RECIRCULATING SAND FILTER SYSTEM
COMPONENT MANUAL FOR
PRIVATE ONSITE WASTEWATER TREATMENT SYSTEMS

State of Wisconsin

Department of Commerce

Division of Safety and Buildings

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I. INTRODUCTION AND SPECIFICATIONS

This Private Onsite Wastewater Treatment System (POWTS) component manual provides design, construction, inspection, operation, and maintenance specifications for a recirculating sand filter system component. However, these items must accompany a properly prepared and reviewed plan acceptable to the governing unit to help provide a system that can be installed and function properly. Violations of this manual constitute a violation of chs. Comm 83 and 84, Wis. Adm. Code. The recirculating sand filter system component must receive influent flows and loads less than or equal to those specified in Table 1. When designed, installed and maintained in accordance with this manual, the recirculating sand filter component provides treatment of domestic wastewater. The effluent from a recirculating sand filter system typically has monthly average values of 15 mg/L for BOD_5, 10 mg/L for TSS, 30 mg/L for Total N, and ≤ 10^4 cfu/100 ml for fecal coliform when inputs are within the range specified in Tables 1 to 3.

Note: Detailed plans and specifications must be developed and submitted for review and approval by the governing unit having authority over the plan for the installation. Also a Sanitary Permit must be obtained from the department or governmental unit having jurisdiction. See Section X for more details.

Table 1 **INFLUENT FLOWS AND LOADS**	
RECIRCULATION TANK	
Design wastewater flow (DWF) from primary treatment tanks	≤ 2250 gal/day
Monthly average value of Fat, Oil and Grease (FOG)	≤ 30 mg/L
Monthly average value of five day Biochemical Oxygen Demand (BOD_5)	≤ 220 mg/L
Monthly average value of Total Suspended Solids (TSS)	≤ 150 mg/L
Monthly average value of Total Nitrogen (TN)	≤ 180 mg/L

Table 1 **INFLUENT FLOWS AND LOADS** (continued)	
RECIRCULATION TANK (continued)	
Design wastewater flow (DWF) from one and two-family dwellings	≤ 150 gal/day/bedroom
Design wastewater flow (DWF) from public facilities	≥ 150% of estimated wastewater flow in accordance with Table 4 of this manual or s. Comm 83.43 (6), Wis. Adm. Code
Forward flow	= Design wastewater flow (DWF)
SAND FILTER MEDIA TANK	
Wastewater particle size	≤ 1/8 inch
Distribution cell area per orifice	≤ 4 ft^2
Design loading rate (DLR)	≤ 5 gpd/ft^2 based on forward flow
Dose frequency	24 to 48 times per day (Every 30 – 60 minutes)
Volume of a single dose	DWF x 2/3 x recirculation rate ÷ dose frequency
Recirculation rate	3:1 to 5:1

Table 2 **SIZE**	
RECIRCULATION TANK	
Recirculation tank capacity	≥ 2.2 x DWF
Reserve volume in recirculation tank or chamber	≥ DWF ÷ 2
Surge volume in recirculation tank or chamber	≥ 2/3 DWF
By-pass zone volume in recirculation tank or chamber	≥ DWF
Pump protection volume capacity in recirculation tank or chamber	≥ Depth as required by pump manufacturer

Table 2 **SIZE (continued)**	
SAND FILTER MEDIA TANK	
Total distribution cell area	≥ DWF ÷ DLR
Orifice spacing along lateral	≤ 24 inches
Spacing between laterals	≤ 24 inches
Spacing between lateral and side wall	½ of spacing between laterals or 12 inches, whichever is less
Depth of filter tank	≥ 37 inches

Table 3 **OTHER SPECIFICATIONS**	
Treatment capability for BOD_5, TSS and Total N	≥ 90% removal for BOD_5 and TSS, and ≤ 70% removal for Total N
Piping material	Meets requirements of s. Comm 84.30 (2), Wis. Adm. Code for its intended use
Liner	≥ 30 mil. PVC or ≥ 45 mil. EPDM
Fabric cover	Geotextile fabric meeting s. Comm 84.30 (6) (g), Wis. Adm. Code
Pipe size of underdrain	4 inches
Distribution cell aggregate material	Meets requirements of Comm 84.30 (6) (i), Wis. Adm. Code
Depth of stone aggregate for underdrain effluent collection	≥ 6 inches
Depth of pea gravel over underdrain pipe	≥ 3 inches
Depth of filter media	≥ 24 inches
Depth of stone aggregate under effluent distribution network	≥ 2 inches
Depth of stone aggregate over effluent distribution network	≥ 2 to ≤ 6 inches

Table 3 **OTHER SPECIFICATIONS (continued)**	
Number of observation pipes	≥ Two 4 inch pipes extending from the filter media aggregate interface to finished grade
Location of observation pipes	Located at a distance equal to approximately 1/6 the distribution cell length from each end along the center of the filter's width
Head pressure on orifice	≥ 5 feet
Difference in flow between any two orifices in a single lateral	≤ 10%
Difference in flow between any two orifices in the effluent distribution network	≤ 15%
Stone aggregate sieve specifications	Aggregate Maximum/minimum Gradation (ASTM Standard C33, Size 4, coarse aggregate)
	Sieve Size / % Passing
	2" / 100
	1-1/2" / 90-100
	1" / 20-55
	¾" / 0-15
	3/8" / 0 – 5
Stone aggregate hardness specification	> value of 3 on Moh's Scale of Hardness
Pea gravel sieve specifications	Aggregate Maximum/minimum Gradation (ASTM Standard C33, Size 7, coarse aggregate)
	Sieve Size / % Passing
	3/4" / 100
	½" / 90-100
	3/8" / 40-70
	#4 / 0-15
	#8 / 0 – 5

Table 3 OTHER SPECIFICATIONS (continued)		
Pea gravel hardness specification	> value of 3 on Moh's Scale of Hardness	
Effective size of filter media	D10 = 1.5 to 2.5 mm	
Uniformity Coefficient	CU ≤ 2.0	
Sand media sieve specifications	Sand Maximum/minimum Gradation	
	Sieve Size	% Passing
	3/8	100
	4	60 - 100
	8	7 - 75
	16	0 - 5
	30	0 - 3
	50	0 - 2
Installation inspection	In accordance with ch. Comm 83 Wis. Adm. Code	
Management	In accordance with ch. Comm 83 Wis. Adm. Code	

II. DEFINITIONS

Definitions unique to this manual are included in this section. Other definitions that may apply to this manual are located in ch. Comm 81 of the Wis. Adm. Code or the terms use the standard dictionary definition.

A. "By-pass valve" means a valve that opens to allow effluent from the filter media to be discharged totally to the recirculation tank during low or no wastewater flow conditions.
B. "By-pass zone" means a volume of liquid in a recirculation tank that is designed to provide the filter with sufficient liquid to keep the filter active when the recirculation tank is receiving little or no flow from a facility.
C. "Infiltrative surface" means a top layer of media that receives effluent from a distribution network.
D. "Recirculation rate" means the portion of the wastewater effluent that is delivered back into the system compared to the wastewater effluent that is not delivered back into the system.
E. "Recirculating sand filter system" means an onsite wastewater treatment component, which contains a recirculation tank and an effluent filtering component which treats wastewater by-passing it through the system more than once.

F. “Recirculation tank” means the tank which receives effluent from a septic treatment tank and sand filter and doses the sand filter.

III. DESCRIPTION AND PRINCIPLE OF OPERATION

POWTS recirculating sand filter system component operation consists of a recirculation tank or chamber and a fixed film aeration process unit in which wastewater passes through a porous media. The system reduces BOD_5, TSS, Nitrogen as Total N, and Fecal coliform. BOD_5 is reduced by supplying oxygen to the wastewater stream. TSS is reduced through settling and filtration. Nitrogen as Total N is reduced by converting ammonia to nitrate then converting nitrate to nitrogen gas. Fecal coliform is reduced by attachment and die off of the bacteria to the media as the wastewater flows through the porous media.

Oxygen diffuses into the thin film of water as air passes through the media by convection due to temperature differences. Air is also drawn in as the wastewater moves through the media. The component is designed to encourage passive air movement through the unit.

Effluent is dosed from the recirculation tank to the filter. The filter is of such coarse material, that orifices may only cover four square feet of surface area. The filtered effluent is then collected and flows by gravity to the recirculation tank. Depending on the liquid level in the recirculation tank, a portion or all of the filtered effluent is discharged into the recirculation tank. The portion that is not discharged into the recirculation tank flows to soil distribution/dispersal cell or a dose tank.

Physical entrapment, increased retention time, and conversion of pollutants in the wastewater are important treatment objectives accomplished under unsaturated conditions. Some pathogens contained in the wastewater are eventually deactivated through filtering, retention, and adsorption by the filter media.

Figure 1 indicates the flow path of a recirculating sand filter system.

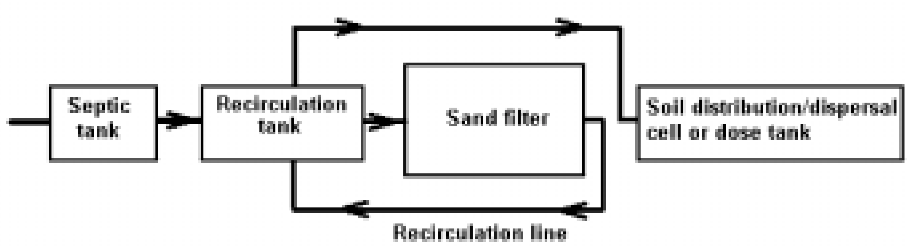


Fig 1 – Flow path of recirculating sand filter system

IV DESIGN

A. Size- Sizing of the recirculating sand filter system must be in accordance with this manual. The means of pressurizing the distribution network must provide equal distribution of influent over the distribution cell. A pressurized distribution network sized using the charts and graphs contained in this manual and methods delineated in either Small Scale Waste Management Project publication 9.6, entitled "Design of Pressure Distribution Networks for Septic Tank – Soil Absorption System" or Dept. of Commerce publication SBD-10573-P, entitled "Pressure Distribution Component Manual for Private Onsite Wastewater Treatment Systems" is acceptable.

B. Recirculating Sand Filter System Component Design – Detailed plans and specifications must be developed, reviewed and approved by the governing unit having authority over the plan for the installation. A Sanitary Permit must also be obtained from the department or governmental unit having jurisdiction.

Design of the recirculating sand filter system component is based on the estimated wastewater flow. It must be sized such that it can accept the daily wastewater flow at a rate that will provide treatment.

Design of the recirculating sand filter system includes three steps, which are: (A) calculating the design wastewater flow, (B) design of the recirculation tank or chamber, and (C) design of recirculating sand filter component.

Step A. Design wastewater flow

One and two-family dwellings. The infiltrative surface size for one and two-family dwelling application is determined by calculating the designed wastewater flow (DWF). To calculate DWF use formula 1.

Formula 1

DWF = 150 gallons/bedroom/day

Public facilities. Infiltrative surface size for a public facility application is determined by calculating the DWF using formula 2. Public facility estimated daily wastewater flows are listed in Table 4. Facilities that are not listed in Table 4 are not included in this manual. Many commercial facilities have high BOD_5, TSS and FOG (fats, oil and grease), which must be pretreated in order to bring their values down to an acceptable range before entering into the recirculating sand filter system component described in this manual.

Formula 2

DWF = 1.5 x Sum of each wastewater flow per source per day (from Table 4)

Table 4

Public Facility Wastewater Flows

Source	**Unit**	**Estimated Wastewater Flow (gpd)**
Apartment or Condominium	Bedroom	100
Assembly hall (no kitchen)	Person (10 sq. ft./person)	1.3
Bar or cocktail lounge (no meals served)	Patron (10 sq. ft./patron)	4
Bar or cocktail lounge* (w/meals - all paper service)	Patron (10 sq. ft./patron)	8
Beauty salon	Station	90
Bowling alley	Bowling lane	80
Bowling alley (with bar)	Bowling lane	150
Camp, day and night	Person	25
Camp, day use only (no meals served)	Person	10
Campground or Camping Resort	Space, with sewer connection and/or service building	30
Campground sanitary dump station	Camping unit or RV served	25
Catch basin	Basin	65
Church (no kitchen)	Person	2
Church* (with kitchen)	Person	5
Dance hall	Person (10 sq. ft./person)	2
Day care facility (no meals prepared)	Child	12
Day care facility* (with meal preparation)	Child	16
Dining hall* (kitchen waste only without dishwasher and/or food waste grinder)	Meal served	2
Dining hall* (toilet and kitchen waste without dishwasher and/or food waste grinder)	Meal served	5
Dining hall* (toilet and kitchen waste with dishwasher and/or food waste grinder)	Meal served	7
Drive-in restaurant* (all paper service with inside seating)	Patron seating space	10
Drive-in restaurant* (all paper service without inside seating)	Vehicle space	10
Drive-in theater	Vehicle space	3
Employees (total all shifts)	Employee	13
Floor drain (not discharging to catch basin)	Drain	25
Gas station / convenience store	Patron (minimum 500 patrons)	3
Gas station (with service bay) Patron Service bay	 Patron Service bay	 3 50
Hospital*	Bed space	135
Hotel, motel or tourist rooming house	Room	65
Medical office building Doctors, nurses, medical staff Office personnel Patients	 Person Person Person	 50 13 6.5
Migrant labor camp (central bathhouse)	Employee	20
Mobile Home (Manufactured home) (served by its own POWTS)	Bedroom	100
Mobile home park	Mobile home site	200

* = May be high strength waste

Table 4 **Public Facility Wastewater Flows** (continued)		
Source	**Unit**	**Estimated Wastewater Flow (gpd)**
Nursing, Rest Home, Community Based Residential Facility	Bed space	65
Outdoor sport facilities (toilet waste only)	Patron	3.5
Parks (toilets waste only)	Patron (75 patrons/acre)	3.5
Parks (toilets and showers)	Patron (75 patrons/acre)	6.5
Public shower facility	Shower taken	10
Restaurant*, 24-hr. (dishwasher and/or food waste grinder only)	Patron seating space	4
Restaurant*, 24-hr. (kitchen waste only without dishwasher and/or food waste grinder)	Patron seating space	12
Restaurant, 24-hr. (toilet waste)	Patron seating space	28
Restaurant*, 24-hr. (toilet and kitchen waste without dishwasher and/or food waste grinder)	Patron seating space	40
Restaurant*, 24-hr. (toilet and kitchen waste with dishwasher and/or food waste grinder)	Patron seating space	44
Restaurant* (dishwasher and/or food waste grinder only)	Patron seating space	2
Restaurant* (kitchen waste only without dishwasher and/or food waste grinder)	Patron seating space	6
Restaurant (toilet waste)	Patron seating space	14
Restaurant* (toilet and kitchen waste without dishwasher and/or food waste grinder)	Patron seating space	20
Restaurant* (toilet and kitchen waste with dishwasher and/or food waste grinder)	Patron seating space	22
Retail store	Patron (70% of total retail area ÷ 30 sq. ft. per patron)	1
School* (with meals and showers)	Classroom (25 students/classroom)	500
School* (with meals or showers)	Classroom (25 students/classroom)	400
School (without meals or showers)	Classroom (25 students/classroom)	300
Self-service laundry (toilet waste only)	Clothes washer	33
Self-service laundry (with only residential clothes washers)	Clothes washer	200
Swimming pool bathhouse	Patron	6.5

* = May be high strength waste

Step B. Design of the Recirculation Tank or Chamber – This section determines the required liquid capacity and depth of the recirculation tank or chamber as well as the operation elevation of the by-pass valve, high water alarm and low level emergency pump cut off. Figure 2 shows a cross section of a recirculation tank for a recirculating sand filter.

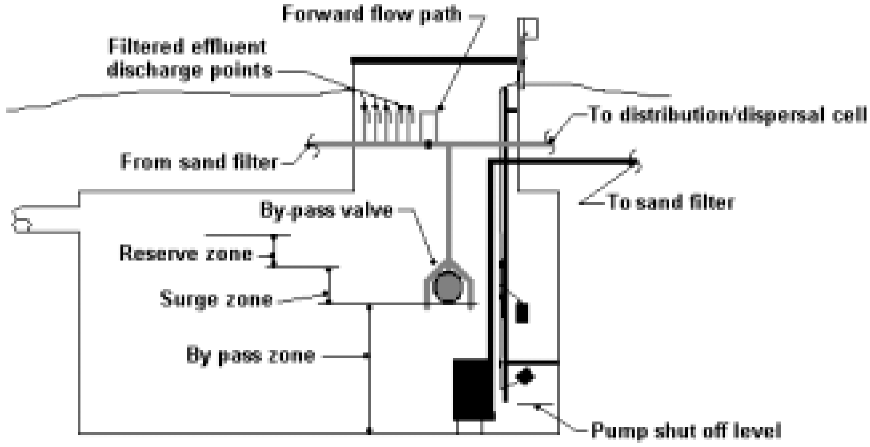


Figure 2 – Cross section of recirculation tank

1. Determine the minimum liquid capacity of the recirculation tank or chamber.

   The minimum liquid volume of the recirculation tank or chamber is equal to 2.2 times the design wastewater flow.

   Minimum liquid capacity of recirculation tank or chamber = 2.2 x DWF

2. Determine the gallons per inch of the tank or chamber selected for recirculation tank or chamber.

   The gallons per inch of the tank or chamber equals the tank or chamber capacity divided by the liquid depth.

   Gallons per inch of tank or chamber = capacity in gallons ÷ liquid depth in inches

3. Determine the elevation of the low-level emergency pump cut off.

   The elevation of the low-level emergency pump cut off is the minimum required liquid level above base of pump as specified by the pump manufacture.

4. Determine the volume of a single dose.

   The volume of a single dose is determined by multiplying the 2/3 of the DWF by the recirculation rate then dividing by the number of doses per day. Number of doses per day must between 24 and 48.

Single dose volume = 2/3 DWF x recirculation rate ÷ number of doses per day (24-48)

5. Determine the elevation at which the by-pass valve will open.

   The minimum elevation at which the by-pass valve opens equals the elevation above the bottom of the tank which will hold a volume equal to the DWF.

   Elevation at which the by-pass valve opens = Elevation required in the tank to hold a volume of liquid equal to the DWF

6. Determine the reserve zone capacity of the recirculation tank or compartment.

   The minimum reserve zone is determined by dividing the DWF by 2.

   Reserve zone capacity = DWF ÷ 2

7. Determine the surge capacity of the recirculation tank.

   The minimum surge capacity is determined by calculating the two thirds of the design wastewater flow.

   Surge capacity = DWF x 2 ÷ 3

8. Determine the required elevation of the inlet invert of the recirculation tank or chamber.

   The minimum elevation of the inlet invert is determined by dividing the sum of the required volumes of the by-pass valve zone, surge zone, and reserve zones by the gallons per inch value of the tank.

   Elevation of inlet invert = by-pass valve volume + surge zone volume + reserve zone volume ÷ gallons per inch of tank.

<u>Step C. Design of the Recirculating Sand Filter Component</u> - This section determines the required size of the distribution cell area as well as the dimensions for the complete sand filter component. Figures 3 and 4 show cross sections of recirculation sand filters that can be used in accordance with this manual.

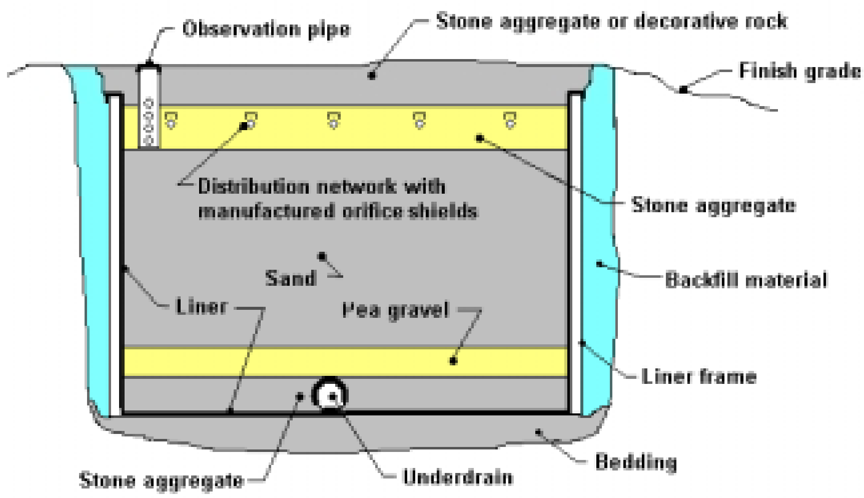


Fig. 3 – Formed sand filter

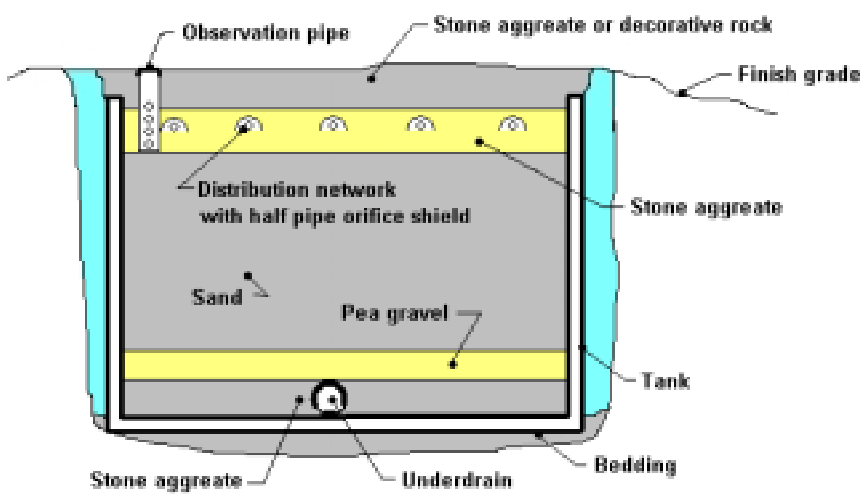


Fig. 4 – Sand filter in a tank

1. Determine the distribution cell area.

   The minimum distribution cell area is calculated by dividing the design wastewater flow by a design loading rate of 5 gpd/ft^2

   Distribution cell area = DWF ÷ DLR of 5 gpd/ft^2

2. Sand filter container

The sand filter container is a watertight open top vessel. The container shall meet requirements of s. Comm 84.25, Wis. Adm. Code or a watertight container, constructed of a durable 30 mil. PVC or 45 mil. EPDM liner is required. The container shall be designed to accommodate all the necessary components. Components include, but are not limited to: infiltrative surface required for the system; cover; distribution system; filter media; collection system; and a means of discharging the collected effluent by gravity. The container must be located to prevent surface and groundwater from entering the container.

3. Filtered effluent collection

A 4" underdrain pipe with slots or holes is placed on the bottom of the container to collect the filtered effluent. Installation orientation of the slots or holes must be on the side of the underdrain pipe. The collection pipe extends outside the sand filter container to the recirculation tank.

4. Filtered effluent collection aggregate

A layer of stone aggregate meeting the specifications listed in Table 3 is placed in the bottom of the tank to a depth of at least equal to the top of the collection pipe. The stone aggregate provides a means for the filtered effluent to flow to the collection pipe.

5. Pea gravel cover over filtered effluent collection stone aggregate and pipe

A layer of pea gravel meeting the specifications listed in Table 3 is placed over the effluent collection stone aggregate and filtered effluent collection pipe to a depth of at least three inches. The pea gravel acts a barrier so the filter media does not migrate into the collection stone aggregate and pipe.

6. Filter media

A two-foot layer of sand media meeting the specifications listed in Table 3 is placed on top of the pea gravel to provide filtration and treatment of the effluent. The top of the filter media is leveled.

7. Distribution cell aggregate

A two-inch layer of stone aggregate meeting the specifications listed in Table 3 is placed on top of the pea gravel to spread the effluent out over the filter media.

8. 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. Typical design consists of:

a. Orifices - orifices shall be located upward with orifice shields or a half pipe protecting the orifices from becoming blocked by aggregate.

b. Laterals – laterals are spaced two feet apart, with an upturned long sweep elbow and valve for clean out. The lateral length can not exceed that indicated in Graph 1 for various diameters. Laterals are sloped back in order to provide drainage of the lateral between doses.

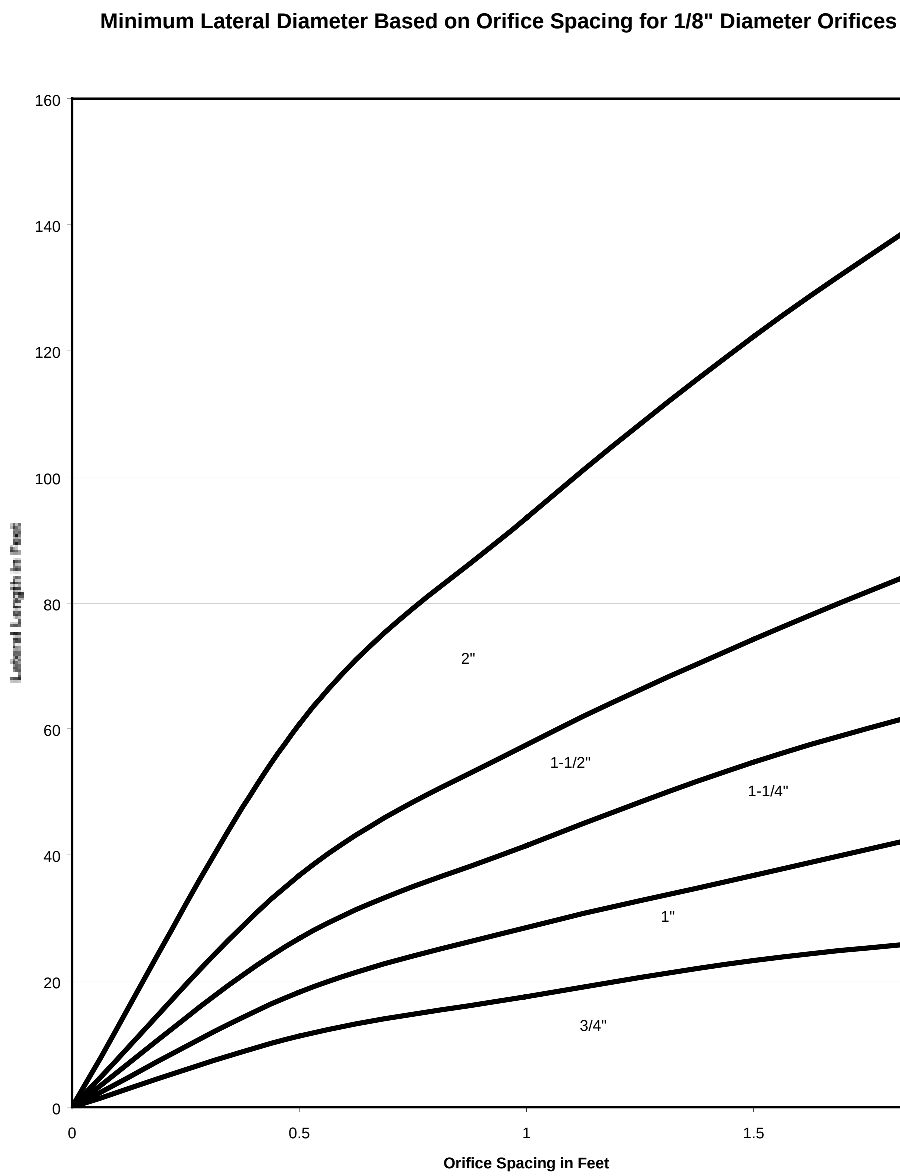
c. Manifold – manifolds slope back to provide drainage of the manifold between doses. The manifold is sized using Table 5.

d. Force main – Force mains slope back to provide drainage of the force main between doses. The force main is sized using Table 6.

e. Recirculation tank pump - the pump is sized to meet flow rate and lateral pressure of at least five feet at distal end.

The distribution network is placed in the stone aggregate with laterals and manifold sloping back to the force main. Additional stone aggregate is placed on top of the network with a minimum cover of two inches. The force main is placed through the tank wall. The pipe penetration is sealed water tight by the use of a gasket to eliminate the intrusion of groundwater through the opening or to prevent ponded effluent from exiting.

Graph 1



Minimum Lateral Diameter Based on Orifice Spacing for 1/8" Diameter Orifices
Lateral Length in Feet
Orifice Spacing in Feet
0
20
40
60
80
100
120
140
160
0
0.5
1
1.5
2
2"
1-1/2"
1-1/4"
1"
3/4"

Table 5 **Maximum Manifold Length Based on Individual Lateral Flow Rates and 2 Foot Lateral Spacing**					
Individual Lateral Discharge Rate		1-1/4”	1-1/2”	2”	3”
End Manifold	Center Manifold	Diameter Manifold	Diameter Manifold	Diameter Manifold	Diameter Manifold
10	5	6 ft	8 ft	12 ft	18 ft
20	10	4 ft	6 ft	8 ft	14 ft
30	15	2 ft	4 ft	6 ft	12 ft
40	20	2 ft	2 ft	6 ft	10 ft
50	25	NP[a]	2 ft	4 ft	8 ft
60	30	NP	2 ft	4 ft	8 ft
70	35	NP	NP	2 ft	6 ft
80	40	NP	NP	2 ft	6 ft
90	45	NP	NP	2 ft	6 ft
100	50	NP	NP	2 ft	4 ft

Note a: NP means Not Permitted

Table 6 **Friction Loss (foot/100 feet) in Plastic Pipe[a]**					
Flow in	Nominal Pipe Size				
GPM	1-1/4”	1-1/2”	2”	3”	4”
10	2.50				
11	2.99				
12	3.51				
13	4.07				
14	4.66	1.92		Velocities in this area are below 2 feet per second	
15	5.30	2.18			
16	5.97	2.46			
17	6.68	2.75			
18	7.42	3.06			
19	8.21	3.38			
20	9.02	3.72			
25	13.63	5.62	1.39		
30	19.10	7.87	1.94		
35	25.41	10.46	2.58		
40	32.53	13.40	3.30		
45	40.45	16.66	4.11		
50	49.15	20.24	4.99		
60		28.36	7.00	0.97	
70		37.72	9.31	1.29	
80	Velocities in this area exceed 10 ft per second, which are not acceptable velocity for this pipe diameter		11.91	1.66	
90			14.81	2.06	
100			18.00	2.50	0.62

Note a: Table is based on Hazen – Williams formula: $h = 0.002082L \times (100/C)^{1.85} \times (gpm^{1.85} \div d^{4.8655})$
Where: h = Feet of head L = Length in feet
C = Friction factor from Hazen – Williams (145 for plastic pipe)
gpm = gallons per minute d = Nominal pipe size

9. Observation pipe(s)

At least two observation pipes are placed extending from the top of the filter media/stone aggregate interface to finish grade to monitor for ponding and/or formation of a clogging mat. The pipes must be secured and have perforations in the bottom 4 inches. Figure 5 shows two examples of observation pipes.

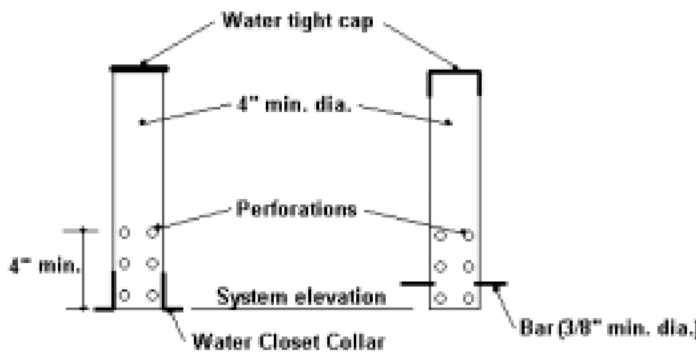


Fig. 5 – Observation pipes

10. Discharge of the sand filter effluent.

The sand filter effluent drains by gravity through the recirculation tank. The filtered effluent drain pipe is installed with a means of diverting 75 to 85% of the effluent to the recirculation tank and with a low liquid level by-pass valve to divert all of the effluent into the recirculation tank during low or no flow conditions.

The filtered effluent drain pipe diverts 75 to 85% of the effluent into the recirculation tank by the use of a special flow splitter fitting. The flow splitter fitting consists of components as shown in figure 6. The inner wall is a circular piece made of material that is the same as the fitting. The inner wall is solvent cemented in place and additional support is provided by the drain pipe. Four to six pipes of the same size are connected to the top of the drain pipe. Three to five of the pipes discharge effluent into the recirculation tank, while the other one discharges effluent to a pipe, which then flows to a pump tank or soil distribution/dispersal cell.

Figure 6 shows a method of designing a flow splitter fitting. The flow splitter fitting may be constructed using proper components or it may be purchased ready to install.

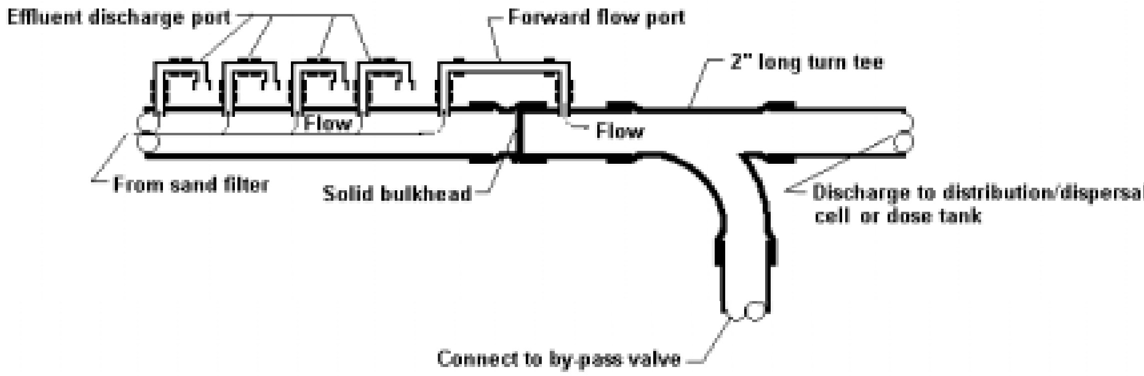


Fig. 6 – Flow splitter fitting using pipe fittings

11. By-pass valve.

The pipe connecting the by-pass valve to the discharge pipe is installed on the discharge side of the flow control fitting by the use of a long turn tee fitting. The by-pass valve is set at an elevation that will open the valve during low or no flow conditions. This elevation is determined in step "E" under "Design of Recirculation tank or Chamber" of this manual.

Figures 8 and 9 show two different by-pass valves. Both of the by-pass valves can be constructed using the proper components or they may be purchased ready to install.

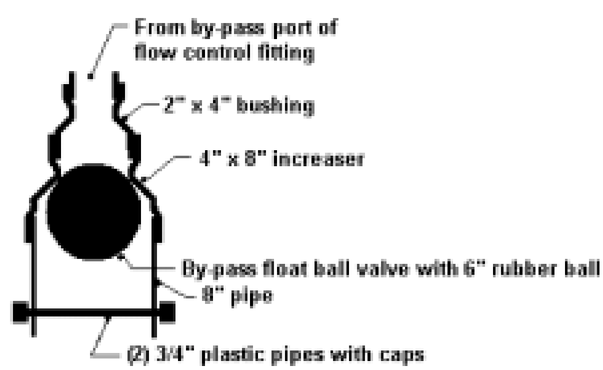


Fig. 8 – By-pass valve using float ball

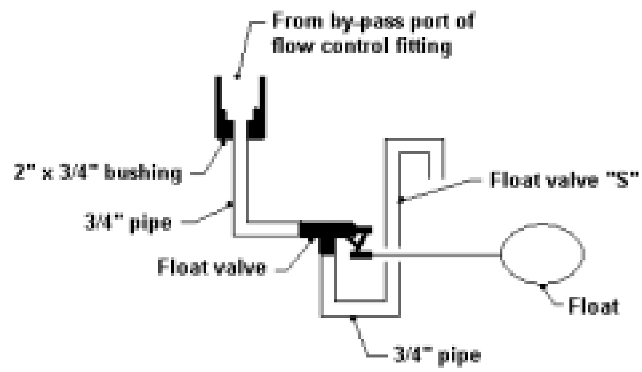


Fig. 9 – By-pass valve using float valve

12. Cover

    The cover over the distribution net work must extend to final grade and be of either wash aggregate or decorative rock. All surface waters must be diverted away from the sand filter.

13. Control panel

    The sand filter is dosed by timed doses. The recirculation tank or chamber must provide for surge loading and surge (reserve) volumes.

V. CONSTRUCTION

Procedures used in the construction of the recirculating sand filter system component are just as critical as the design of the component. A good design with poor construction results in component failure.

A. Lay out the location and size of the recirculation tank, sand filter and the soil distribution/dispersal component and/or its dose tank or chamber.

B. Determine where the force main from the recirculation tank will connect to the effluent distribution system of the sand filter component. The size of the force main pipe is determined from the pressure distribution design and sizing requirements specified in this manual and **sizing methods** of either Small Scale Waste Management Project publication 9.6, entitled "Uniform Distribution in Soil Absorption Fields" or Dept. of Commerce publication SBD-10573-P, entitled "Pressure Distribution Component Manual for Private Onsite Wastewater Treatment Systems" publication.

C. Excavate and install the necessary tanks at the proper elevations and locations. When a watertight container using a durable 30 mil. PVC or 45 mil. EPDM liner is used, the following is required. The 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 around it to buried with the top 2” to 6” below original grade surface. It is imperative that surface and ground water not be allowed to enter the filter.

The excavation is made 6” to 12” larger than the filter. Untreated plywood, waferboard or other suitable material is formed into a box to support the liner and allow the liner to be draped over the top. Only sand is placed between the frame and soil to protect the liner 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 liner must be above the seasonal high water table so groundwater does not flow into the sand filter.

When the excavation around the frame is backfilled, it is done with sand that is placed in one foot increments and compacted by use of water or tamping prior to additional sand being placed.

D. Install a four inch diameter underdrain filtered effluent collection pipe with slots or holes by placing it on the bottom of the sand filter tank and connecting it to solid wall pipe prior to exiting the tank. The installation orientation of the slots or holes must be on the side of the underdrain pipe. The opening in the tank wall shall be sealed by use of a gasket.

E. Place a four-inch layer of stone aggregate meeting the specifications of Table 3 in the bottom of the filter component tank.

F. Place a three-inch layer of pea gravel meeting the specifications of Table 3 over the underdrain effluent collection pipe and stone aggregate.

G. Place 24 inches of filter media meeting the specifications listed in Table 3 on top of the pea gravel.

H. Install the required observation pipes with the bottom four inches of the observation pipes perforated. Installations of all observation pipes include a suitable means of anchoring. See figure 3.

I. Place two inches of stone aggregate meeting the specifications of Table 3 over the filter media.

J. Install the valve boxes, cleanouts and pressure distribution network with laterals sloped at least 1 inch toward the manifold.

K. Test the system to adjust the head pressure to at least 5 feet at the distal orifice.

L. Install the orifice shields or half pipe.

M. Place at least two inches of stone aggregate meeting the specifications of Table 3 over the distribution laterals.

N. Cover the sand filter with additional aggregate such as washed rock or decorative rock until a maximum of six inches is over the distribution network.

3. <u>Other specifications for materials and design</u>

A. Filtered effluent discharge pipe.

The filtered effluent discharge pipe is installed to discharge the effluent to the distribution/dispersal cell and recirculation tank. All pipe penetrations shall be sealed water tight by the use of gaskets.

The filtered effluent pump discharge pipe is connected to the flow splitter fitting. The flow splitter fitting shall be properly sized to allow 75 to 85% of the effluent to be discharged into the recirculation tank.

The discharge end of the flow splitter fitting shall be connected to a long turn tee that directs the wastewater to the by-pass valve. The discharge end of the long turn tee is connected to a pipe, which discharges to the distribution/dispersal cell by gravity, or to a dose tank serving the distribution/dispersal cell. .

The bottom of the long turn tee is connected to a two inch diameter pipe that extends down to the by-pass valve.

VI. OPERATION, MAINTENANCE AND PERFORMANCE MONITORING

A. The component owner is responsible for the operation and maintenance of the system. The county, department or POWTS service contractor may make periodic inspections of the components, and effluent levels, etc.

The owner or owner's agent is required to submit appropriate records routinely to the county or other appropriate jurisdiction and/or the department.

B. Design approval and site inspections before, during, and after the construction are accomplished by the county or other appropriate jurisdictions in accordance to Ch. Comm 83 of the Wis. Adm. Code.

C. Other routine and preventative maintenance aspects are:

1. The effluent filter in the septic tank is to be inspected and maintained at least every six months.
2. The septic and recirculation tanks are to be inspected and maintained at least every three years. If the scum and sludge occupies 1/3 of the tanks' volume, the tank shall be pumped and its contents properly disposed of. If the tank is not pumped at this time, it shall be pumped when the scum and sludge occupies 1/3 of the tanks' volume.
3. Inspections of recirculating sand filter component performance is required at least every six months for the first two years. Then once a year for the next two years.

Then once every three years, thereafter. These inspections include checking the liquid levels in the observation pipes and examination for any seepage around the filter.

4. The pump frequency and run time are to be check at least every six months.

5. A good water conservation plan within the house or establishment will help assure that the filter system will not be overloaded.

D. User's Manual: A user's manual is to accompany the recirculating sand filter component. The manual is to contain the following as a minimum:

1. Diagrams of all system components and their location.

2. Specifications for electrical and mechanical components.

3. Names and phone numbers of local health authority, component manufacturer or management entity to be contacted in the event of a failure.

4. Information on the periodic maintenance of the recirculating sand filter system, including electrical and mechanical components.

E. Performance monitoring must be performed on recirculating sand filter system components installed under this manual.

1. The frequency of monitoring must be:

   a. At least once every six months after installation for the first two years. Then once a year for the next to years. Then once ever three years thereafter, and

   b. At times of problem, complaint, or failure.

F. The minimum criteria addressed in performance monitoring of recirculating sand filter system components are:

1. Type of use.

2. Age of system.

3. Nuisance factors, such as odors or user complaints.

4. Mechanical malfunction within the component including problems with valves or other mechanical or plumbing components.

5. Material fatigue or failure, including durability or corrosion as related to construction or structural design.

6. Neglect or improper use, such as overloading the design rate, poor maintenance of vegetative cover, inappropriate cover over the recirculating sand filter system component, or inappropriate activity over the recirculating sand filter component.

7. Installation problems such as improper materials or location.

8. Pretreatment component maintenance, including dosing frequency, structural integrity, groundwater intrusion or improper sizing.

9. Pump chamber maintenance, including improper maintenance, infiltration, structural problems, or improper sizing.

10. Pump malfunction including dosing volume problems, pressurization problems, breakdown, burnout, or cycling problems.

G. Reports are to be submitted in accordance to Ch. Comm. 83, Wis. Adm. Code.

VII. REFERENCES

David Venhuizen 1997. "A Minnesota regulator's Guide to the Venhuizen Standard Denitrifying Sand Filter Wastewater Reclamation System."

James C. Converse 1997. "recirculating Sand Filters for On-Site Treatment of Domestic Wastes."

T.R. Bounds, P.E. and Design Staff Orenco Systems, Inc. 1994. "Design Criteria for Recirculating Sand Filters."

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David Venhuizen, P.E. – 1997. "Sand Filter/Drip Irrigation Systems Solve Water resources Problems" ASAE proceedings of the Eighth International Symposium on Individual and Small Community Sewage Systems.

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VIII. WORKSHEET

RECIRCULATING SAND FILTER SYSTEM WORKSHEET

A. Design wastewater flow (DWF)

<u>One or Two-family Dwelling.</u>

DWF = 150 gal/bedroom x # of bedroms

= 150 gal/bedroom x ______# of bedrooms

= ____________ gal/day

<u>Public Facility.</u>

DWF = 1.5 x Sum of each wastewater flow per source per day

= __________ gal/day

B. Recirculation tank liquid capacity

Recirculation tank liquid capacity = DWF x 2.2

= _______ gal x 2.2

= _________ gallons

Selected tank size and manufacturer = ________ gallons – tank manufactured by

____.

C. Average gallons per inch of the recirculation tank

Gallons per inch = liquid capacity of tank (gallons) ÷ Liquid depth (inches)

= _______ gal ÷ ____ inches

= _______ gal/in.

D. Elevation of low level emergency pump cut off/alarm

Elevation of cut off = distance required by pump manufacturer (inches)

= _____ in.

E. Volume of a single dose

Dose volume = 2/3DWF x recirculation rate ÷ dose frequency (24 to 48 times/day)

= _______ gal/day x ______ ÷ ____ doses/day

= _______ gal/dose

F. Distance from opening point of by-pass valve to bottom of tank

Distance = DWF ÷ gallons per inch of tank capacity

= ____ gal ÷ _____ gal/in

= ______ inches

G. Surge zone capacity

Capacity = DWF x 2 ÷ 3

= _______ gal x 2 ÷ 3

= _______ gallons

H. Reserve zone capacity

Capacity = DWF ÷ 2

= _______ gal ÷ 2

= _______ gallons

I. Distance from activation point of high water alarm to bottom of tank

Distance = Distance from opening point of by-pass valve to bottom of tank + (surge zone capacity ÷ gal/in value of recirculation tank)

= _____ inches + (_____ gal ÷ ____ gal/in)

= ______ inches

J. Infiltration surface of sand filter

Infiltrative surface area = DWF ÷ 5 gpd/ft^2

= _______ gpd ÷ 5 gpd/ft^2

= _______ ft^2

K. Width and length of sand filter container

Width of infiltrative surface = infiltrative surface area ÷ chosen cell length

= ________ ft^2 ÷ _____ ft.

= _______ ft.

or

Length of infiltrative surface = infiltrative surface area ÷ chosen cell width

= ________ ft^2 ÷ _____ ft.

= _______ ft.

L. Total number of distribution laterals

Total number of distribution laterals = quotient of width of distribution cell ÷ 2, rounded up to next whole number

= ______ ÷ 2 =

=

M. Number of orifices in system

Number of orifices = Length of lateral ÷ orifice spacing x number of laterals

= _________ ft ÷ ______ orifices/ft x ______ .

= ______ orifices

N. Diameter of distribution lateral

Diameter per Graph 1, using length of individual lateral

= _____ ID

O. Minimum discharge rate of recirculation tank pump

Discharge rate = ______ total number of orifices x 0.41 gpm/orifice

= _____ gpm

P. Diameter of force main from recirculation tank pump

Diameter = size from Table 5, using minimum discharge rate of recirculation tank pump

= _____ ID

IX. EXAMPLE WORKSHEET

RECIRCULATING SAND FILTER SYSTEM WORKSHEET

A. Design wastewater flow (DWF)

One or Two-family Dwelling.

DWF = 150 gal/bedroom x # of bedrooms

= 150 gal/bedroom x __4____# of bedrooms

= _600______ gal/day

Public facility.

DWF = 1.5 x Sum of each wastewater flow per source per day

= __________ gal/day

B. Recirculation tank liquid capacity

Recirculation tank liquid capacity = DWF x 2.2

= _600_____ gal x 2.2

= _1320___ gallons

Selected tank size and manufacturer = _1350_______ gallons – tank manufactured by

____Best Tanks in the World, Inc.________________.

C. Average gallons per inch of the recirculation tank

Gallons per inch = liquid capacity of tank (gallons) ÷ Liquid depth (inches)

= _1350___ gal ÷ _50.5__ inches

= __26.74___ gal/in.

D. Elevation of low level emergency pump cut off/alarm

Elevation of cut off = vertical distance required by pump manufacturer (inches)

= _8___ in.

E. Volume of a single dose

Dose volume = 2/3DWF x recirculation rate ÷ dose frequency (24 to 48 times/day)

= _400___ gal/day x 5 (5:1 recirculation rate) ÷ _24__ doses/day

= _83.33__ gal/dose

F. Distance from opening point of by-pass valve to bottom of tank

Distance = DWF ÷ gallons per inch of tank capacity

= 600 gal ÷ 26.74 gal/in

= 22.44 inches

G. Surge zone capacity

Capacity = DWF x 2 ÷ 3

= 600 gal x 2 ÷ 3

= 400 gallons

H. Reserve zone capacity

Capacity = DWF ÷2

= 600 gal ÷2

= 300 gallons

I. Distance from activation point of high water alarm to bottom of tank

Distance = Distance from opening point of by-pass valve to bottom of tank + (surge zone capacity ÷ gal/in value of recirculation tank)

= 22.44 in + [(400 gal + 300 gal) ÷ 26.74 gal/in]

= 22.44 in + 26.18 in

= 48.26 inches

Invert elevation of selected tank = 50.5 inches

J. Infiltration surface of sand filter

Infiltrative surface area = DWF ÷ 5. gpd/ft^2

= 600 gpd ÷ 5 gpd/ft^2

= 120 ft^2

K. Width and length of sand filter container

Width of infiltrative surface = infiltrative surface area ÷ chosen cell length

= 120 ft^2 ÷ 16 ft.

= 7.5 ft.

or

Length of infiltrative surface = infiltrative surface area ÷ chosen cell width

= ________ ft^2 ÷ _____ ft.

= _______ ft.

L. Total number of distribution laterals

Total number of distribution laterals = quotient of width of distribution cell ÷ 2, rounded up to next whole number

= 7.5 ÷ 2 = 4

= 4 .

M. Number of orifices in system

Number of orifices = Length of lateral ÷ orifice spacing x number of laterals

= 16 ft ÷ 2 orifices/ft x 4 .

= 32 orifices

N. Diameter of distribution lateral

Diameter per Graph 1, using length of individual lateral

= 3/4 ID

O. Minimum discharge rate of recirculation tank pump

Discharge rate = flow rate of lateral from table 5 x number of laterals

= 3.3 gpm x 4 .

= 13.2 gpm

P. Diameter of force main from recirculation tank pump

Diameter = size from Table 5, using minimum discharge rate of recirculation tank pump

= 1” ID

X. PLAN SUMBITTAL AND INSTALLATION INSPECTION

A. Plan Submittal

In order to install a component correctly, it is important to develop plans that will be used to install the component correctly the first time. The following checklist may be used when preparing plans for review. The checklist is intended to be a general guide. Conformance to the list is not a guarantee of plan approval. Additional information may be needed or requested to address unusual or unique characteristics of a particular project. Contact the reviewing agent for specific plan submittal requirements, which the agency may require that are different than the list included in this manual.

General Submittal Information

- Submittal of additional information requested during plan review or and questions concerning a specific plan must be referenced to the Plan Identification indicator assigned to that plan by the reviewing agency.
- Plans or documents must be permanent copies or originals.

Forms and Fees

- Application form for submittal, provided by reviewing agency along with proper fees set by reviewing agent.
- Onsite verification report signed by the county or appropriate state official.

Documentation

- Architects, engineers or designers must sign, seal and date each page of the submittal or provide an index page, which is signed, sealed and dated.
- Master Plumbers must sign, date and include their license number on each page of the submittal or provide an index page, which is signed, sealed and dated.
- Three completed sets of plans and specifications (clear, permanent and legible); submittals must be on paper measuring at least 8-1/2 by 11 inches.

Plot Plan

- Dimensioned plans or plans drawn to scale (scale indicated on plans) with parcel size or all property boundaries clearly marked.
- Slope directions and percent in component area.
- Benchmark and north arrow.
- Setbacks indicated as per appropriate code.
- Location information; legal description of parcel must be noted.
- Location of any nearby existing component or well.

Plan View

- Dimensions for Recirculating filter media filter distribution cell(s).
- Location of observation pipes.
- Pipe lateral layout, which must include the number of laterals, pipe material, diameter and length; and number, location and size of orifices.
- Manifold/force main locations, with materials, length and diameter of each.

Cross Section of Component

- Lateral elevation, position of observation pipes, dimensions and depths of aggregates and filter media, and type of cover material such as geotextile fabric, and depth, if applicable.

Component Sizing

- For one and two-family dwellings, the number of bedrooms must be included.
- For public facilities, the sizing calculations must be included.

Tank and Pump Information

- All construction details for site-constructed tanks.
- Size and manufacturer information for prefabricated tanks.
- Notation of pump or siphon model, pump performance curve, friction loss for force main and calculation for total dynamic head.
- Cross section of tank / chamber to include storage volumes; connections for piping, vents, and electricity; pump “off” setting; dosing cycle and volume; and location of vent and manhole.
- Cross section of two compartments tanks or tanks installed in a series must include information listed above.

Other

- For design flows greater than 1000 gpd, include the manufacturer, model, and location of a metering device, which accurately meters the amount of effluent entering the component.

B. Inspections.

Inspection shall be made in accordance with ch. 145.20,. Wis. Stats and s. Comm 83.26, Wis. Adm. Code. The inspection form on the following two pages may be used. The inspection of the component installation and/or plans is to verify that the component at least conforms to specifications listed in Tables 1-3 of this manual.

GENERAL INFORMATION		ISF INFORMATION
Permit Holders Name:	County:	ISF outside dimensions:
VRP Elevation:	Sanitary Permit Number:	Orifice position:
VRP Description:	Plan ID Number:	Filter media source:
Inspector Name & License #:	Parcel Tax Number:	Force main length:
Dates Inspected:		Force main diameter:

CONTRACTOR INFORMATION	
Plumber Name:	Phone #:
Electrician Name:	Phone #:
Excavator Name:	Phone #:

ELEVATION DATA				
STATION	BS	HI	FS	ELEV
VRP:				
STFM:				
STFM End:				
SFPB FM:				
SFPB FM End:				
Base of STPB:				
Base of SFPB:				
STFM pitch:				

TANK INFORMATION	
Manufacturer: Tank Capacity:	Gallons/inch
Capacity of First Compartment:	
Capacity of Second Compartment:	

SEPTIC TANK VAULT	
Inside height:	inches
*Alarm/timer override:	inches
*Timer off:	Inches
*Red. Off/low level alarm:	Inches
Force main Diameter:	Inches
Force main Length:	Feet

* Measured from bottom of tank cover.

PUMP INFORMATION		
	DTPB	SFPB
Manufacturer:		
Model Number:		
Lift:		
Friction Loss:		
System Head:		
As-Built TDH:		
System Demand:		

OPERATIONAL REVIEW		
STPB floats tested	Yes	No
SFPB floats tested	Yes	No
Distribution pipes flushed	Yes	No
As-built TDH below pump curve	Yes	No
Septic tank tested for water tightness	Yes	No
Owner issued operational manual	Yes	No
Residual head at start up		
Programmable timer settings	On	Off

ADMINISTRATIVE REVIEW		
Revision to plans required	Yes	No
Construction directive issued	Yes	No
Construction order issued	Yes	No
Date of directive		
Directive deadline		
Enforcement order date		
Enforcement order deadline		
Date compliance issued		

DTPB – Recirculation tank Pump Basin
SFPB – Filter media Filter Pump Basin
SFPB FM - Filter media Filter Pump Basin, Force Main
STFM – Septic Tank Force Main
STPB – Septic Tank Pump Basin
VRP- Vertical Reference Point

DEVIATIONS FROM APPROVED PLANS:

Date Installation Approved ____________ **Inspector Signature** ______________________________