

SMALL SCALE WASTE MANAGEMENT PROJECT

**Single Pass Sand Filters for On-Site Treatment
of Domestic Wastes**

by

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January 1997

Revised, January 1999

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SINGLE PASS SAND FILTERS
FOR
ON-SITE TREATMENT OF DOMESTIC WASTES

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The conventional septic tank/soil absorption system utilizes both anaerobic and aerobic treatment concepts. The septic tank, operating under anaerobic conditions, serves primarily as a settling unit and provides partial treatment of the wastewater. The soil provides most of the treatment and serves as the dispersal unit for the effluent.

With increased pressure on developing sites not suitable for the conventional system, new treatment process units are being developed that provide a higher degree of treatment than does the septic tank. This allows for sites to be developed that have soils not suitable for soil dispersal systems requiring the 3 ft separation distance. These new systems include aerobic units, sand filters, peat filters and constructed wetlands, all of which utilize both aerobic and anaerobic treatment.

Sand filter technology has been available for many years but new advances, as well as increased environmental regulations, have made the technology more attractive and reliable. With increased interest in sand filter technology, it is imperative that the designer, installer and regulator/inspector have a good understanding of design, installation and maintenance concepts. This paper should provide a basic knowledge of single pass sand filter principles, design, construction and maintenance.

A. System Components

On-site treatment systems employing sand filter technology consists of 1) wastewater source and characteristics, 2) septic tank and pump chamber, 3) sand filter and 4) dispersal unit (Fig. 1).

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Note: Names of products and equipment mentioned in this publication are for illustrative purposes and do not constitute an endorsement, explicitly or implicitly.

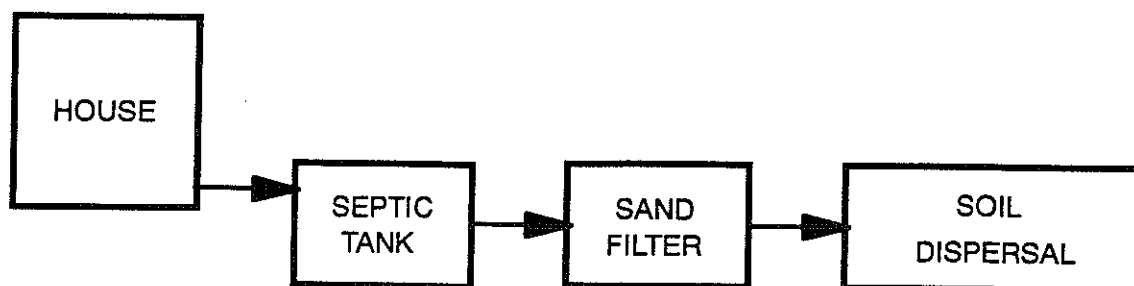


Fig. 1. Components of On-site Treatment System Utilizing a Single Pass Sand Filter

1. Source of Wastewater

The source and characteristics of wastewater are important considerations when selecting the treatment alternatives. Sand filters can be designed to accept wastewater of varying strength characteristics. There is considerable difference in strength between septic tank effluent from homes and from commercial sources such as restaurants. **This paper assumes that the wastewater strength is equivalent to or less than domestic septic tank effluent from homes.** If the strengths are greater than normal septic tank effluent from homes, other design considerations must be implemented.

2. Septic Tank/Pump Chamber

All sand filters require a septic tank upstream to remove settleable solids and a pump chamber to dose the sand filter. Sand filters perform best if the septic tank effluent is applied often in small doses instead of by demand. The following criteria must be incorporated into the septic tank/pump chamber proceeding the sand filter.

- a. Surge capacity in septic tank/pump chamber of about 300 gallons.
- b. Filter or screen in septic tank/pump chamber to retain all solids greater than 1/8".
- c. Timed doses in range of 40-50 gallons/dose every hour or two.
- d. Pump must be able to distribute the effluent over the surface of the sand filter with sufficient pressure to minimize orifice plugging. The pump may be either a centrifugal effluent pump or a turbine well pump. The latter provides higher network heads.
- e. Water tight tanks and easy access to the tanks.

3. Sand Filters

Fixed film aeration is a unit process in which wastewater passes through a porous media such as fine or coarse aggregate or synthetic media. The bacteria attach themselves to the media and extract food and nutrients as the wastewater flows through the porous media. Oxygen diffuses into the thin film of water as the air passes through the media by convection due to temperature differences and air is also drawn in as the wastewater moves through the media. The system must be designed to encourage passive air movement through the unit.

As the effluent passes through the filter, various physical, chemical and biological reactions take place. Suspended solids are filtered out. Bacteria convert organic matter to carbon dioxide and water. Organic nitrogen and ammonia are converted to nitrate under aerobic conditions. Examples of fixed film aeration units include sand filters, gravel filters, trickling filters, peat filters and rotating biological contractors. This discussion is restricted to sand filters.

There are two general classes of filters, namely:

Single Pass Filters

- Buried sand filter
- Open surface sand filter
- Stratified sand filter
- Sand-lined bottomless trench
- Mound systems

Multiple Pass Filters

- Recirculating sand filter
- Recirculating gravel filter

This discussion will be limited to the buried single pass filters. The open surface sand filter is similar to the buried sand filter except the surface is exposed instead of buried and it is normally loaded heavier. It also has a cover over it to keep out the sunlight. The stratified sand filter consists of "stratified layers of sand" of different sizes. The sand-lined bottomless trench is essentially a buried sand filter configured in the form of trenches with no bottom. The mound is a combination sand filter and dispersal unit in one unit. Converse (1997) provides information on recirculating sand/gravel filters.

Figures 4 and 5 show a cross section and a plan view of a single pass filter. Single pass sand filters are composed of the following components:

a. Container and excavation

A water tight container, such as a concrete tank or a durable 30 mm membrane liner, is required. Normally concrete tanks are not large enough for single pass filters. The membrane liner must be protected from punctures that can be caused by sharp rocks and construction tools. The filter can be placed at various elevations in the landscape from placement on the ground surface with soil mounded over it to buried with the top 6" below ground surface. It is imperative that surface and ground water not be allowed to enter the

Figures 2 and 3 show two combinations of septic tank and pump chambers incorporating these criteria. Other combinations are possible.

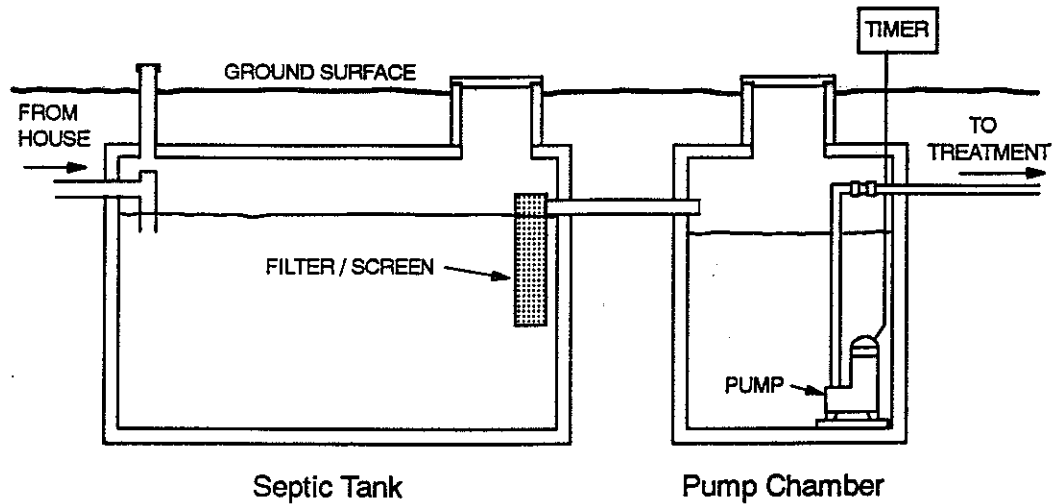


Fig 2. Separate septic tank with filter and pump chamber with surge capacity built into the pump chamber and timed control panel. A 1000 gallon septic tank and 750 or 1000 gallon pump chamber for a 3 bedroom home. The larger pump chamber will provide more surge capacity especially if a turbine pump is used.

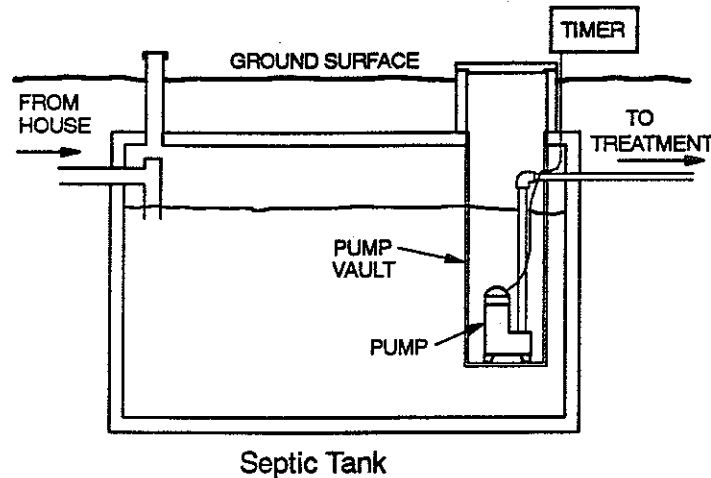


Fig. 3. A single compartment septic tank with screened pump vault with timed control panel. A 1500 gallon septic tank for a 3 bedroom home should provide sufficient surge storage capacity. A combination 1000/500 gallon tank with a 4" hole in the common wall located at 70% of the liquid height may be desired over a single compartment tank.

filter. Precipitation falling on the filter is okay.

The excavation is made 12" larger than the filter. A non-treated plywood/waferboard box is formed to support the membrane and allow the membrane to be draped over the top. Sand is placed between the wall and soil to protect the membrane after the plywood has decomposed. Approximately 2" of sand is placed in the bottom of the excavation prior to placement of the liner. The top of the membrane must be above the seasonal high water table so ground water does not flow into the sand filter.

b. Effluent collection

A 4" collection pipe (slotted or holes) is placed on the membrane to collect the sand filter effluent. The collection pipe connects to an internal pump vault or extends outside the tank to an external pump chamber or drains by gravity to a dispersal area. For an internal pump vault, a 4' by 4' excavation, 18" deep with sloping sides is made in the center of the filter and lined with sand prior to placement of the membrane liner.

c. Aggregate

A four inch layer of 3/4 to 1 in. dia. (No. 1) washed aggregate is placed on the membrane and mounded over the collection pipe. A three inch layer of washed pea gravel (3/8") is placed on top of the aggregate to keep the sand from infiltrating into the larger aggregate.

d. Air tube

An air tube is placed on top of the gravel with a vertical pipe connected to one end and extended to the top of the filter. This allows air to be supplied via a pump to the filter if needed at a later date. The tube can be drip irrigation tubing placed in concentric circles on the aggregate surface or 3/4" diameter PVC pipe with 1/8" holes spaced 2 ft apart with 2 ft. lateral spacing, connected to a 1" PVC manifold. Air is pumped into the filter to provide additional oxygen to break up a clogging mat that may have developed on the sand surface. It is used only when effluent becomes ponded at the aggregate/sand interface. Air is not pumped into the sand filter when air temperatures are below freezing as it may freeze the filter.

e. Sand media

A two foot layer of coarse sand, placed in 8" lifts and wetted to minimize settling, is placed on top of the pea gravel. The top of the sand is leveled. Media size, septic tank effluent quality and loading rates are interrelated. In general, for a given wastewater strength (BOD and SS), the hydraulic loading rate can be higher on coarser filter media but the effluent quality (BOD and SS) will be less when compared to single pass filters with lower loading rates and finer media. Higher loading rates on finer media will lead to a clogging mat.

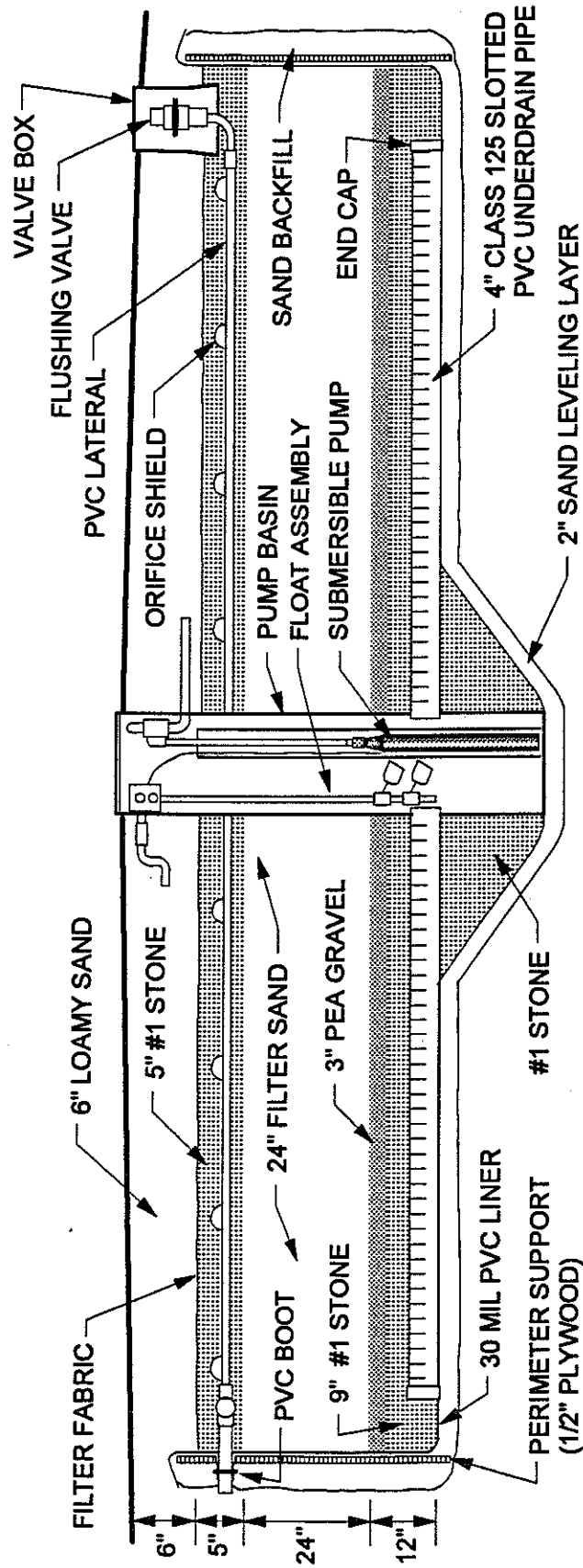
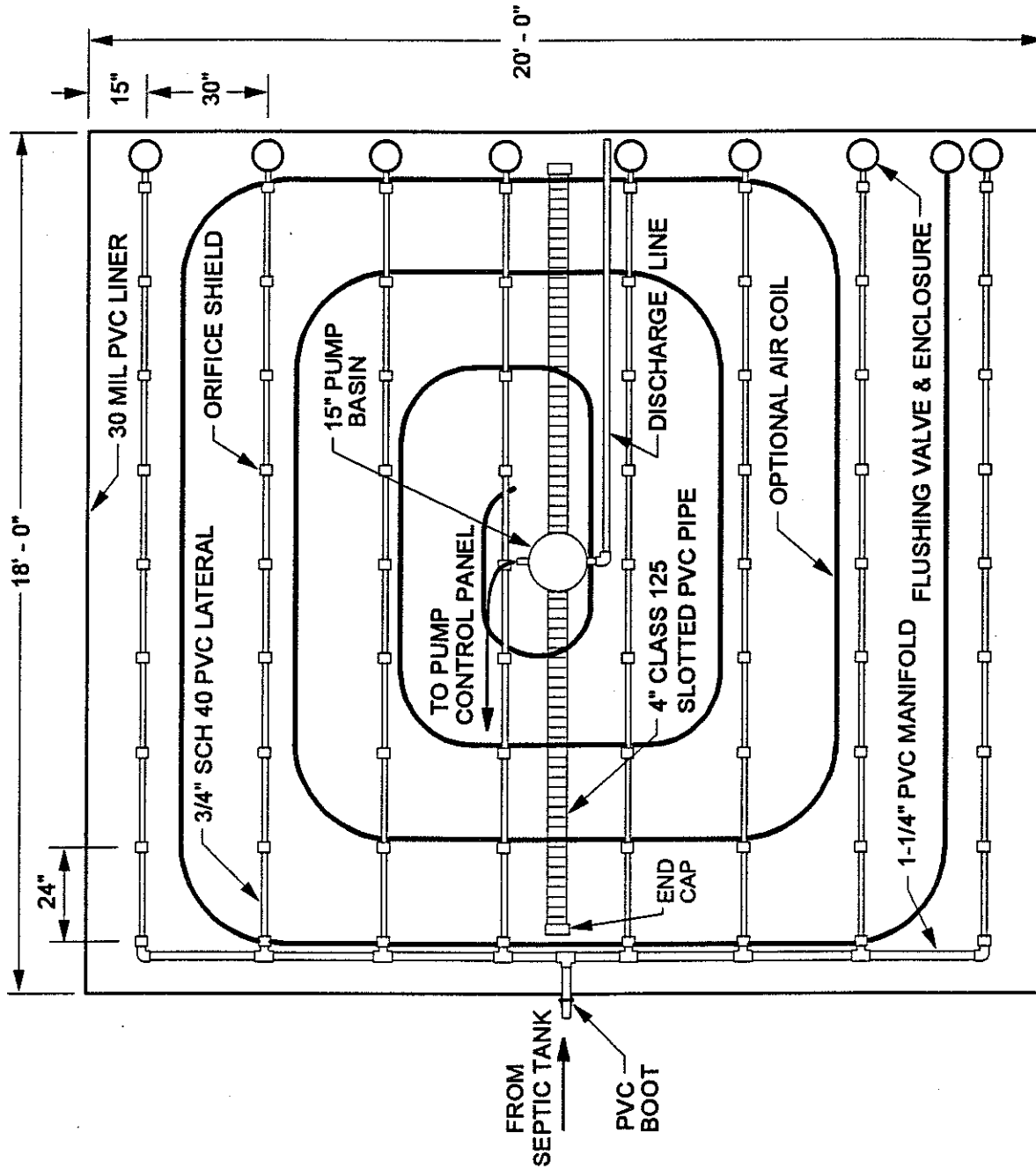


Fig. 4. Cross section of a single pass intermittent sand filter with an internal pump chamber. Filter is shown with 6" of sandy loam soil cover. An optional cover would be decorative rock or No. 1 stone to the surface. If stone is used place 2" of coarse sand then 4-5" of decorative stone. This will allow good air movement and eliminate any potential odors during dosing (Adapted from Orenco).



TOP VIEW

Fig. 5. Plan view of a single pass sand filter with an internal pump chamber. Other configurations are possible (Adapted from Orenco).

Figure 6 gives the recommended sand media for single pass filters receiving typical septic tank effluent which has passed through a septic tank screen/filter. The recommended design loading rate is 1.2 gpd/ft². For a 3 bedroom home with a design loading rate of 450 gallons per day, the filter surface area is 360 ft².

If the specified media is not locally available, it is very tempting to use available media which is either finer or coarser rather than pay the transportation costs of getting the specified media. That could be a costly mistake. Fine media have greater risk of clogging and coarser media will not treat the wastewater as well in single pass filters. However, it is better to err on the coarse side than the fine side.

f. Distribution network

The distribution network spreads the septic tank effluent as uniformly as possible over the sand filter surface. The network consists of a manifold and laterals. A typical design consists of:

- Orifices - 1/8" orifices spaced 2 ft apart with orifices located upward with orifice shields.
- Laterals - 3/4" or 1" dia. PVC pipe , spaced 2.5 ft apart, with an upturned sweep elbow and valve for clean out. The lateral must uniformly slope back to the manifold with distal end elevated 1 to 1 1/2". Lateral lengths should not exceed those given in Table 1 for various diameters.
- Manifold - 1 1/4" PVC pipe with center feed with ends elevated 1" for flow back to force main.
- Valve boxes - Circular valve boxes for access of valves at end of laterals.
- Pump - Sized to meet flow rate and lateral pressure of 5-7 ft.

Note: If the force main slopes toward the sand filter, then the orifices must be placed downward and the orifice shields eliminated. The laterals and manifold are laid level.

In all cases the force main and distribution network must drain after each dose.

Two inches of 3/4 -1" (No. 1) washed aggregate is placed on the surface of the leveled sand. The distribution network is placed in the aggregate with laterals and manifold sloping back to force main. Additional aggregate is placed on top of the network with minimum of 1" cover. The force main is placed through the plywood wall and membrane. A boot should be glued to the membrane and attached to the pipe to eliminate the intrusion of groundwater through the opening or ponded effluent from exiting the sand filter.

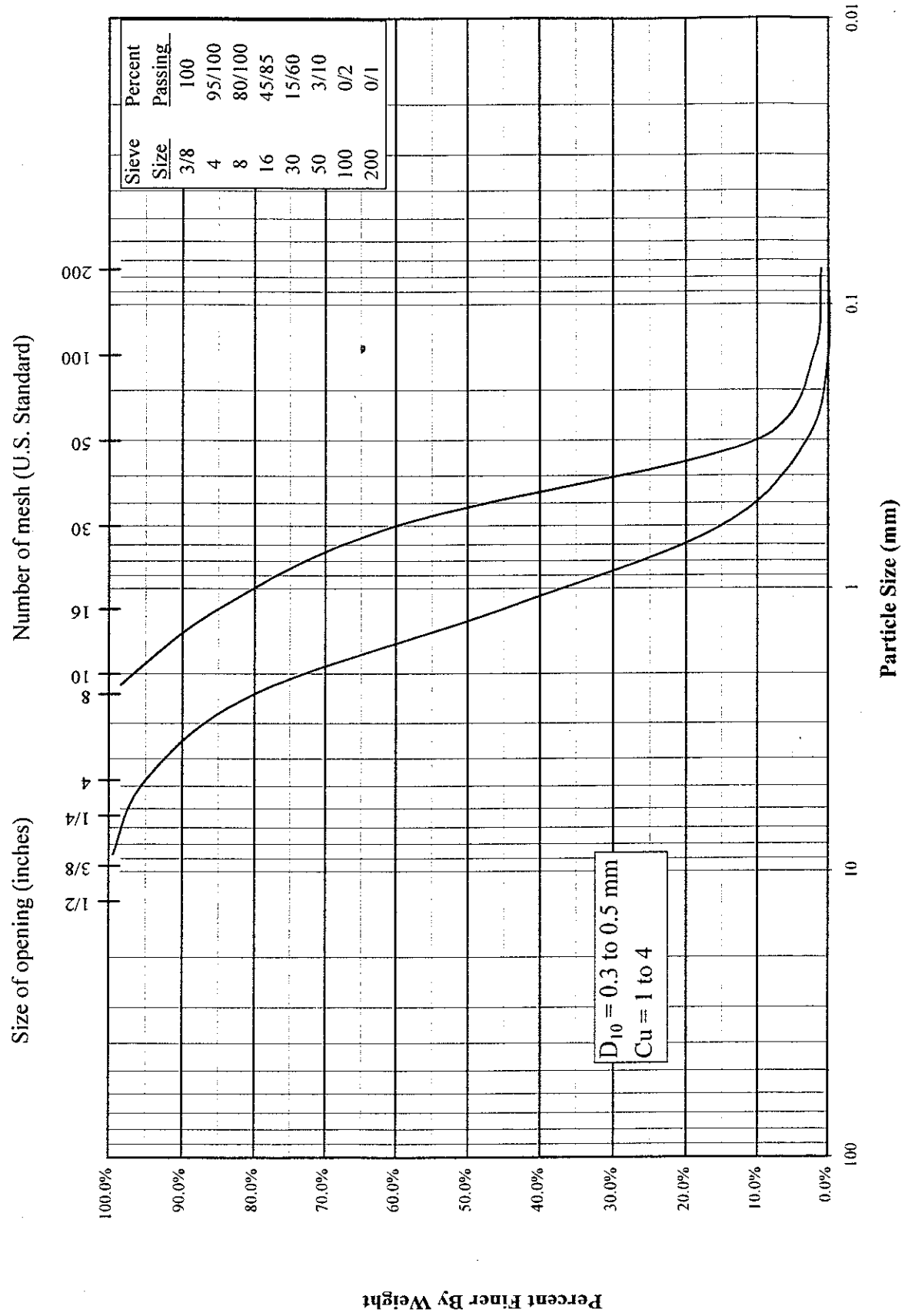


Fig. 6. Recommended sand media for single pass sand filter. The recommended design loading rate in 1.25 gpd/ft². It is recommended that D_{10} range between 0.30 and 0.50 mm. Sands with more fines than recommended may fail prematurely at this design loading rate.

Table 1. Maximum length of distribution laterals for Schedule 40 PVC pipe sizes having 1/8 in. orifices spaced 2 ft with 5 ft of head at distal end (Loudon, 1995).

Lateral Diameter (in.)	Maximum Length (ft)	No. of Orifices	Total Flow (gpm)	Input Head (ft)
1.0	52	26	11.0	6.1
1.25	84	42	17.8	6.2
1.5	108	54	22.9	6.1
2.0	166	83	35.1	6.2

g. Observation tubes

At least one 4" observation tube should be placed to the sand/aggregate interface to monitor for ponding/clogging formation. The tubes must be secured and have several slots in the bottom 4 inches.

h. Sand filter pump vault and force main to dispersal area

The force main exiting the pump vault must be sloped to either drain back to the pump vault or to the dispersal area. The force main will exit through the membrane wall. A boot should be installed similar to the boot installed for the force main from the septic tank pump chamber. Electrical wires from the control panel to the pump vault should be placed in conduit which is located on top of the aggregate. The pump can be a centrifugal effluent pump or a turbine well pump, which will provide higher heads and lower flows. High and low level floats control the liquid level in the sand filter. The high water alarm, when activated, must shut off the septic tank effluent pump so as not to flood the sand filter. The two pumps must be interconnected so if the sand filter pump fails to pump, the septic tank pump will not pump effluent to the sand filter.

I. Fabric and cover

Geotextile fabric, similar to that used in soil absorption units, is placed on top of the aggregate. The filter can be either covered with lawn or decorative rock.

Lawn: Up to six inches of sandy loam soil is placed on the fabric, seeded and mulched. Heavier textured soils, such as silt loam or clay loam, are not allowed as they will restrict air flow into the filter. All surface waters must be diverted away from the unit. The pump vault and valve box covers are placed at ground surface for easy access but below

the reach of the lawn mower.

Decorative rock: To eliminate the potential for septic odor emitting from the filter when it is dosed, up to 2" of coarse sand should be placed on the filter fabric. Decorative rock or other aggregate (depending on preference) is placed on top of the sand to final grade. All surface waters must be diverted away from the sand filter.

j. Control Panel

The sand filter can be dosed either on demand or via timed doses throughout the day. The filter performs best under timed doses and is the preferred loading sequence. However, it requires a more complex control panel. With time control, the septic tank/pump chamber must provide for surge loading. It can be set to pump in a certain amount of effluent per day. If the flow exceeds that amount, an alarm will sound warning the homeowner that he/she is using more water than the system is designed to handle. Commercial units are available and should be used instead of designing your own. Most are extremely user friendly.

4. Sand Filter Effluent Dispersal

The sand filter effluent will be very low in BOD and TSS (5-10 mg/L), low in fecal coliform (< 1000 counts/100 ml) and moderate concentrations of nitrate (20-40 mg/L). These values will vary depending on loading to the sand filter and performance of the filter. The effluent can be dispersed into the environment in the following manner:

- a. Disinfected and surface discharge to a ditch. Nitrogen remains and may cause surface water degradation. Health/environmental codes may not allow surface discharge.
- b. Dispersed through a soil absorption unit to ground water with the soil polishing the effluent to remove the remaining fecal coliform and potential pathogens. Since the BOD is very low, a clogging mat will not develop so the infiltration rates can be increased over septic tank effluent. However, the system must be designed to hydraulically accept the wastewater. Converse and Tyler (1997) describes several systems available for soil dispersal of highly pretreated effluent.

B. Sand Filter Design

Design a single pass sand filter for a three bedroom home.

1. Determine the Design Flow.

The design flow for a 3 bedroom home is 150 gpd/bedroom or 450 gpd.

2. Select a Septic Tank and Pump Chamber.

Select either a two tank system (Fig 2) or a single tank with pump vault (Fig. 3). The effluent must be screened/filtered prior to pumping. Screening/filtering can be done in the septic tank with a screen or filter or through a pump vault which has a screen or filter on it. The pumps should be controlled with timed dosing instead of on demand. This will require surge capacity in the tank(s). The pump can be either a centrifugal effluent pump or a turbine pump. Select the system that allows the effluent to be drawn down for surge storage. Select the two tank system (Fig. 2) with the 1000 gallon septic tank and the 1000 gallon pump chamber as a turbine pump will be selected.

3. Design the Single Pass Sand Filter.

a. Media Selection

Select a media that meets the specification shown in Fig. 6. The $D_{10} > 0.30$ mm (effective diameter) with a $C_u = 4.0 \pm$ (uniformity coefficient). Use a design loading rate of 1.25 gpd/ft² for this sand.

Proper media selection is critical to the operation of the sand filter.

b. Filter Surface Area

With a design loading rate of 450 gpd and sand loading rate of 1.25 gpd/ft², the required surface area is :

$$\text{Surface Area} = 450 \text{ gpd} / 1.25 \text{ gpd/ft}^2 = 360 \text{ ft}^2$$

c. Surface Dimensions

System configuration will be determined by the site. For level sites a 18 by 20 ft unit may be preferred. For sloping sites, a 10 by 36 ft unit, placed on the contour, would be more appropriate. Other configurations may be appropriate for the site. **For this example use an 18 by 20 ft unit.**

d. Media Depth

Specify 5" of No. 1 (3/4 - 1") washed stone in the bottom. Mound at least one inch of No. 1 stone over the collection pipe. New designs recommend 9" of No. 1 stone which will increase height of pump chamber and allow for more draw down by the pump.

Specify 3" of 3/8" washed pea gravel placed on top of the No. 1 stone.

Specify 24" of sand media (See Fig. 6).

Specify 6" of No. 1 (3/4 -1") washed stone on the surface of the sand. The distribution network will be placed in this layer.

e. Filter Container

Specify a 30 mm membrane liner.

f. Collection Pipe in Bottom of Filter

Use either:

- a. 4" Class 125 PVC slotted drain pipe with 1/4" slots 2 1/2" deep and spaced 4", located vertically.
- b. 4" PVC perforated sewer drain pipe with holes located at 5 and 7 o'clock.
- c. 4" corrugated perforated agricultural drain tile without sock.

Specify the pipe to be located along the length of the unit and in the center. Since an internal pump vault is specified, each collection pipe will be 8 or 9 ft long depending on how placed in filter with an end cap on one end and the other end inserted about 1.5" into the vertical pump vault. Pipe is laid approximately level. For external pump vaults or gravity flow, the collection pipe is 19 ft. long connected to a 4" solid PVC Schedule 40 pipe which extends through the membrane via water tight boot.

g. Effluent Collection Unit

Internal Pump Vault

Specify a 15" dia. PVC pipe with bottom and an insulated fiberglass cover for the pump vault. The pipe should be 64" or 69" long depending if 4 or 9" of No. 1 stone is used in the bottom (plus 3" of pea gravel). Place 4.5" holes with grommets in the sides with center located at 20.5 in above the bottom for insertion of collection pipes. Holes will have to be drilled near the top for effluent pump force main and for the electrical wire.

External Pump Chamber

External pump chambers can be similar to pump chambers used for mounds. The sand filter will have to be elevated or pump chamber located deep on level sites. External pump chambers may only be practical on sloping sites.

h. Distribution Network

The distribution network must be matched to the pump in the septic tank or pump chamber following the septic tank. The more uniform the application the better the treatment and longevity of the sand filter.

The following is recommended:

- Orifice diameter and spacing: 1/8" holes on 2 ft on centers.
- Lateral diameter and spacing: 3/4" or 1" dia. pipe and 30" spacing.
- Lateral distal Pressure: 5 ft. (Assume 6 ft at inlet end).
- Orifices located upward.
- Orifices located downward when force main drains into filter.
- Orifice shields for upward orifices.
- No orifice shields for downward orifices.
- Manifold: 1 1/4" diameter with center feed.
- All laterals and manifolds are Schedule 40 PVC pipe.

For a 18 by 20 ft sand filter.

Lateral length - 16' -2" (lateral parallel filter width)
 Lateral diameter - 1" (Table 1)
 Number of orifices - 9 per lateral (2' spacing and 2" from ends)
 Number of laterals - 8 with 30" spacing
 Number of orifices - 72
 Manifold diameter and length - 1-1/4" and 17.5' with center feed
 Flow @ 6 ft of head - 32 gpm (0.45 gpm @ 6 ft head)
 Pump capacity:
 Flow: 32 gpm
 Head: Elevation lift
 Force main friction loss
 In-line pressure - 6 ft

For 10 by 36 ft sand filter.

Lateral length - 34' -2"
 Lateral diameter - 1" (Table 1)
 Number of orifices - 18 per lateral (2' spacing and 2" from ends)
 Number of laterals - 4 with 30" spacing
 Number of orifices - 72
 Manifold diameter and length - 1-1/4" and 7.5' with center feed
 Flow @ 6 ft of head - 32 gpm (0.45 gpm @ 6 ft head)
 Pump capacity:

Flow: 32 gpm
 Head: Elevation lift
 Force main friction loss
 In-line pressure - 6 ft

I. Pumps, run time and controls

1. Septic tank effluent pump and run time.

a. Pump type and size

There are basically two types of pumps available for pumping effluent to the sand filter; namely, centrifugal effluent pumps, or turbine effluent pumps. The centrifugal effluent pump provides a relatively high volume flow against a low head with a flat performance curve. The turbine pump provides a small volume flow against a large head with a steep performance curve. The turbine pump is preferred as it provides a high head to help keep the orifices open and maintains relatively constant flow when head changes.

Fig. 7 provides performance curves for several turbine type pumps. For this example, the pump must be capable of pumping at least 32 gpm (see section on distribution laterals for 18 by 20 ft unit) against a total dynamic head determined from the following components:

Static head - elevation difference between pump and laterals
 Residual head in laterals - minimum of 5 ft.
 Friction loss in force main and manifold -

Plot the system performance curve on the pump performance curves and determine the flow rate. Use standard procedures for determining the various heads and system curve. (Assume system performance curve on Fig. 7 is for this example).

The system will operate at 42 gpm at total dynamic head of 33 ft.

b. Pump controller and pump run time:

Small frequent doses, controlled by a repeat cycle timer, will provide better treatment than large infrequent doses controlled on demand by a float switch. The repeat cycle timer is recommended.

Use the following to set the timer initially, adjustments may need to be made later based on actual flow.

Dose volume = 0.25 gallons/orifice.

Number of orifices = 72 (For this example, there are 72 orifices).

Dose volume = 18 gpdose + 12 gpdose (assumed flow back)
= 30 gpdose

Doses per day = 200 gpd / 18 gpdose = 11doses/day

(An estimated actual flow is better to use than design flow. To estimate use 50 gpd/person)

Cycle on time = (28 gpdose / 42 gpm pump flow) = 43 sec. ~ 40 sec.

Use an 18 hour day for cycling instead of 24 hrs.

Cycle time = 18 hours / 11 doses = 1.6 hrs

So set the repeat timer to pump for 40 seconds every 1.5 hrs.

Note: Some adjustments after start p will need to be made if the alarm frequently especially during morning or evenings indicating the surge capacity is being exceeded.

2. Sand filter effluent pump

This pump is controlled by a float switch on demand. Typical dose volume is about 45 gpdose with an internal pump vault. Select a pump based on flow rate and head to match the pressure distribution network in the dispersal unit. Use standard procedures for determining head. The sand filter with the deeper aggregate in the bottom will allow for slightly larger dose volumes.

If the force main to the dispersal unit drains back to the pump vault, the drain back volume must be considerably smaller than the volume pumped, otherwise the pump will continue to cycle after flow back. Typical dose volumes from the internal vaults are 25-40 gallons. A two inch pipe holds 0.163 gallons per foot. If the force main is long, a smaller diameter pipe should be used to reduce the flow back. It must drain after dosing.

j. Fabric

Specify the same geotextile fabric as used for soil absorption units.

k. Cover Sand Filter

Lawn cover:

For soil cover over mound, specify 6" of a **sandy loam top soil**, mulch and seed to lawn. **Heavier top soil such as silt loam or clay loam will restrict the flow of air to the filter and cause premature failure.** Specify surface waters diverted from sand filter.

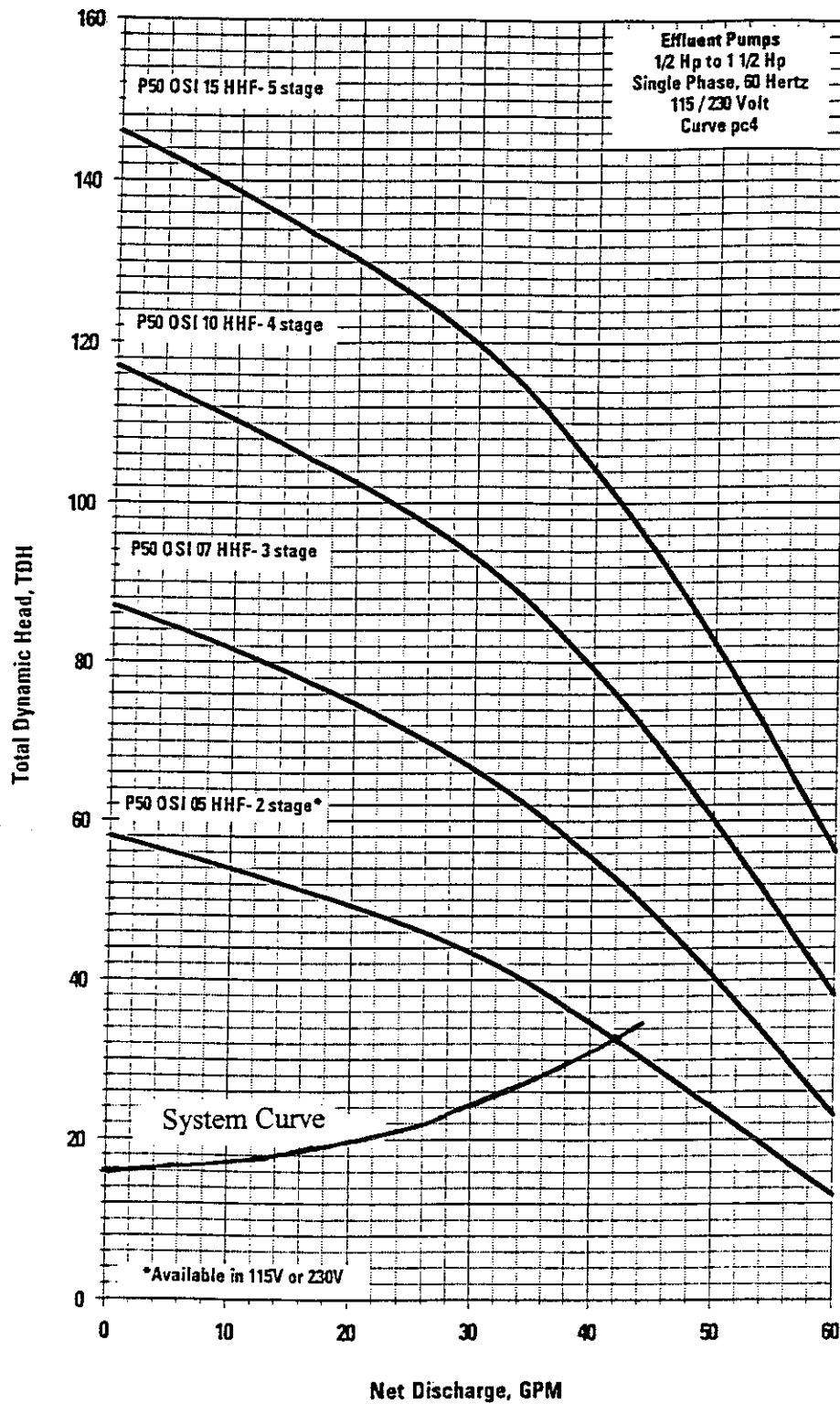


Fig. 7. Pump performance curves for several turbine type pumps showing a system performance curve for example illustrated in text (Orenco, Inc.)

Rock Cover:

For rock cover, specify 2" of sand over the fabric followed by 4" of decorative rock. Specify surface waters be diverted from sand filter.

C. Sand Filter Maintenance

All on-site soil absorption systems need to be maintained, some more than others. Annual maintenance is as follows:

1. Monitor solids and scum build up in septic tank.
2. Monitor build up of solids on septic tank screen or pump vault screen and clean if necessary.
3. Flush all laterals.
4. Monitor pressure in laterals. If it is considerably different than initial measurement, unplug orifices.
5. Observe ponding at sand/aggregate interface in the sand filter through observation tubes.
6. Observe ponding in the observation tubes for soil dispersal unit.
7. Monitor water appliances for leaks on monthly basis and repair as needed.
8. Protect the sand filter area and dispersal area from heavy equipment, excavations etc.

D. Sand Filter Construction

A series of photos and captions (in Appendix) provides a visual sequence of the installation of a single pass sand filter installed to convert a holding tank to a septic tank, sand filter and soil dispersal unit. In most cases a new septic tank will be installed. Neither one has any bearing on the sand filter construction which is the emphasis of this presentation. The sand filter emphasized here is an 18 by 20 commercially available unit. It is assumed all permits have been secured, all designs completed and all materials secured.

E. References

Converse, J.C., 1997. Recirculating sand filters for on-site treatment of domestic wastes. Small Scale Waste Management Project. University of Wisconsin, 345 King Hall, 1525 Observatory Drive, Madison, WI 53706.

Converse, J.C. and E.J. Tyler. 1997. Soil dispersal units with emphasis on aerobically treated domestic effluent. Small Scale Waste Management Project. University of Wisconsin, 345 King Hall, 1525 Observatory Drive, Madison, WI 53706.

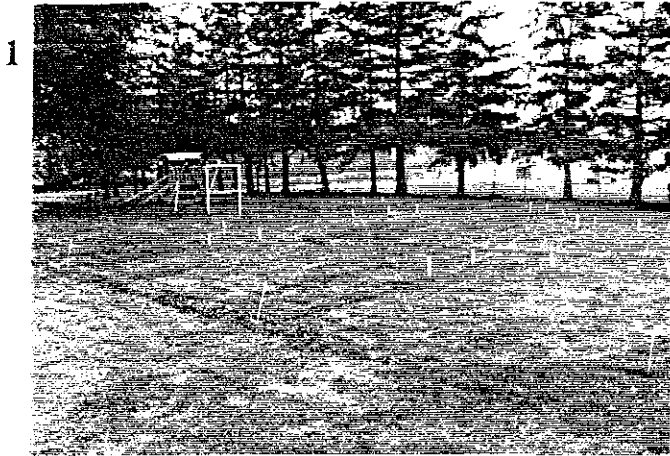
Loudon, T.L. 1995. Design of recirculating sand filters. Agricultural Engineering Depart. Michigan State University, East Lansing, MI.

Orencia Inc. , 814 Airway Avenue, Sutherlin, Oregon. 97479-9012.

Appendix A

CONSTRUCTION OF SINGLE PASS SAND FILTER

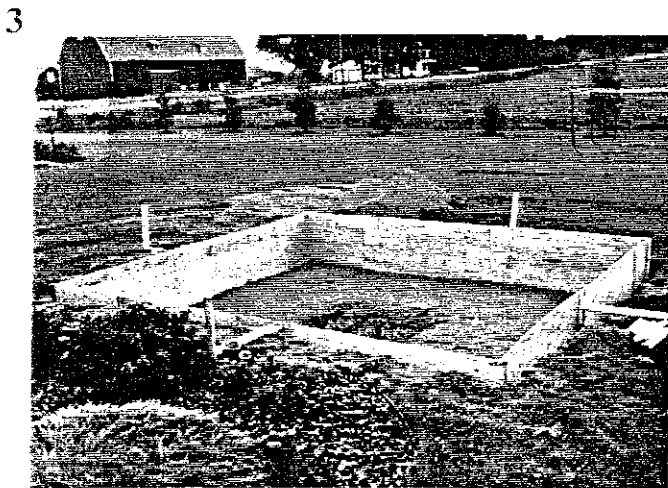
Sand Filter Construction



Stake out the sand filter, making it at least 1 ft larger than finished filter size of 18 by 20 feet. Make sure it is squared up.



Excavate the area. Keep walls vertical. Excavate to the prescribed elevation with a relatively level bottom. This unit has an internal pump chamber, so excavate a 4' by 4' area with sloping sidewalls in the center to a depth of 18 inches beneath the filter bottom



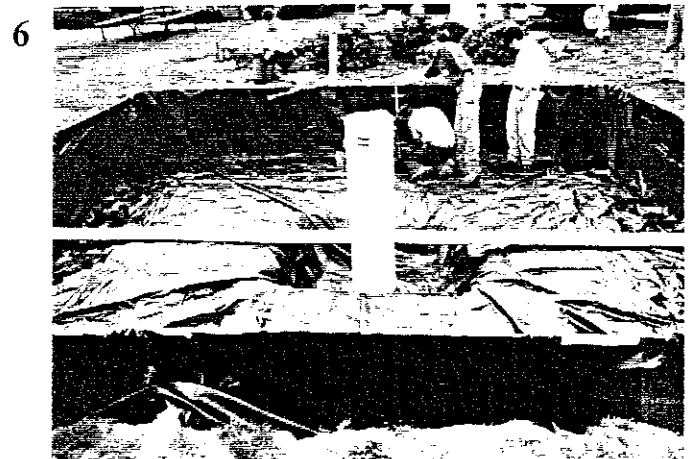
Construct 3/8 or 1/2" plywood/wafer board walls (2 @ 18' by 39" and 2 @ 20' by 39"). Square the unit and make it level all around. Place 2" of sand in the bottom. Secure it in the center and at corners to the earth wall using 2x4s.



Unroll the membrane and follow instructions to minimize reorienting the membrane.



Hang the membrane over the wall, depress it into the center excavation, fold the corners and tuck membrane at the floor/wall edge. The wrinkles do not need to be removed. Secure the membrane at the top of the wall to eliminate sagging. Use U shaped flanges, preferable plastic. Do not puncture membrane.



Set the pump vault in the center of the depression and connect the collection pipes with slots upward. Put end caps on pipes and cover on vault. Using masking tape, mark the heights of the various media in the corners and in middle of walls. This minimizes use of level during construction.

Sand Filter Construction

7



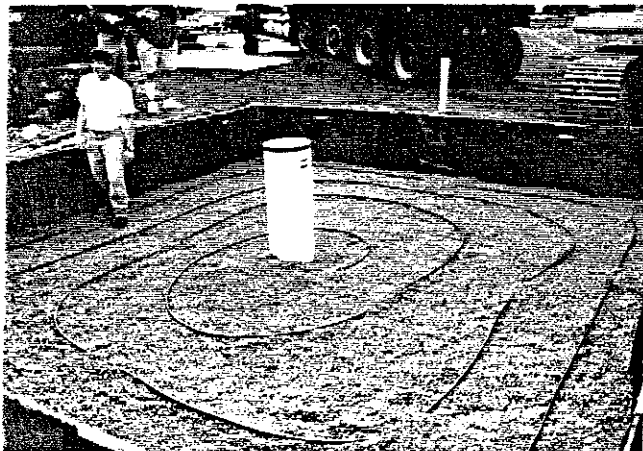
Add 4" of No 1 washed stone (3/4-1) mounding it 1" over the collection pipes. Level the collection pipes and plumb vault vertical.

8



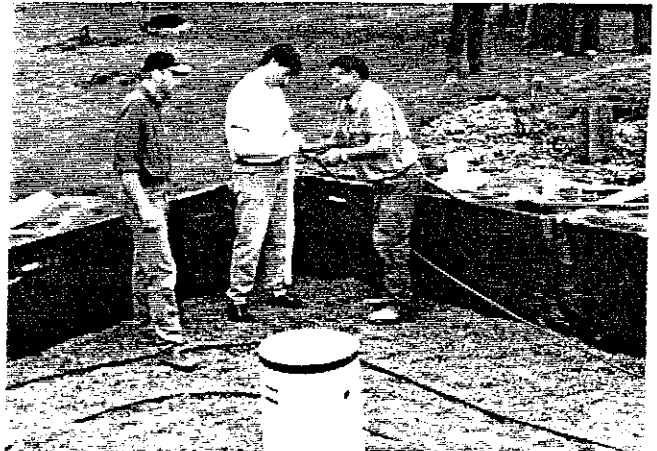
Place 3" of pea gravel (3/8") over the No. 1 stone. Note the slight mound of No. 1 stone over the collection pipe.

9



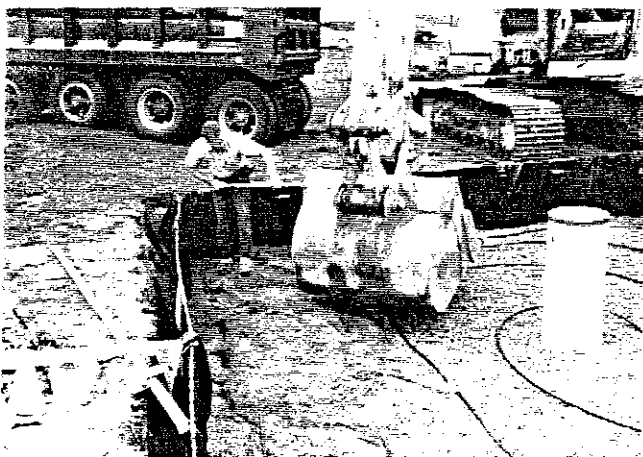
After leveling the pea gravel, place the air tube over the surface area. Perforated small diameter PVC pipe could be placed instead of the drip irrigation tube.

10



Connect a vertical tube to the air tube which comes to the surface.

11



Place the sand media over the air tube and pea gravel. Make sure that it meets specification as the sand quality may vary between loads.

12



Place sand in 8" lifts and wet sand to minimize settling.

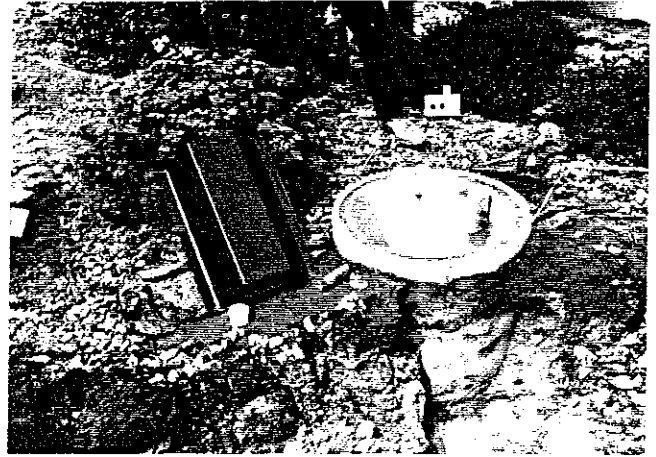
Sand Filter Construction

13



Level the sand.

14



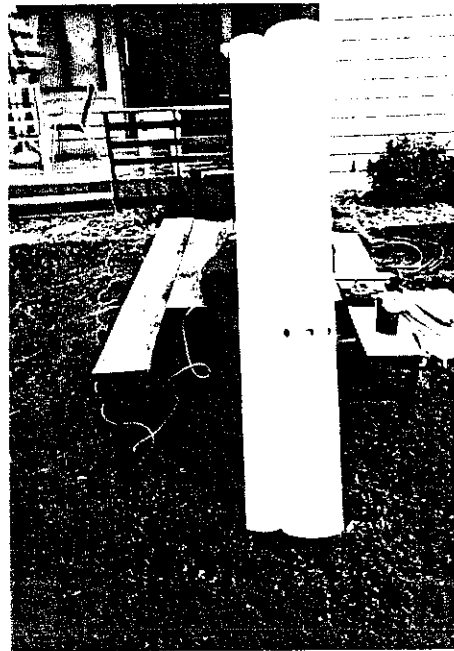
Modify the 2 holding tanks into a septic tank and a pump chamber. Install a baffle in the tank, if not already there. In new installation install the septic tank/pump chamber.

15



Drill the hole through the riser for the force main to the sand filter. Make sure it is at correct elevation for the pump vault and provide slope for drainage.

16



Install pump vault in tank. There are other options available also. This vault is for pump chambers.

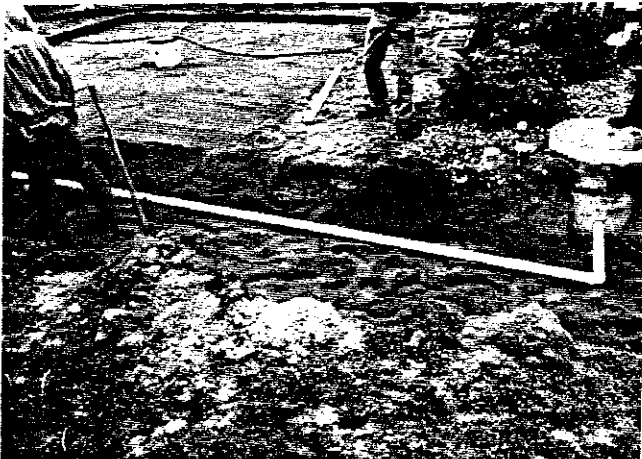
Sand Filter Construction

17



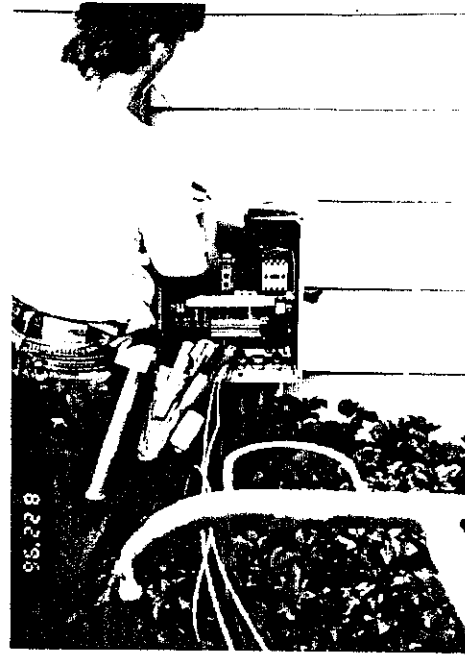
Install the pump and pump screen in to vault. Other options are also available. Once installed start filling pump chamber with water.

19



Install the force main between the pump chamber and sand filter. Slope the pipe to the pump chamber or sand filter so it drains after dosing.

18



With the assistance of an electrician, install the control panel and connect the pump and floats.

20



Drill hole through the plywood wall and membrane and cement a boot to the membrane for the pipe to fit through

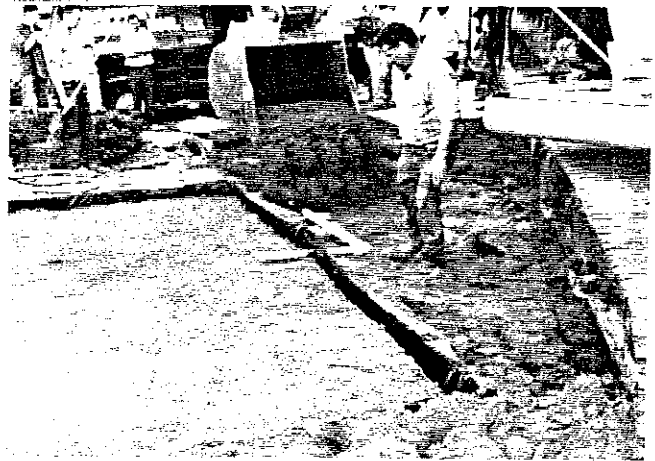
Sand Filter Construction

21



Boot installed around pipe to give a water tight entrance of force main to the sand filter.

22



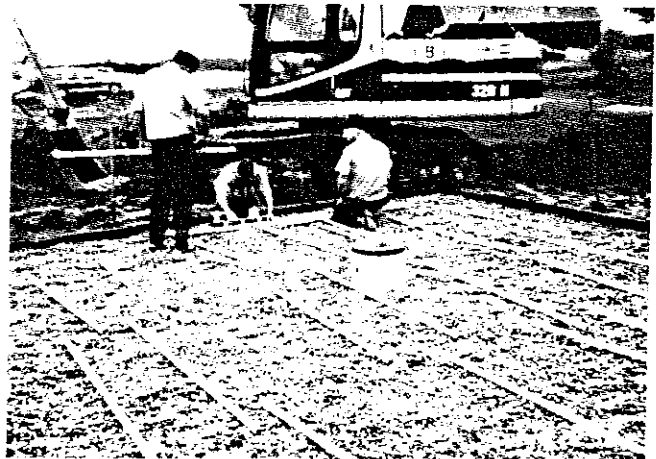
Back fill around the force main with sand.

23



Place 3" of washed No.1 stone (3/4-1) on the leveled sand surface.

24



Assemble the distribution laterals and manifold with holes located upward.

25



Place orifice shields. Slope the manifold to the center (1" pitch) and slope the laterals toward the manifold (1 1/2" pitch) Place stone around and over the distribution network.

26



Pressure test the distribution network by turning on the pump. Measure the squirt height and record it. Replace orifice shield and cover lateral with aggregate.

Sand Filter Construction

27



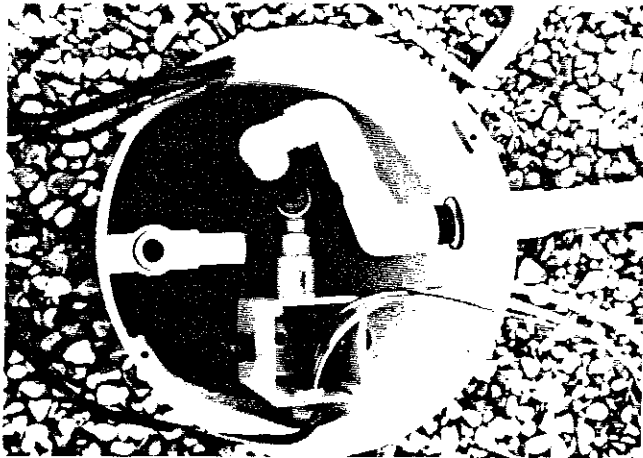
Place the force main from the sand filter pump chamber to outside the sand filter. Slope the pipe to drain either to the pump chamber or to the soil dispersal unit. Install a boot, if a hole is cut through the membrane. Cover the pipe with stone.

28



Install the pump and controls in the pump chamber. Install an air release valve (or weep hole on bottom side of pipe inside the pump chamber).

29



Install the electrical conduit (buried in aggregate) and wires from the control panel. Note the electrical box is installed inside the chamber. It is a water tight box and connections are sealed with heat shrink wrap.

30



Place the valve boxes over the flush valves and air tube riser. Level the aggregate.

31



Place geotextile fabric over the aggregate.

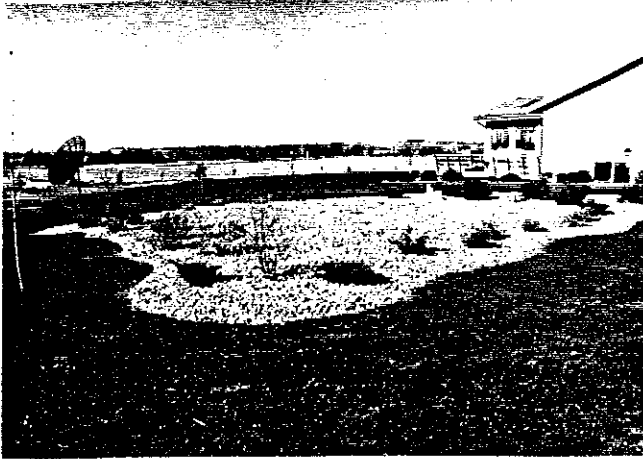
32



If the top of the filter is to be decorative rock, place two inches of sand on the fabric for odor control.

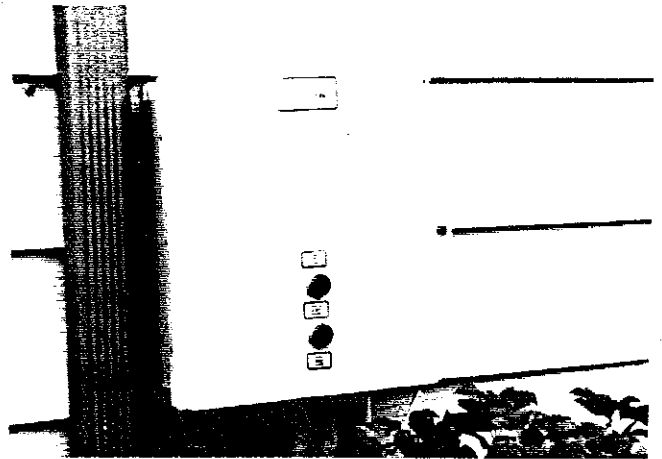
Sand Filter Construction

33



Place 2-3" of decorative rock on top of the sand layer. Landscape with bushes. Note that the rock comes to the same elevation as the valve covers and pump chamber cover. If lawn is desired, place sandy loam soil to the top of the valve covers and pump chamber cover, seed and mulch. In both cases make sure surface waters flow away from the filter.

34



Control panel on side of house.