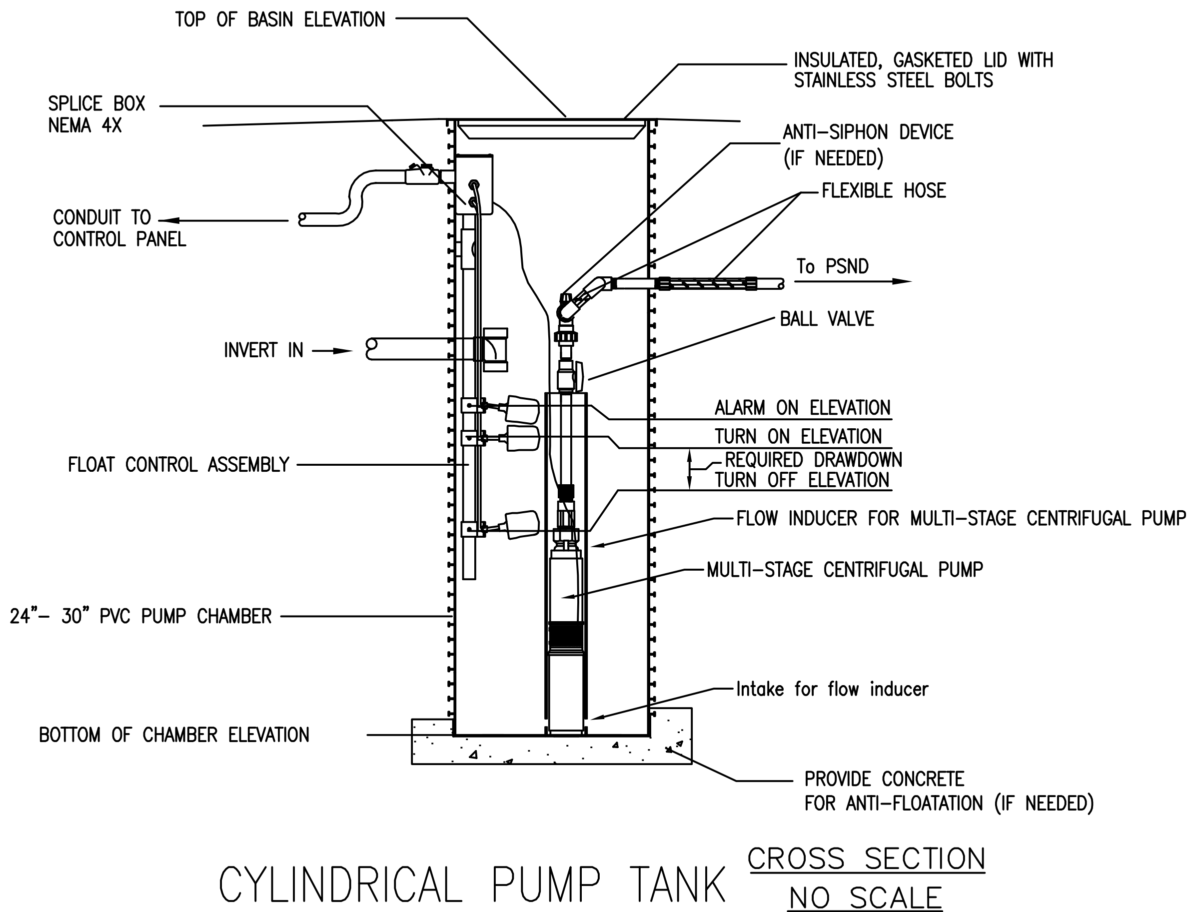


Figure 14 A: Category 1 Cylindrical Pump Tank - Multi-stage cylindrical pump

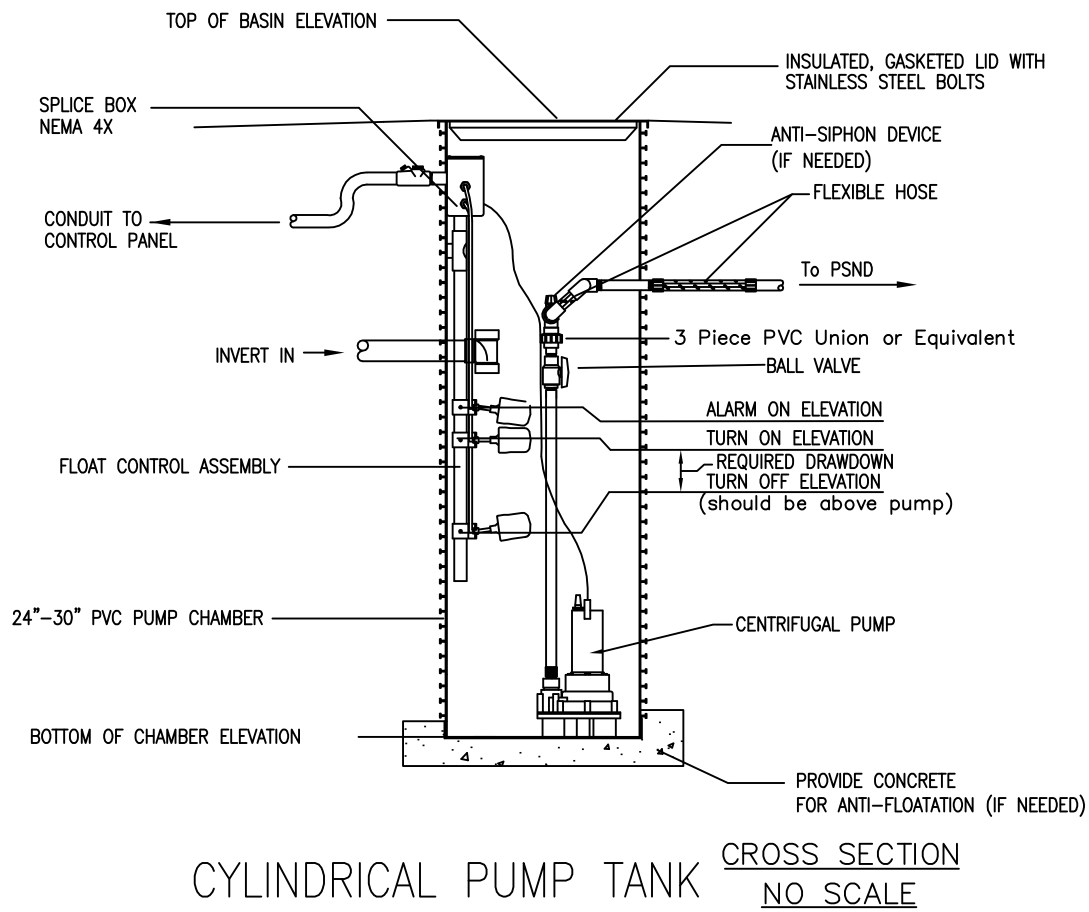


Figure 14B: Category 1 Cylindrical Pump Tank - Centrifugal pump

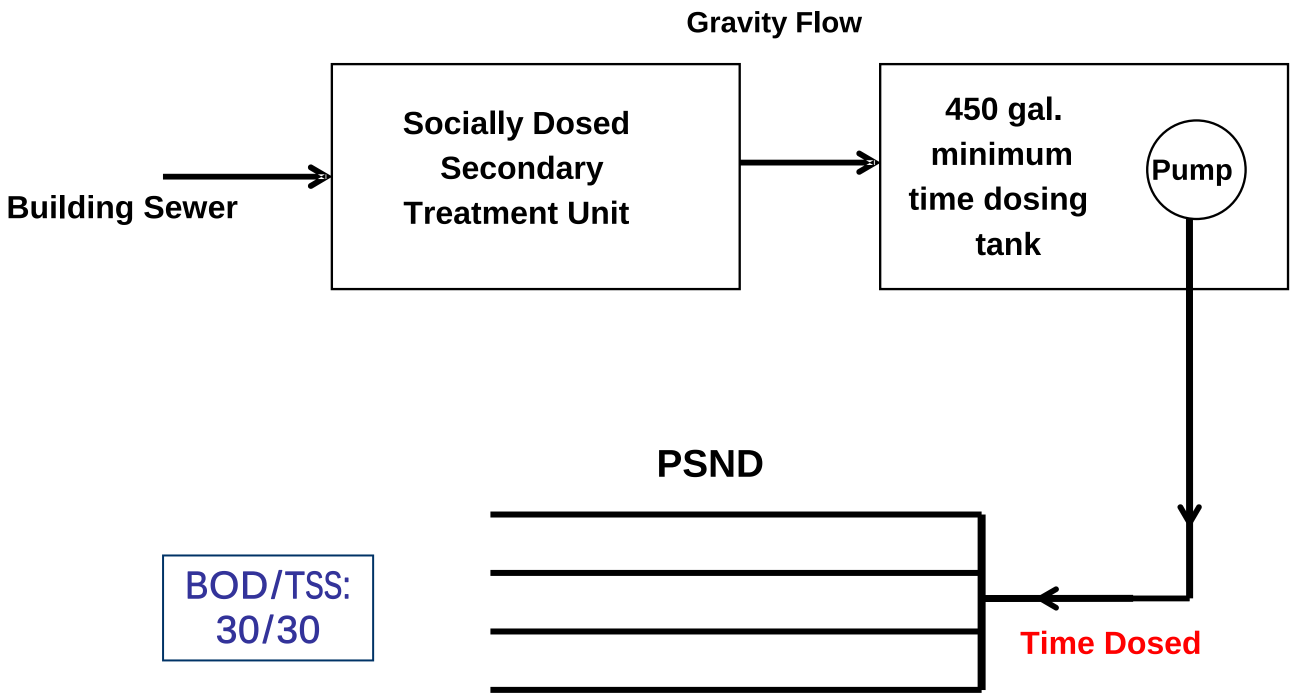


Figure 15: Category 2 System and PSND - Typical Treatment Train

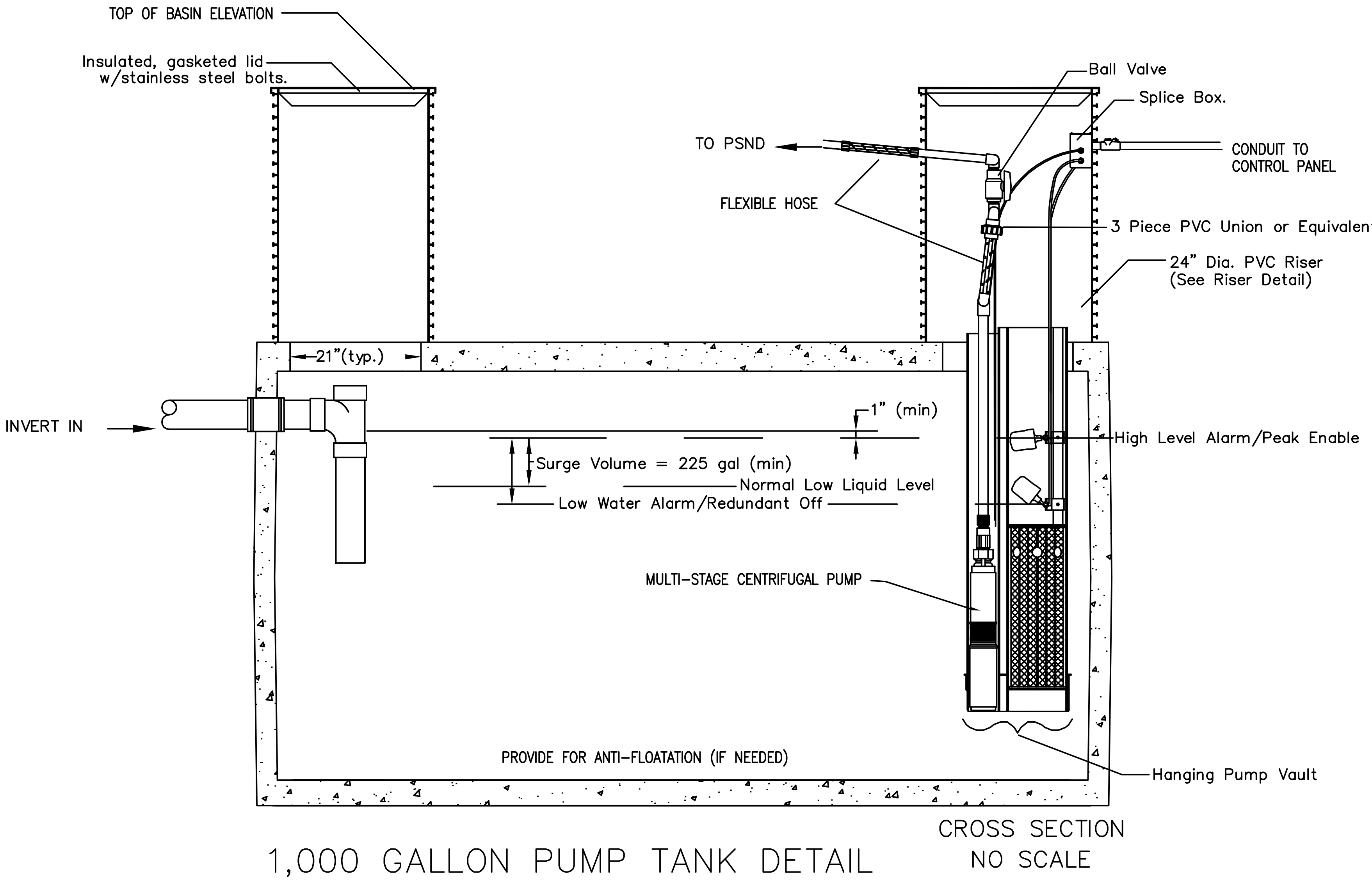


Figure 16A: Category2 Pump Tank Option 1 (Hanging Pump)

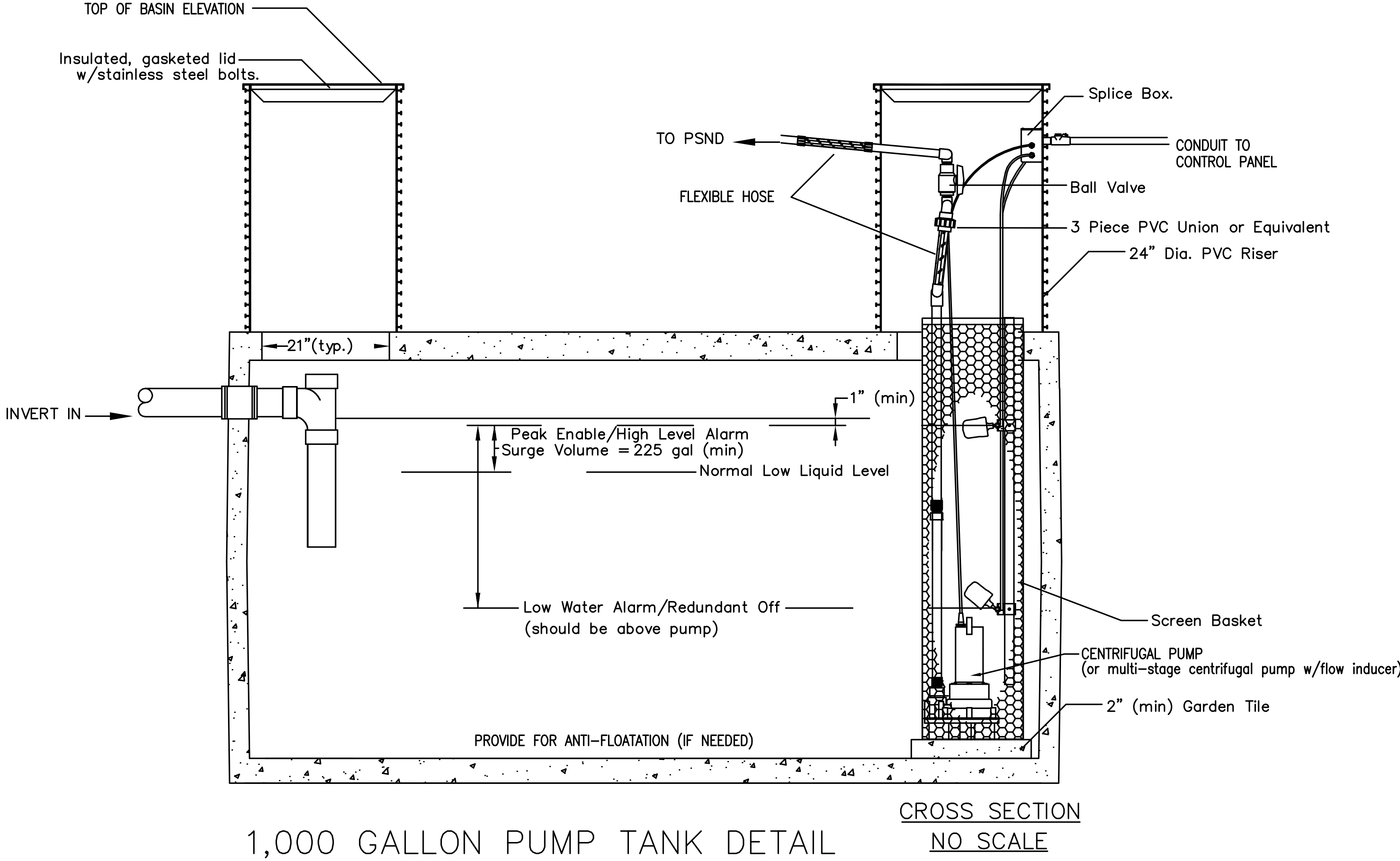


Figure 16B: Category 2 Pump Tank Option 2 (Basket Pump)

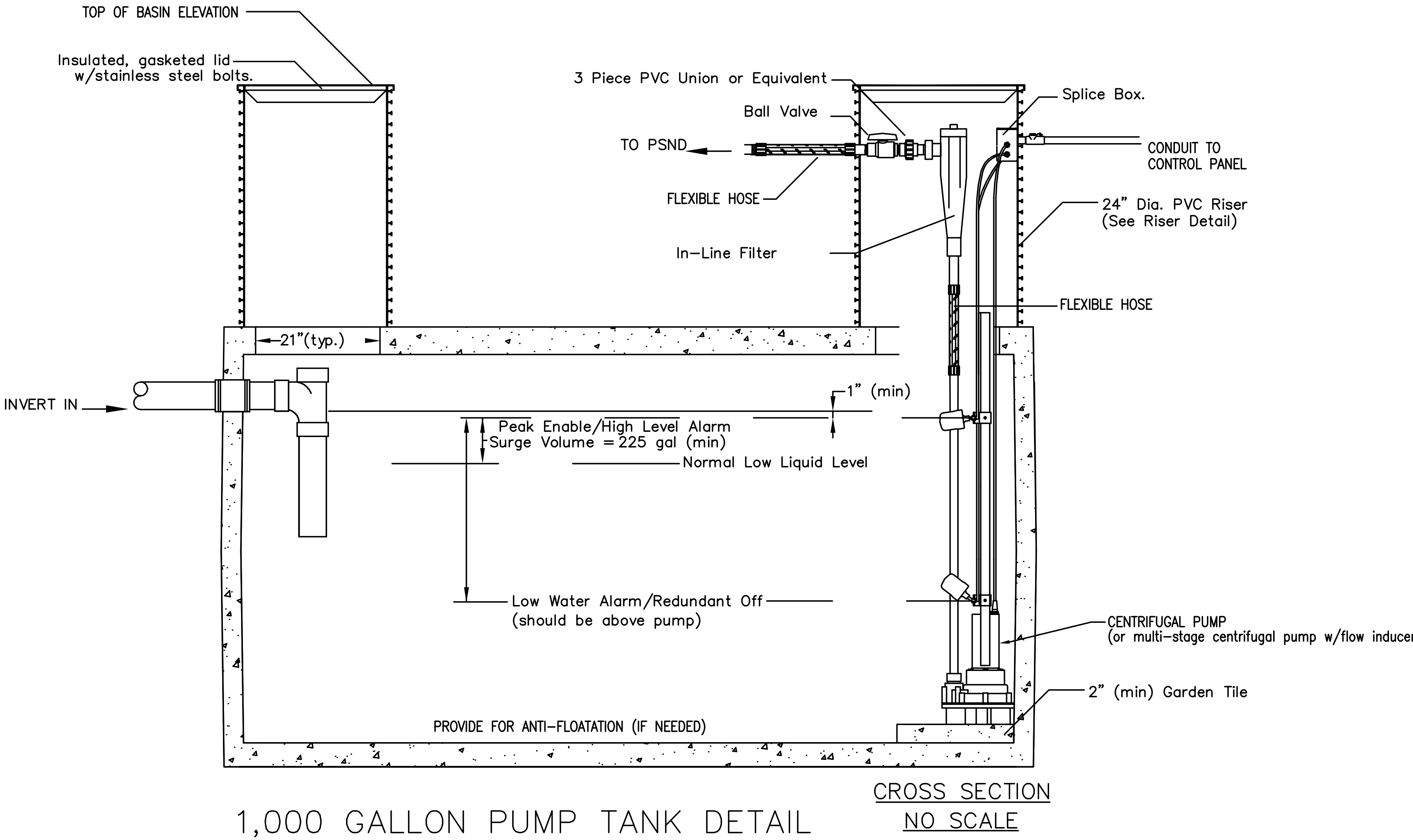


Figure 16C: Category 2 Pump Tank Option 3 (In-line)

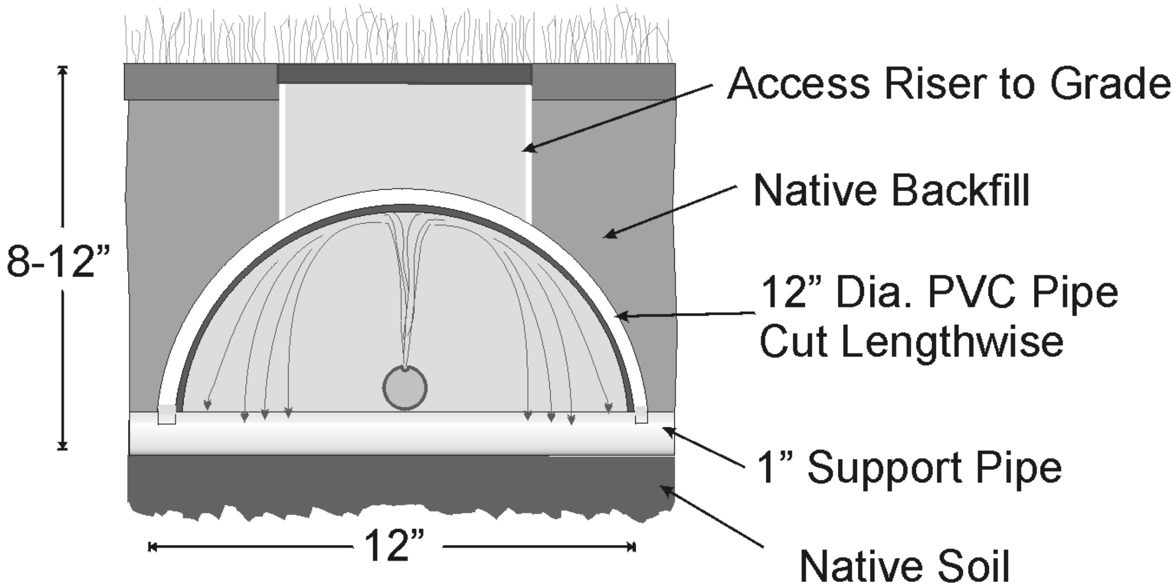


Figure 17: Pressurized Shallow-narrow drainfield (cross section)

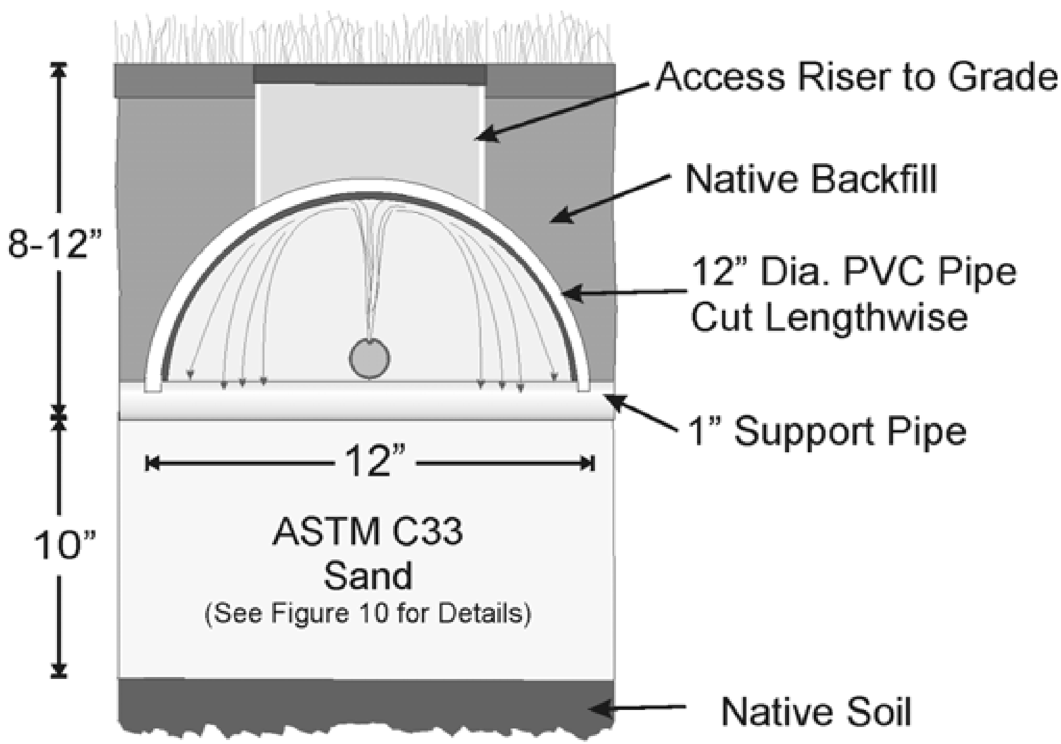


Figure 18: Pressurized Shallow-narrow drainfield (cross section)