

SECTION 6: Plumbing and Collection

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PLUMBING AND COLLECTION

Introduction

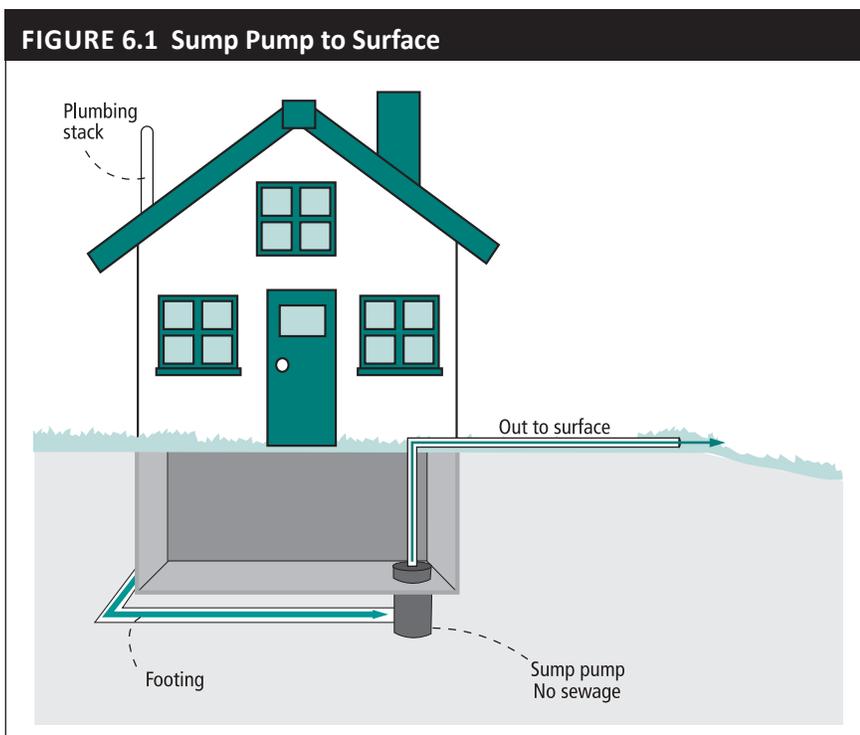
The plumbing and collection portion of the system transports wastewater from the structure to the treatment system. For single-family homes this is the building sewer while for cluster systems this is a designed collection system. The size and components of the collector systems depend on the number of residences, land topography and the type of treatment system. For individual residences or other establishments, a four-inch building sewer is a simple technology, but it is critical for the long-term operation of the system. When installed properly, the building sewer will function for many years. When not installed properly, this component can be a continuing problem for the owner.

Definitions

Plumbing

Basement sump, grinder and effluent pumps

In the basement structure typical to freeze-thaw climates such as Minnesota's, there are two types of pump applications: sump pump and sewage ejector. Sump pumps deal with the footing drains and other approved clean water sources. These should never discharge into the soil treatment system. MN Rules Chapter 7080.1550 prohibits sump pump and footing drain discharge into an SSTS. In fact, the discharge should even be directed away from the system to avoid additional water to the system as shown in Figure 6.1.

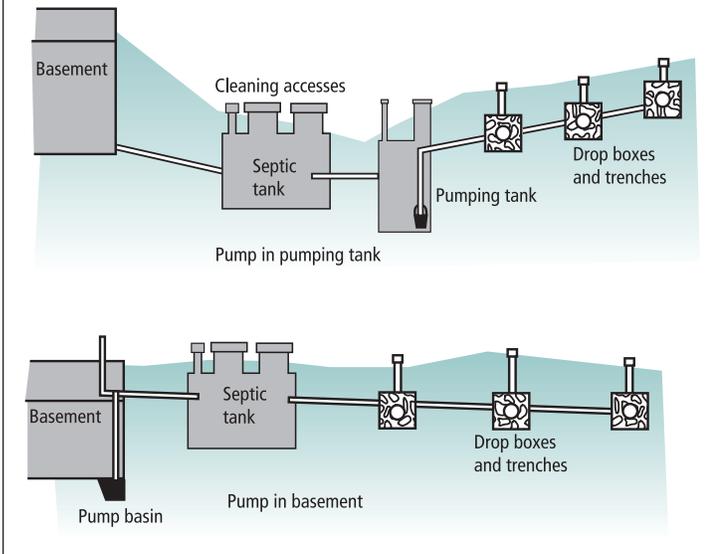


The second type of application is a sewage ejector, which is used to lift the wastewater in lower levels of the home into the system as shown in the lower half of Figure 6.2 (next page).

These pumps are also used to lift sewage into a septic tank placed at a shallower bury depth. In these applications, minimizing the dose is important to allow for separation in the tank. When the pumping system is used, care should be taken not to overload the system. It is recommended that each dose into the tank be between 1 and 5 percent of the total septic tank volume. Also, the pumped effluent should be delivered into the 4-inch piping as far away from the septic tank as possible. This will allow for maximum energy reduction before entering the septic tank. When effluent is being delivered via a pump into

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FIGURE 6.2 Pumping Applications



the septic tank, the septic tank capacity is required to be increased by 50 percent and have multiple compartments or tanks (MN Rules Chapter 7080.1930, Subp. 3). This will allow for the tank to better separate the solids that are being applied and reduce the energy in the flow stream. It is also recommended that an effluent screen be utilized to reduce the flow of solids to the soil treatment area.

Effluent pumps are only used with effluent that has undergone primary settling such as in a septic tank.

Non-flush toilets

There are several types of non-flush toilets, all based on the goal of water conservation. Waterless and forced-air composting toilets produce compost. Electric toilets burn the waste. Some models use a very small amount of water or a chemical foam to assist the passage of waste to the composting chamber. A composting toilet is a self-contained unit (not connected to a septic or sewer system)

which breaks-down, reduces the volume, and dehydrates human waste to a compost which can be added to soils. The toilet will consist of a place to sit (which is likely to look a lot like any other toilet), a composting chamber which breaks down and sanitizes the sewage, and a drying chamber or tray which permits moisture to escape, reducing the sewage volume. The Minnesota Plumbing Code does not recognize composting toilets as an approved fixture.

Composting toilets come in models which use a little water or no water at all, and in electric (heated and power-vented) models and non-electric models. Some models include electro-mechanical mixers which mix waste in with a mulch product to speed and improve the composting process. Properly designed and installed the toilet is vented so that there are no abnormal toilet odors. Periodically the compost must be emptied and on occasion toilet components are cleaned.

People use the toilet in a normal manner, and modern composting toilets in fact look pretty familiar, resembling water-based toilets in general shape and comfort. Waste is mixed with a “starter mulch” to begin the composting process. Composted waste is emptied from the toilet at intervals ranging from one or two months to 12 months depending on level of usage and toilet design. Composting toilets which do not mix new human waste with material already being composted produce a compost which is easier and safer to handle. This is a reason that some models use multiple containers or compartments, though there are other solutions to this problem. If the visible portions of the toilet need cleaning, normal household cleaner and toilet brush are used.

Maintenance requirements vary by manufacturers, and although minor for many systems, they may prevent wider interest. People are typically interested in composting toilets when they do not have other satisfactory toilet options (e.g. lack of space for a septic field, impossibility of using heavy equipment on a site) or when they live on nitrogen sensitive environments. The waste from a composting toilet is considered septage and must be treated properly. More information about non-flush toilets can be found in Section 7.

Flammable waste and sediment traps

The plumbing code regulates flammable waste traps. The MPCA has a fact sheet that best describes the management of floor drains and flammable traps and it is placed on the next page. (Waste/Hazardous Waste #4.18, October, 2007). From MN Rules, Chapter 4714, Sections 1009.1 and 1017.1, requires vehicle storage, repair garages, gasoline stations with grease racks, work or wash racks, auto washes, and all buildings where oily and/or flammable liquid wastes are produced have an interceptor. The interceptor is designed to catch oil, grease, and sand bearing and/or flammable wastes before building drainage system or other point of disposal when floor drains or trench drains are provided. The exception is private garages serving one and two-family dwellings.

The Minnesota Pollution Control Agency regulates the disposal of the waste produced from the cleaning of sediment traps and flammable waste traps. Hazardous waste is defined in MN Rule Chapter 7045.0135 as a waste that has one or more of the characteristics of ignitability, corrosivity, reactivity, lethality or toxicity. These wastes must be transported by a certified hazardous waste hauler. These traps must be cleaned periodically to maintain the integrity of the wastewater leaving facilities. Traps of this nature shall not be discharged to a SSTS.

Sediment traps and flammable waste traps are designed to hold solid and oily wastes that are produced from normal washing and maintenance of vehicles, equipment, and floors. The flammable waste trap generally has three layers of waste; the top oil layer, the middle water layer, and the bottom sand layer.

Best management practices should be employed to prevent flammable materials from getting into the system including:

1. Good general housekeeping
2. Clean spills immediately
3. Keep containers sealed when not in use
4. Only wash engines if absolutely necessary
5. Sweep up solids and properly dispose
6. Use screens in the drain to prevent solids from reaching the trap
7. Use drip pans to collect fluids
8. Have necessary equipment in place to quickly clean up a spill before it can escape
9. A clean sediment trap will keep the sediment out of the flammable waste trap
10. Prevent liquid wastes (solvents, oils, etc.) from entering into floor drains

Maintenance

Sediment Traps

The wash stall sediment traps need to be checked periodically. When the sediment trap is in need of cleaning, follow these procedures:

1. Drain water down outlet pipe using buckets, pumps, etc.
2. Remove sand/sediment from trap.
3. Properly dispose of sediment/sand.

Best Management Practices for Managing Floor Drains and Flammable Traps

(Post in Shop)

Using these best management practices in your shop will enable you to manage flammable trap waste as an industrial solid waste rather than a hazardous waste.

If you:	You need to know that:	Best Management Practice:
Use aerosol solvents or other degreasers	These chemicals can compound waste management problems by contaminating wash water and sludge with hazardous materials.	Clean parts over a drip pan — not on the floor; collect waste. Use a parts washer to clean engine parts and manage the solvent in the washer as a hazardous waste. To prevent contamination of the parts washer by listed* solvents, do not spray listed aerosols over the unit.
Change vehicle fluids (oil, brake fluid, antifreeze, etc.)	These chemicals can compound waste management problems by contaminating wash water and sludge with hazardous materials.	Use drip pans under vehicles to collect fluids. Recycle transmission and brake fluids with used oil. Drain radiators before flushing and recycle waste antifreeze.
Clean shop floors	Hosing down the floors with water or solvent can flush contaminants into floor drains, contaminating liquids and sludges in the drain system.	Use drip pans to collect fluids. Use dry sweeping compounds. Reuse them as long as they remain absorbent. Combustible sweeping compounds may be burned to heat your shop if burned in an approved burning device.
Accidentally spill material	Many materials used in vehicle maintenance may be hazardous and can contaminate other wastes in the plumbing system.	Clean up spills immediately. Notify the Minnesota Duty Officer at 612-649-5451 or 800-422-0798 — if it is a petroleum spill of more than 5 gallons or if it is a spill of any material of any size that impacts soil or water. Have appropriate spill cleanup materials on hand and train employees how to properly use them.
Store solvents	Spilled or leaked solvents and their vapors are dangerous and can contaminate other wastes in the plumbing system	Keep containers sealed when not in use. Store solvents in a “flammables” cabinet. Do not use solvents near drains.
Store waste vehicle fluids in a room with a floor drain	Spilled or leaked solvents and their vapors are dangerous and can contaminate other wastes in the plumbing system	Keep containers sealed when not in use. Keep waste containers in a separate storage area with no floor drain. Install a curb or berm to contain any wastes that may leak from storage containers. Inspect containers for leaks on a weekly basis. See MPCA Hazardous Waste fact sheet # 2.41, <i>Documenting Container Inspections</i> .
Wash engines	The resulting wastewater is likely to be hazardous from greases, oils and solvents.	Only wash engines if absolutely necessary. If you do, separate the resulting wastewater and evaluate it.

*Solvents on F-list like methylene chloride, methyl ethyl ketone, tetrachloroethylene, toluene and xylene.

Flammable waste interceptor

According to MN Rules Chapter 4714, Section 1017.0, each interceptor shall be of watertight construction sized in accordance with sections 1017.1 and 1017.2, be provided with a water seal of not less than two inches on the inlet and not less than 18 inches on the outlet. The minimum size of the discharge drain shall be three inches and must be vented. The interceptor may be constructed of monolithic poured reinforced concrete with a minimum floor and wall thickness of six inches, or of iron or steel of a minimum thickness of 3/16 inch, or other approved materials protected with an approved corrosion resistant coating on both the inside and outside. The administrative authority must approve all interceptors.

The interceptor must be provided with a nonperforated iron or steel cover and ring of not less than 24 inches in diameter, and the air space in the top of the tank must have a three-inch vent pipe. It shall be constructed of approved metallic material, extending separately to a point at least 12 inches above the roof of the building or in accordance with MN Rules, Chapter 4714, Section 1017.1. Drains and piping from motor vehicle areas must be a minimum of three inches in size. Drains discharging to an interceptor must not be trapped and must be constructed so as not to retain liquids. A sand interceptor that meets the requirements of MN Rules, Chapter 4714, Section 1016.0 may be installed to receive wastes before discharging into a flammable waste interceptor.

No cleanout, mechanical joint, or backwater valve shall be installed inside the interceptor that could provide a bypass of the trap seal. Only wastes that require separation shall discharge into the interceptor. A backwater valve shall be installed in the outlet branch drain whenever in the judgement of the administrative authority backflow from the building drain could occur. An interceptor must be installed to be readily accessible for service and maintenance, and must be maintained by periodic removal of accumulated liquids and solids from the interceptor.

Maintenance

The flammable waste interceptor top oil layer needs to be cleaned regularly, a minimum of once per year, to keep oils and other potential chemicals from going to the sanitary sewer. Sediment may build in the flammable waste interceptor due to improper or insufficient cleaning of the sediment interceptor and may also need to be removed. When the flammable waste interceptor is in need of cleaning, follow these procedures:

1. Separate the top oil by using absorbent/hydrophobic pads and recycle with the used oil rags and sorbents. Another option is skimming or vacuuming it off the surface. This oil can be mixed with other used oil.
2. The middle water layer can be removed and temporarily stored in clean drums. After the sediment is removed, the water can return to the flammable waste interceptor.
3. Remove sand from tank.
4. Properly dispose of sediment/sand. See following section on Bottom Sand/Sediment Layer Management.

Bottom Sand/Sediment Layer Management

1. Can be disposed in an Industrial Landfill. All liquids must be removed/separated from sand prior to disposal. The landfill must be contacted and arrangements made prior to use.

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2. Can be managed in an Asphalt Plant. All liquids must be removed/separated from sand prior to disposal. The Asphalt Plant must be contacted and arrangements made prior to use. The facility must have an air quality permit, water quality permit, and pass a Mn/DOT Environmental End Site Audit.
3. Facilities can contract out cleaning, transport, and disposal through a licensed Maintainer.

Collection

The Minnesota Plumbing Code sets several definitions related to SSTS.

Building sewer as the part of the horizontal piping of a drainage system that extends from the end of the building drain and that receives the discharge of the building drain and conveys it to the public sewer, private sewer, private sewage disposal system, or other point of disposal (co-defined in 7080.1100, Subp 10b).

Plumbing system means and includes all potable water supplies and distribution pipes, all plumbing fixtures and interceptors, all drainage and vent pipes and all building drains (including their respective joints and connections, devices and appurtenances) within the property lines of the premises. It also includes potable water treatment or using equipment (MN Rules, Chapter 4714, Section 218.0).

Soil pipe means a pipe which conveys the discharge of water closets or similar fixtures containing fecal matter with or without the discharge of other fixtures to the building drain or building sewer (MN Rules, Chapter 4714, Section 221.0).

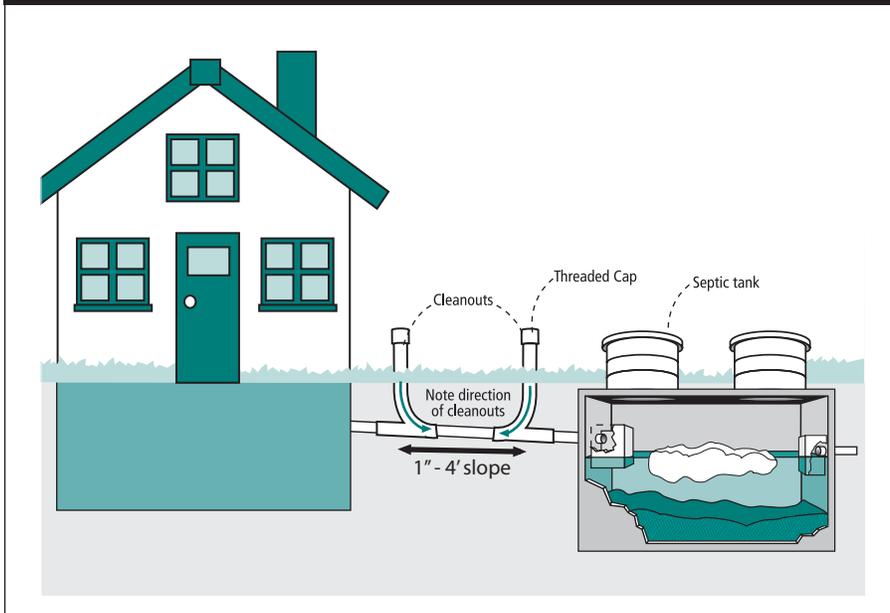
The piping is an important part of all onsite sewage treatment systems. Over the last 50 years, there have been changes in this component, particularly in the materials used for installation. Older components, such as cast iron and clay pipe, have been replaced by plastic materials. The application of the system determines the necessary pipe characteristics and how that pipe is installed. Applications can be divided into several categories. First is the building (or business) sewer that connects the treatment system to the user. Second is the supply pipe from the septic tank to another pre-treatment device, pump tank or the distribution system for final dispersal. Third is the supply pipe from a pump tank to some type of pressure distribution network. Finally, there is the gravity distribution pipe in soil treatment beds or trenches. Each application needs a specific kind, size and strength of pipe.

Building sewer

Definition, description, rule requirement

The building sewer is defined in the plumbing code MN Rules, Chapter 4714, Section 204.0, as the piping that runs from the structure beginning 2 feet outside the building wall to the septic tanks, as shown in Figure 6.3 (next page), or the sewer main in the road. Approved materials are identified under Table 701.1 of the Minnesota Plumbing Code. Plastic materials are recommended and used in all new construction. Typically, building sewer plastic PVC schedule 40 (ASTM D2665) is used from the home to the septic tank. This material may be installed in the same trench as water service.

FIGURE 6.3 Building Sewer With Cleanouts



Building sewers

Pipe material

According to MN Rules Chapter 4714, Section 301.1, Quality of Materials, all materials used in any part of a drainage or plumbing system should be free from defects. No damaged or defective materials should knowingly be installed. Further, all materials must be marked, unless otherwise easily identifiable, so as to provide a visual means of identification as to types, grades, weights, and strengths. The installer should, as far as possible, position the identification marks so as to provide ease of inspection by the administrative authority (MN Rules Chapter 4714,

Section 301.1.1, Identification of Materials). This means that the pipe should be installed so the lettering is viewable from the edge of the excavation. MN Rule Chapter 4714, Table 701.1 provides a list of materials approved for building sewers.

Determining load and the proper pipe size is an important step in installation. According to MN Rules Chapter 4714, Section 703.0 and Table 702.1, the load on drainage system piping should be computed in terms of drainage fixture units in accordance with subparts 2, 2a, and 3; the administrative authority may allow variations where it is shown by a hydraulic analysis of the piping system, submitted to the administrative authority, that such variation would result in a more desirable flow rate in the piping system (Subp. 1, Load on Drainage Piping). Pipe size is determined from subparts 2 and 3 on the basis of drainage load computed from MN Rules Chapter 4715.2300.

Chapter 4714, Section 703.2 and Tables 702.2(b) and 703.2. Maximum loads for horizontal drains in fixture units. Fixture units are defined as one fixture unit equals 7.5 gallons/minute pipe capacity. This information is portrayed in Table 6.1.

Design

Pumps in the basement

See Section 9 for information on pumps.

Separation technology

See section 5, 7 and 12 for more information on the design of graywater systems.

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TABLE 6.1 Maximum Unit Loading and Maximum Length of Drainage and Vent Piping

Size of Pipe (inches)	1 ^{1/4}	1 ^{1/2}	2	2 ^{1/2}	3	4	5	6	8	10	12
Maximum Units Drainage Piping ¹											
Vertical	1	2 ²	16 ³	32 ³	48 ⁴	256	600	1380	3600	5600	8400
Horizontal	1	1	8 ³	14 ³	35 ⁴	216 ⁵	428 ⁵	720 ⁵	2640 ⁵	4680 ⁵	8200 ⁵
Maximum Length Drainage Piping											
Vertical, (feet)	45	65	85	148	212	300	390	510	750	—	—
Horizontal (unlimited)											
Vent Piping Horizontal and Vertical ⁶											
Maximum Units	1	8 ³	24	48	84	256	600	1380	3600	—	—
Maximum Lengths, (feet)	45	60	120	180	212	300	390	750	750		

For SI units: 1 inch = 25 mm, 1 foot = 304.8 mm

Notes:

¹ Excluding trap arm.

² Except sinks, urinals, and dishwashers - exceeding 1 fixture unit.

³ Except six-units traps or water closets

⁴ Only four water closets or six-unit traps allowed on a vertical pipe or stack; and not to exceed three water closets or six-unit traps on a horizontal branch or drain.

⁵ Based on 1/4 inch per foot (20.8 mm/m) slope. For 1/8 of an inch per foot (10.4 mm/m) slope, multiply horizontal fixture units by a factor of 0.8.

⁶ The diameter of an individual vent shall be not less than 1 1/4 inches (32 mm) nor less than one-half the diameter of the drain to which it

is connected. Fixture unit load values for drainage and vent piping shall be computed from Table 702.1 and Table 702.2(b). Not to exceed one-third of the total permitted length of a vent shall be permitted to be installed in a horizontal position. Where vents are increased one pipe size for their entire length, the maximum length limitations specified in this table do not apply. This table is in accordance with the requirements of Section 901.2.

Using 4" piping for building sewers should be required for all applications.

Clay and Orangeburg Pipe

The following material through page 12 was created in cooperation with the Consortium of Institutes for Decentralized Wastewater Treatment. Vitrified clay pipe (with a salt glazing applied to both the pipe's interior and exterior surfaces) was the material of choice for a lot of building sewers in the past.

Orangeburg pipe is made from wood pulp and pitch. It was used from the 1860s through the 1970s, when it was replaced by PVC pipe. The name comes from the fact that most Orangeburg pipe was manufactured in Orangeburg, New York. Be careful handling Orangeburg pipe as it has often been treated with creosote to repel rodent and root invasion.

Ductile Iron

Ductile iron, also called ductile cast iron or nodular cast iron, is a type of cast iron which is much less brittle than cast iron. Ductile iron pipe is stronger and easier to tap and requires less support compared to other pipe materials. In some instances it may be appropriate or required to sleeve plastic pipe in ductile iron for road and stream crossings.

High Density Polyethylene

The use of high density polyethylene (HDPE) pipe is limited in onsite wastewater treat-

ment system installations because of cost. It may be the appropriate material for installations requiring a flexible piping in inaccessible, unstable, or shifting soil environments or where large temperature variations are expected. Other applications include trenchless installations like pipe bursting or horizontal direction drilling. It is commonly used at sites that require piping to be pulled through tunnels, under roads, or structures. This material can be pulled in long assembled lengths using special installation equipment.

Acrylonitrile Butadiene Styrene

Acrylonitrile butadiene styrene (ABS) is a widely approved drain-waste-vent pipe material. This material is available in Schedule 40 dimensions as specified in ASTM D2661. This specification covers fittings and single and coextruded ABS plastic drain, waste, and vent pipe (DWV) made to Schedule 40 iron pipe sizes (IPS). ABS is a good application for gravity-flow conditions, but it is not pressure rated.

Polyvinyl Chloride

Polyvinyl Chloride (PVC) is the most common pipe material used in wastewater treatment systems. It is a plastic pipe used in both gravity and pressure applications. PVC has many advantages over other piping materials:

- Light weight - half the weight of aluminum, one-fifth the weight of cast iron, and one-sixth the weight of steel
- Low friction loss due to its smooth and seamless interior walls
- Requires no special tools to cut and can be installed by cementing, threading, gasketing, or flanging
- Ease of installation, resulting in lower installation costs
- Corrosion free, both internally and externally, and inert to attack by strong acids, alkalies, salt solutions, alcohols, and many other chemicals
- Self extinguishing and does not support combustion
- High tensile and impact strength that can withstand high pressure for a long period of time
- Low thermal conductivity factor compared to metal pipe thus, piped fluids maintain a more constant temperature

PVC Standard Dimensions and Materials

As previously mentioned, PVC is the most common pipe material used in onsite wastewater treatment systems. PVC pipe manufacturers must follow accepted standards for dimensions and material strength. The installer must have some understanding of these standards in order to ensure that the correct PVC product is selected for the job.

Nominal Diameters

All pipes have a nominal diameter. This value is typically the nearest one-quarter or one-half inch value of the actual internal diameter. These nominal diameters are “name” only. By the standards listed below, each pipe size and material type must be manufactured with an internal and external diameter that meets the accepted tolerances.

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Iron Pipe Standard - IPS

Many PVC pipe products conform to IPS external diameter standards. This allows PVC (with IPS dimensions) to be fitted to standard steel pipe. PVC pipe that conforms to ASTM D1785 and D2241 have IPS external diameters.

Material Codes

PVC compounds range in strength and chemical resistance. In order to specify PVC pipe for a given task, material codes were developed to provide standardization. These codes provide information about the impact strength, chemical resistance, and hydrostatic design stress of various PVC compounds. For wastewater systems, most PVC pipe has a material code of PVC 1120 or PVC 1220. The material code must be known in order to compare the pressure rating of various combinations of external diameters and wall thicknesses.

ASTM International

ASTM International provides widely recognized standards for material performance and uniform dimensions. These standards are critical to the success of piping systems; manufacturers must follow these standards in order to ensure that the designers and installers can depend on pipe materials to withstand internal and external forces and depend on the standardization of pipe dimensions.

ASTM D1785 - Schedule 40, 80, and 120

This standard established the dimensions of Schedule 40, 80, and 120 PVC pipe. Pipe that has the “Schedule” designation has the same external diameter and wall thickness independent of pipe material. In other words, 2-inch diameter Schedule 40 PVC has the same external diameter and wall thickness as 2-inch diameter Schedule 40 steel pipe.

The higher the schedule number, the thicker the wall and the more pressure it can withstand. While Schedule 80 has a thicker wall than Schedule 40, for the same nominal diameter, the external diameter is the same for Schedule 40 and Schedule 80. Because the wall thickness increases, the internal diameter of Schedule 80 decreases. Thus, Schedule 80 can withstand more pressure but will transmit less fluid because of the reduced cross-sectional area.

For example: A 1-inch (25.4 millimeter) Schedule 40 pipe has an outside diameter of 1.315 inches and an inside diameter of 1.029 inches. Whereas a 1-inch Schedule 80 pipe has an outside diameter of 1.315 inches and an inside diameter of 0.936 inches.

ASTM D2241 - Pressure Rated, Standard Dimension Ratio PVC Pipe

This standard provides specification for the wall thicknesses and external diameter of various PVC materials that are needed to meet established pressure ratings. Standard Dimension Ratio (SDR) is a method of rating pressure piping. The SDR is the ratio of pipe diameter to wall thickness, as shown in Figure 6.4, and can be expressed as:

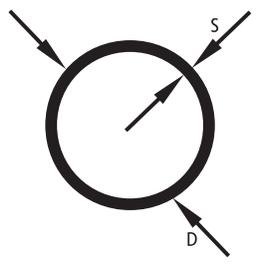
$$\text{SDR} = D / s$$

Where: D = pipe outside diameter

s = pipe wall thickness

For example: An SDR 21 means that the outside diameter (D) of the pipe is 21 times the thickness of the wall.

FIGURE 6.4 SDR
Pipe Dimensions



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TABLE 6.2 SDR and Pressure Class of PVC 1120 and PVC 1220

SDR	Class/ Pressure Rating [PVC 1120, 1220] (psi)
41	100
32.5	125
26	160
21	200
1.5	315

Relatively speaking, high SDR pipe has a thinner wall, and a low SDR pipe has a thicker wall. Thus, high SDR pipe has a lower pressure rating, and low SDR pipe has a higher pressure rating. Some SDR pipe is pressure rated by “class.” All pipes with the same class number have the same pressure ratings. A class/pressure rating is associated with SDR’s with a specific material designation. Example SDR ratios and pressure classes for PVC 1120 and PVC 1220 are shown in Table 6.2.

SDR and Schedule Comparison

Both SDR (D2241) and scheduled (D1785) pipe have outer diameters that are based on IPS, but their inner diameters differ. SDR pipes of the same outer diameter have larger inner diameters/smaller wall thicknesses than similar sized Schedule 40 pipe, as expressed in Table 6.3.

TABLE 6.3 Pipe Inner Diameter of Various Pipe Specifications, Uni-Bell, 2001

Nominal Diameter (inch)	Sch. 40	Sch. 80	SDR 26	SDR 21	SDR 13.5
	Inner diameter in inches (PVC 1120, 1220)				
1/2	0.622	0.546			
3/4	0.824	0.742		0.930	0.894
1	1.049	0.957	1.195	1.189	1.121
1-1/4	1.380	1.278	1.532	1.502	1.414
1-1/2	1.610	1.500	1.754	1.720	1.618
2	2.067	1.939	2.193	2.149	2.023
2-1/2	2.469	2.323	2.655	2.601	2.449

Additional Plastic Pipe Standards

For gravity applications, ASTM D 3034 and D 2729 pipe are typical plastic sewer main (PSM) specifications for both solid and perforated pipe. However, both materials must be approved by the plumbing authority prior to installation as alternates. Both materials are not approved for installation within 10 feet of water or at water crossings. These ASTM standards identify the required material, impact resistance, dimensions, stiffness, diameters (along with allowable minimal variations/tolerances), and thickness. These pipe standards are not for pressure-rated pipe; therefore, typical applications in onsite wastewater treatment systems are building sewers, piping between tanks and other components, and distribution system pipe for septic tank effluent.

In addition to ASTM, the American Water Works Association (AWWA) provides standards for plastic sewer pipe. Frequently, sewer mains need to connect to existing cast iron pipes. The standard dimensions for cast iron pipe are different from IPS. Thus plastic sewer pipe that conforms to AWWA C900 and C905 have the same outer diameter as cast iron pipe.

PW and DWV

Most PVC pipe is either approved for potable water (pw) or for use as a drain, waste, and/or vent pipe (dwv). This determination is made by NSF International. Most PVC pipe is marked NSF-pw (potable water) or NSF-dwv (drain, waste, or vent). This demarcation is especially important for PVC fittings. It is assumed that NSF-pw fittings are under pressure and, therefore, have more cement surface-area. Likewise, the NSF-dwv pipe is

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generally used in gravity-flow or low pressure flow situations, and these fittings have less surface area for bonding.

Storage and Handling

Although PVC is relatively resilient to damage, care should still be taken to prevent denting or scraping the pipe when loading, unloading, and storing the pipes. Damage can occur if tie-down straps are over tightened. Although the pipe is light, resist the tendency to throw or drag the pipe. Contact with sharp objects should be avoided. If any section becomes damaged, that piece should be cut out and discarded.

When storing pipe, protect it from direct sunlight, excessive heat, and potentially harmful chemicals. Pipe should be stored under cover or indoors if possible. When stacking the pipe, it is best to have the pipe with the strongest/thickest wall on the bottom of the pile. If long sections of pipes are stored on racks, make sure the pipe is supported along its entire length and not allowed to bow in the middle. Also, be sure to rotate stocks of stored pipe: the first pipe in storage should be the first out of storage.

Pipe Marking and Identification

All PVC has external markings along its length. The standardization for the markings has the manufacturer's name or trademark, the standard to which it conforms (for example ASTM), the nominal pipe size, and the material designation code. That information is followed by the pressure rating if it is meant for pressure or DWV if for drainage. Next, the markings indicate standard dimension ratio (SDR) or schedule number. Lastly, a marking indicates whether the material is approved for potable water use (Harvel, 2006). An example of these marking is shown in Figure 6.5.

FIGURE 6.5 PVC Markings



3/4" Brandname PVC-1120 SCH.40 PR 480 PSI @ 73EF ASTM D-1785 NSF-pw

Pipe Colors

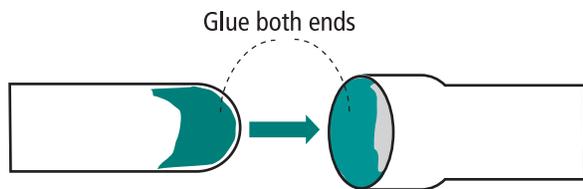
PVC materials can be made in many colors. Plumbing codes usually dictate pipe colors for various applications. Some of the typical applications and pipe colors are:

- White: sewer and water
- Blue: water
- Green: sewer and water
- Purple: water reuse (treated sewage being reused)
- Yellow: gas
- Gray: electrical
- Red: fire

Fittings and Joints

Overlapping joints are used to connect pipe lengths and fittings. Whether using threaded or solvent-welded connections, there is an expanded-diameter section that allows entry of the previous pipe. The expanded-diameter portion is the female end and it is often called a socket, bell, and/or hub. The male end is frequently called a slip or spigot.

FIGURE 6.6 Pipe Cementing

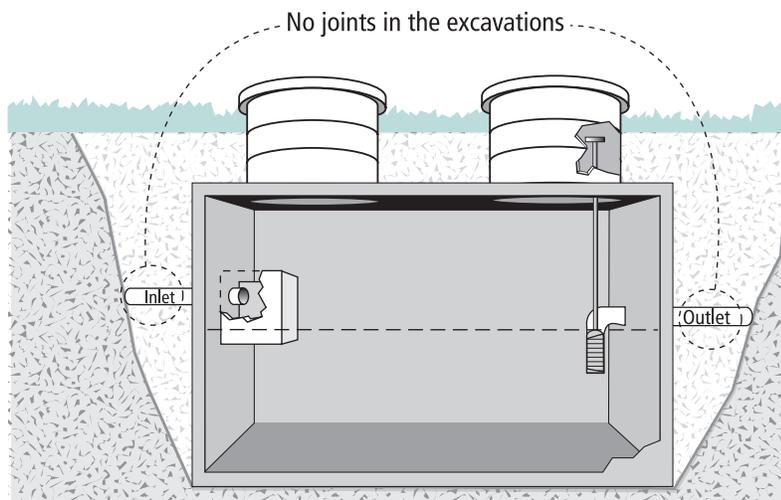


1. Measure
2. Cut and test fit
3. Deburr
4. Bevel
5. Apply primer (purple) and cement
6. Insert and twist $\frac{1}{4}$ turn

An advantage of PVC pipe is the ease of connections. In onsite wastewater applications, the most common means of connecting pipe is with solvent-welded fittings. A strong solvent is used to chemically weld pipe sections, as shown in Figure 6.6. Sometimes called “gluing” or “cementing,” solvent welding provides a mechanically strong and watertight seal. As shown in Figure 6.7, joints should not be placed in areas of excavation.

PVC pipe can also be jointed with gasket fittings. This connection style uses a bell end that contains one or more molded gaskets or o-rings. The spigot end is pushed into the bell, and the o-rings provide a watertight connection. This is not a rigid connection; if the pipes and fittings are not supported by overburden or by mechanical fasteners, then water pressure within the pipe will force the fittings apart.

FIGURE 6.7 No Joints in Excavated Areas



Fittings

Among other uses, fittings are used to transition between pipe diameters, provide directional changes, and convert between solvent-welded and threaded connections. The most common fitting is a coupling, which is used to connect two sections of pipe. When many lengths of pipe are assembled, pipe should be specified that has an integral bell on one end. This eliminates the need for a coupling between the pipe lengths. A coupling adds two connections in a line that provide additional potential locations for leaks and clogs.

Couplings can be specified that transition into different pipe diameters. A “bush-

ing” fits into a pipe hub to reduce the diameter for a smaller pipe spigot. A “reducer” connects the spigot ends of pipes with different diameters. Elbow or “El” are angled joints and allow the pipeline to change directions. Fittings are available that provide 22.5-, 45-, and 90-degree directional changes.

Most fittings have a hub (or socket) on each end. A street fitting contains both a hub on one end and a spigot on the other end. This fitting style takes up less space than two regular fittings connected with a short length of pipe. Place the spigot end of a street fitting on the downstream side whenever possible to limit catching debris.

Unions are fittings that provide a means of pipe-system disassembly. These fittings are easy to break apart. By placing a union on each side of a valve or pump, that device can be removed without damaging the pipeline.

All fittings increase the friction in a hydraulic system due to the added roughness in the transitions. The number and types of fittings can impact the required pump size. Multiple fittings can increase the required pump size.

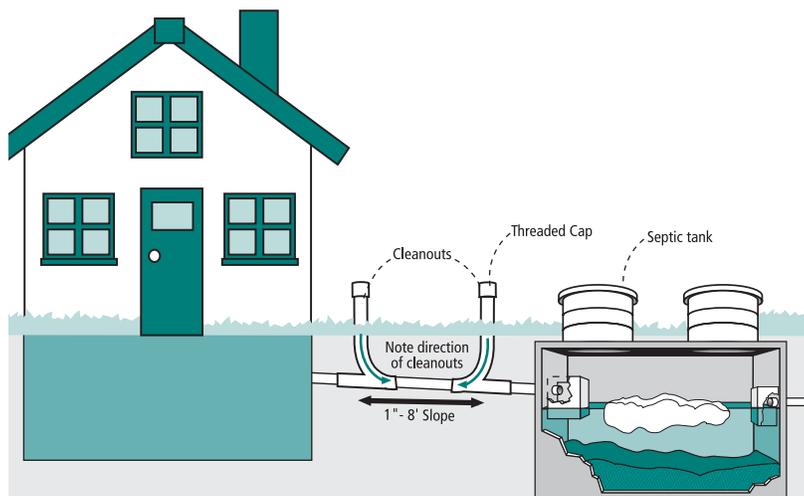
Slope/Grade

“Grade” describes the fall (slope) of a line of pipe in reference to a horizontal plane. In drainage it is usually expressed as the fall in a fraction of an inch per foot length of pipe (MN Rules Chapter 4714, Section 708.1). New systems use plastic pipe, typically PVC schedule 40, for building sewer applications. The choice of plastic over other materials, such as cast iron or clay tile, is related primarily to ease of care, handling and cost. Ease of handling includes the ability to make watertight connections between pipe sections to reduce root intrusion or leaking. For a building sewer that carries raw sewage from the house to the septic tank, the pipe must be at least 4 inches in diameter to accommodate toilet paper and large solids in the sewage. Because of the solids, there is a minimum slope necessary for this pipe to deliver the sewage to its destination. The two purposes for the slope in the sewer piping are to ensure movement of water and solids. In order to move water, the pipe has to point downhill. The typical minimum code requirement to maintain water flow in 4-inch pipe without allowing solids to settle is a slope of 1 inch in 8 feet, or 1/8 inch per foot (1.0 percent) his helps to maintain shallow systems. The plumbing code recommends a steeper slope [1” and 4’] where depth is not a concern. In the building sewer, sharp bends should be avoided. When 45- or 90-degree bends are necessary, use long sweep elbows that will allow a plumber’s snake to go through the sewer line. MN Rules Chapter 4714, Section 708.1, Pitch or Horizontal Drainage Piping states that horizontal drainage piping should be installed in uniform alignment at uniform slopes in accordance with the requirements detailed below.

Cleanouts

A cleanout is important for all systems. Installing a cleanout at the wall outside the home or business is a good idea if the system ever needs to be jetted or cleaned as shown in Figure 6.8. This cleanout allows all this work to be done outside, so any mess stays outside. Inside the home, there is potential for the cleanout to be hidden and the possibility of a major spill. They can either be one direction to clean the pipe either forward or backward or two directional to clean in both directions. Cleanouts should be accessible at the surface and located in a protective enclosure such as a valve box.

FIGURE 6.8 Cleanouts



There should be at least two cleanouts in the building drain, one at or near the base of the stack and one near the connection between the building drain and the building sewer. The cleanout at the outside wall may be inside or outside the building, should be made with a full “Y” branch fitting, and should extend at least two inches above grade or finished floor, except when the administrative authority grants permission to use a flush cover in traffic areas.

The cleanout should be of the same nominal size as the pipes they serve: up to four inches in diameter and not less than four inches for larger piping. The distance between cleanouts in horizontal piping should not exceed

100 feet in straight runs and for each aggregate horizontal change in direction exceeding 135 degrees (MN Rules, Chapter 4714, Section 719.1).

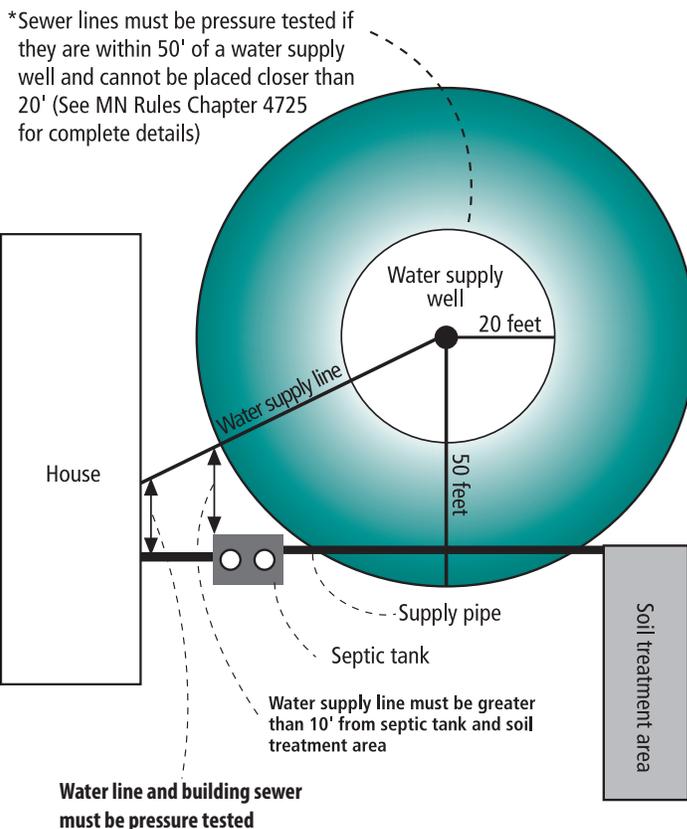
The riser pipe on the cleanout should be made to standard pipe sizes, conform in thickness to that required for pipes and fittings of the same material and extend not less than one-fourth inch above the hub. The cleanout cover or plug should be of brass, cast iron, or approved plastic. Neoprene or norden rubber with a plastic disc and a single stainless steel (300 series) band may be used for a cleanout cover provided that it is exposed and readily accessible. Section 707.1 states that plugs should have raised square heads or approved countersunk rectangular slots.

Each cleanout, unless installed under an approved cover plate or left flush with the finished floor, should be at least two inches above grade, readily accessible, and should not be covered with cement, plaster, or other permanent finish material.

Setbacks

Setbacks refer to the required separation distances based on safety or environmental concerns. The main safety issue is to separate pipes carrying wastewater from water supply pipes. This reduces potential for drinking water contamination. To help promote separation of the two, different-colored pipes are typically used, although not required: blue for drinking water, green for sewage. Purple pipe is used for treated wastewater that is to be reused for another application. In many states this treated effluent is used for irrigation water on landscapes.

FIGURE 6.9 Pressure Testing Requirements



A safety issue aside from separation of wastewater and water supply pipes is to assure the sewage pipe does not leak. This requires proper gluing techniques, and upon completion, a pressure test should be conducted before the piping has been backfilled. This makes it simpler for any required repairs, but also means an installer needs to be careful backfilling the trench to avoid any breaks. Refer to Figure 6.9 for a detailed illustration for the setback between the building sewer and the water supply line.

For your building sewer and other piping, the setback distance is the same as for a clean water line: 10 feet for water lines from the sewer is required. For the well itself, the setback to the building sewer is 50 feet without pressure testing. With pressure testing, it is 20 feet if the sewer is made with approved materials. Pressure tests are conducted by plugging the pipe at both ends and adding compressed air. It is important

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to have a method to add air and measure the pressure in the pipe. Air pressure is raised to a set level, typically 5 to 15 pounds. The pipe then should hold this pressure for 15 minutes (MN Rules Chapter 4714, Sections 609.4 and 712.0). If the pipe and joints can hold this pressure, it is considered watertight. Along with a pressure test, the proper paper work must also be completed and signed for the Minnesota DOLI and submitted to the regional offices. The air tests should be applied to the plumbing drainage system

in its entirety or in sections. Sections which are found satisfactory need not be retested after completion of the entire system unless considered necessary by the proper administrative authority (MN Rules Chapter 4714, section 712).

A building sewer pipe may be in a common trench with water service pipe if the sewer pipe material such as ASTM D2665 or ASTM D1785 is approved for use within a building (see MN Rules, Chapter 4714, Sections 609.2 and 720.1). If the building sewer and water line are going to be run in the same trench the water line must be placed 12 inches higher than the sewer and water pipe must be on a solid shelf at least 12 inches horizontally from the sewer in the excavation as shown in Figure 6.10.

The bottom of the water service crossing a sewer of clay or materials not approved within a building must

be at least 12 inches above the top of the sewer (see MN Rules, Chapter 4714, Sections 609.2 and 720.1). The water service should not contain any joints or connections within 10 feet of the crossing as shown in Figure 6.11. The materials used for both applications are detailed more specifically in the plumbing code.

Collection Design

The collection system delivers effluent to the first pretreatment component. This can be accomplished by either gravity or pressure. In gravity systems, 4-inch pipe is used. With larger flows, larger pipe sizes are used. A minimum flow rate of 2 feet per second is necessary to properly move the solids through the system because effluent traveling slowly can potentially cause build-up of solids over time. The 1-inch in 8-foot slope is necessary for 4-inch pipe to achieve this flow rate. For larger diameter pipe, a lower slope will maintain these velocities. Make sure that there are clean outs every hundred feet to allow access for maintenance. As the system becomes larger, ensuring this condition becomes more complicated. **Collection of greater than 2,500 gallons per day of sewage from multiple buildings or multiple other establishments discharging into an ISTS must be:**

FIGURE 6.10 Water Supply and Sewer in Same Trench

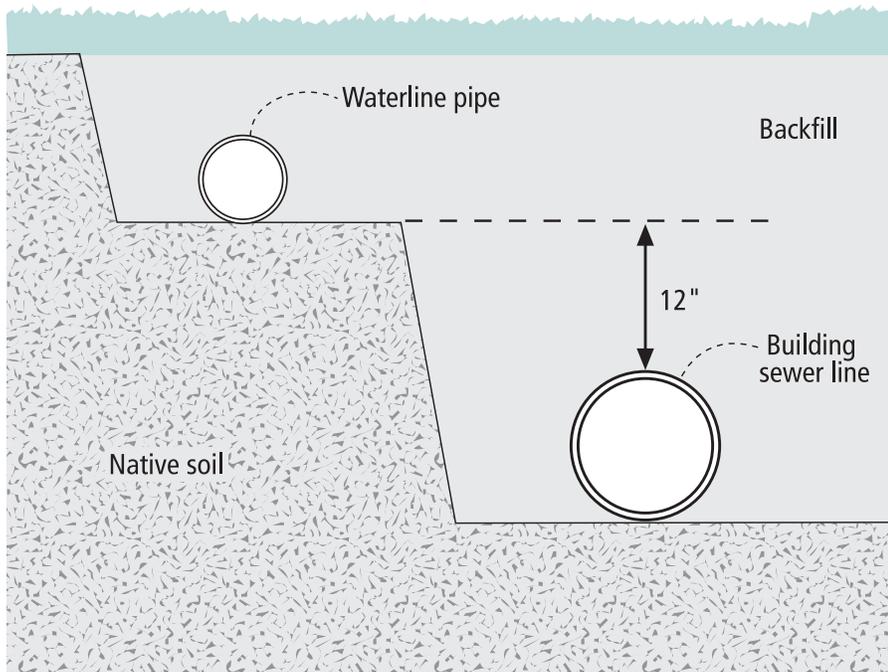
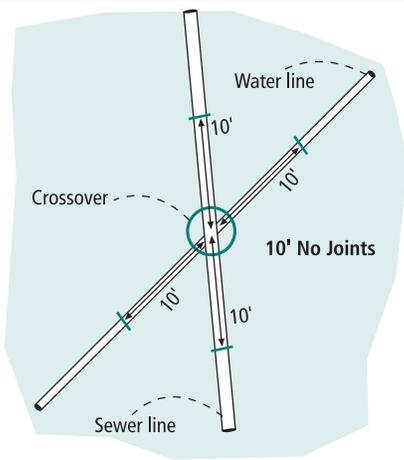


FIGURE 6.11 Water and Sewer Line Cross-over



A. according to the Prescriptive Designs and Design Guidance for Advanced Designers, incorporated by reference under part 7080.1550, Subp. 2; or

B. designed by a Minnesota licensed professional engineer (MN Rules Chapter 7080.2440).

For pressure collection systems, there are two options for the application. The first option is grinder pump stations and grinder pumps. These systems move the effluent directly from a structure and have relatively small tanks. This will lower the capital cost and lessen some of the costs for installation. However, as a result of using a grinder, all of the solids will be smaller, potentially adding to treatment problems and capacity issues in the septic tank.

The second option is septic tank effluent pumps [STEP]. These systems insert a pump following or with a pump vault in the septic tank. The advantage of this is that solids are not being moved, so all the piping systems can be smaller. Further, it's easier to treat the effluent since some of the treatment facilities are incorporated in the structures of the homes. The downside of this is that multiple maintenance locations have to be added to the septic tanks being employed at the homes. All piping systems should be designed to drain effectively; for gravity systems, the drain is always towards the next treatment component.

Installation

The installation of plastic material sewers must comply with ASTM D2321, which requires open-trench installation on a continuous granular bed (see MN Rules, Chapter 4714, Section 718.1). All plastic pipe materials need to be placed on a solid base. The base can either be granular fill, or when appropriate, natural unexcavated soil. If the soil is excavated and then backfilled it must be compacted in 6 to 12-inch lifts. In order to properly backfill around the pipe, the trench bottom should be at least three times the diameter of pipe. This means that for 4-inch piping, a minimum of a 12-inch trench is necessary.

The identification of the benchmark is step number one for the installation of the piping. Relating back to this benchmark for both actual surface elevations and the pipe flow lines is critical for the proper installation of the system. Be sure that all of the crew understands the proper readings of the laser and target for the elevations of the pipe flow lines. Do not run the supply line through the absorption area. In mound systems this typically creates the location of the pressure manifold. Running the pump in the same trench as the gravity supply line for drop boxes can minimize excavation work.

Remember that the proper slope is required on the pipe:

For gravity systems: 1 inch per 8 feet going towards the next treatment component.

For pressure systems: 1 inch per 8 feet returning back to the dosing chamber.

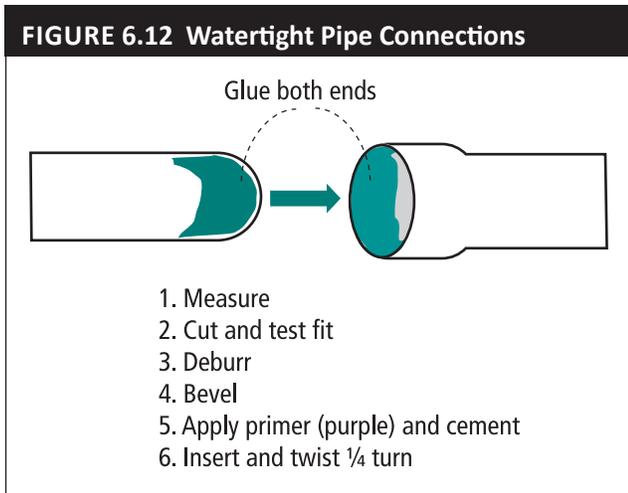
Beginning excavation

The excavation should follow the designated pathway for the pipe. Good pipe installation procedures as discussed above should be followed. Be careful not to over-excavate, which will require additional work. It is best if the pipe can be bedded on natural soil, which will minimize settling, which can cause deflections or bellies to form in the pipe.

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If the excavation is in any organic material, such as peat, it should be removed from the excavation. Bring an inorganic (sand or pea rock) base back to the required elevation to support the piping. Use a gradation that minimizes the migration of materials when using rock for bedding and haunching.

The key for any sub base is to make sure that there will not be any settling or bellies in the pipe.



Pipe Cutting

Proper pipe cutting is critical to ensure that a watertight seal is created between pipes and fittings. Figure 6.12 illustrates the proper process. Below is a narrative outlining the recommended procedure for cutting pipe:

- **Prepare:** Examine the pipe to ensure that it is not damaged with cracks, gouges, dirt, and abrasion. If the pipe end is imperfect, cut it back to expose good material. Discard a damaged fitting. The pipe and fittings should be at the same temperature to ensure a proper joint between the two components.
- **Cut:** The pipe must be cut square at the end using a PVC pipe cutter, hand, or chop saw. Make sure that the end of the pipe diameter is not compromised and remains circular.
- **Deburr:** Cutting PVC pipe nearly always creates burrs on both the inside and outside edges of the pipe. Make sure all burrs from cutting are removed with a file, knife, or other deburring tool on both the outer and inner surface of the pipe end. If burrs are left on the end, they will scrape cement from the inside of the fitting as it is being pushed in, resulting in a non-watertight seal. Burrs on the inside pipe surface can snag hair or other debris, plugging up the pipe. With gloves on, run your fingers around both edges to feel for any burrs that might have been missed.
- **Bevel:** Before connecting the cut-end, bevel the end 10 to 15 degrees with a file or reamer. This prevents cement from being pushed aside by the square ends of the cut pipe. You can now apply primer and cement to both ends of the fitting. Insert the male end and twist the pipe $\frac{1}{4}$ turn.

When using pipe lengths that have spigot and bell ends, the pipes should be arranged such that the flow travels from the bell end to the spigot end. This avoids a lip which can catch material.

Excavation and Backfilling

These two steps are related, since problems with the excavation will create problems in backfilling. The right material, proper location and the following three simple rules can help your system always move effluent the right way.

Rule 1: Avoid over-excavating the trenches when possible. If wastewater is to flow properly, the pipe must be supported. Unsupported pipe can lead to clogging and freezing problems. By minimizing unexcavated soil under the pipe, you reduce potential for development of low spots where water can collect. In general, natural soil provides a

solid base (unless you work in organic or peat soils). If the trench is over-excavated, you will need to compact the soil before you place the pipe. When placing pipe in organic soils, remove the organic material and replace it with a solid material or rock with appropriate gradation. Organic soils - peat and muck - do not provide a solid base, and settling and heaving are likely to take place. This movement puts pressure and stress on the pipe and will cause leaks at the joints. More important, the pipe will not maintain the proper pipe slope.

Rule 2: Support the pipe over deep excavations. If you removed material, like organic soil, or if you installed a sewage tank and the piping going in and out of the structure, the pipe will be at least partially on fill, and this can settle. To minimize problems, use a granular fill material and compact it as the material is installed. Sand or rock is most typically used as fill. If too large of a rock is used, silting into the rock is a form of settling that can cause an aesthetic problem like a depression in the yard. Rock also can create a drain system that channels groundwater into sewage tanks. The pipe material itself can also provide support. Using a heavier pipe (such as Schedule 40) helps minimize bowing. In pressure supply pipes where 2-inch pipe is used, the smaller pipe can be placed inside a 4-inch pipe, adding strength and decreasing the potential for bowing. Be sure that the 4-inch pipe is sealed to avoid having a pipe full of soil or groundwater.

Rule 3: Backfill with good material. The backfill material has two jobs: protecting the pipe system and maintaining the slope. Protection means the pipe is surrounded by and covered with the material, providing some protection from freezing. For this to occur, the backfill must be all around the pipe. It is crucial to be careful of large stones that can damage the piping during the backfilling process. The strength of the pipe is related to its round shape. If the shape is deformed, the strength is reduced, and that can lead to failure. To minimize the weight of the cover and the potential for collapse, apply granular backfill at least to the midway point of the pipe.

Plastic pipe needs to be covered to protect it from UV rays and other surface activities that can cause failure. Lawn mowing and traffic over excavations can break and crack the pipe. You can minimize these problems by creating a backfill system that properly supports the pipe. Avoid using large stones, as these also can damage the pipe during backfilling. Big rocks should not be returned to the trench in contact with the piping. In heavier clay soils, dry soil clods can act like rocks, so don't use them to backfill the excavation. Using a granular material in contact with the pipe will minimize the impact of soil clods.

Embedment

When multiple pipes are running in the same trench or in to a component, the installer should label the pipes with either a permanent marker or with a stamp to aid in future troubleshooting. It is recommended to place a marking every 20 feet and at any location where a portion of the pipe or cleanout is visible.

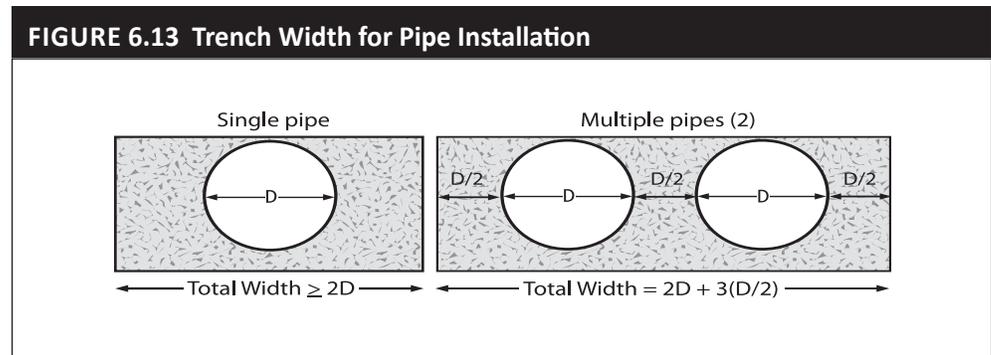
When piping needs to be installed in areas near a septic tank or advanced treatment unit excavation, it is best if the pipe is supported by undisturbed soil instead of running it across the top of the tank or unit. This can be done by creating a bench.

Embedment Methods

Trenches need to be dug and prepared in a way that the pipe is protected from dam-

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age. Trench bottoms should be free of rocks and debris and provide uniform support. If there is bedrock, hardpan, or large rocks on the trench bottom, the trench should be bedded. Particularly on long runs with small-diameter pipe, the trench width (TW) should be wide enough to allow the pipe to be snaked from side to side and at least twice the pipe diameter (D). From Figure 6.13, TW must be equal to or greater than two times D. The trench backfill should also be free of rocks and debris.



Where multiple lines of pipe are installed in the same trench, they should be spaced far enough apart to permit thorough tamping of earth between adjacent lines with a minimum of 0.5 times the nominal pipe diameter apart.

Bedding material and its placement is of critical importance to installation and performance. It is essential that native and imported materials are properly classified for use in bedding. Many jurisdictions have their own bedding specifications which call for special material to completely cover the pipe; care must be taken to meet these requirements. Soil to be used as bedding in the pipe zone must be appropriately compacted.

When selecting embedment materials, make sure that native soil migration from the trench walls cannot occur. A well graded, compacted granular material prevents this. In trenches subject to groundwater inundation, the granular material should be compacted.

The trench bottom should be dry. Surface water draining towards the trench must be redirected. Installation of piping is much more difficult if water is in the trench due to the tendency for pipe flotation; therefore, dewatering is required to minimize these issues and the likelihood of instability of trench walls and slopes. Groundwater should not be permitted to rise above the trench bottom until after the installed pipe is fully bedded and enough fill is in place to prevent flotation.

The foundation is the underlying natural soil material. The bedding material is usually less than 6 inches thick in trenching but can be deeper around the tank, and provides continuous support of the pipe and underside of the pipe. If a coarse, granular material is used for bedding the pipe, it should also be used up to the midpoint of the pipe. Otherwise, side support may be lost due to the migration of finer material into the bedding.

As the pipe is installed, make sure the pipe does not bow; this is a sign that the pipe is too long. The pipe should lay perfectly flat. PVC will expand or contract 3.36 inches for every 100 feet of pipe per every 100 degree F change in temperature (Vinyl Institute, 2006). To compensate for the natural expansion and contraction, the pipe can be snaked from side to side in the trench. Ideally, the pipe should be installed and the trench backfilled during the cool part of the day.

The next layer is the haunching that comes from the top of the bedding to about half way up the pipe diameter (springline) and is a strong factor controlling pipe performance and deflection. Proper selection of haunching material is essential to PVC pipes' ability to support vertical loads. It is frequently a special material with sizes not exceeding 3/4 inch. The haunching procedure is to tamp the embedment materials under the haunches and around the pipe to the midline of the pipe to providing effective support. Following haunching, initial backfill is applied followed by final backfill.

Some piping excavations do not have vertical support walls above the piping. These excavations are backfilled with a similar approach. The bedding and haunching materials extend at least one pipe diameter to the side of the piping. The initial backfill material should extend to at least half the pipe diameter over the top and sides of the pipe. The final backfill fills the remainder of the excavation. This embedment approach is used when running piping through tank excavations or benches along tank excavations.

Finishing

Finishing should be done with a soil that will establish a vegetative cover. Make sure that there is a low crown on the finishing material to allow for settling. This material should meet the definition of topsoil borrow from [MN Rules Chapter 7080.1100 Subp. 88](#), **Topsoil borrow means a loamy soil material having:**

- a. less than 5% material larger than 2 mm, #10 sieve**
- b. no material larger than 2.5 cm.**
- c. a moist color value of less than 3.5**
- d. adequate nutrients and pH to sustain healthy plant growth**

Connecting Pipe and Fittings

Solvent welds, threaded connections, mechanical joints, and gaskets are the most common methods of connecting PVC pipe. In this manual, solvent welds with slip joints are the most common. These solvent welds will be referred to as “glued” and the solvent as “glue.” The solvents (PVC primer and cement) emit strong organic vapors, so always work in a well ventilated area.

Solvent-Welding

There are many key points to keep in mind when making glued joints:

- It is critical that the exterior and the interior of the pipe be clean and dry.
- Before priming and gluing, the fit of the connection should be tested.
- Primer is a mixture of solvents, similar to those found in the glue and is used to soften or “prime” the pipe and fitting prior to adding glue. A suitable primer penetrates and softens the surfaces more quickly than the cement alone. There is no substitute for primer. It is important to note that cleaners and primers are not the same thing. Do not use water, rags, gasoline, or any other substitutes for priming PVC surfaces.

There are many different types of primers on the market. They differ mostly by viscosity. It is important to make sure that the primer is appropriate for the pipe type, size, and air temperature. The primer and glue should not be adjusted or thinned by any means. If they begin to look jelly-like or their viscosity has changed, they should be discarded. MN Rules Chapter 4714, Section 705.7, states PVC solvent weld joints must include ASTM

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F656 purple primer and ASTM D2564 solvent cement. The most common color for primer is purple. Read the warning labels and take necessary safety precautions such as protective equipment for eyes and skin.

Primer should be applied to the fitting socket and the pipe end, making sure that the primer does not puddle inside the socket. Time must be allowed for the surface to soften. The amount of primer and time may need to be increased when the temperature is cold.

There are a variety of applicators for primer and glue. Daubers are typically provided by the supplier and can be used on smaller diameter pipe. Brushes, with natural bristles, can be used on any diameter pipe. Rollers are commonly used for 4-inch diameter and greater. As a rule of thumb, select an applicator that is at least half the diameter of the pipe.

In order to have an effective solvent-weld, apply sufficient glue to fill the gap between the pipe and fitting. The primer and glue work to dissolve the two surfaces. When the pipe is inserted into the fitting, the two surfaces blend and become one as the primer and glue evaporate. The joint strengthens as the PVC hardens, so it must be allowed to fully cure to reach its full strength.

It is important to use the right type of glue. Read the label as the wrong glue can melt the pipe. Brush on a coat of ASTM-rated glue, such as ABS, PVC, or Styrene, that is matched to the type of pipe and fitting you are using. As the wall thickness of the pipe increases, more viscous glue is needed. Glue must be applied to the inside of the fitting as well as the outside of the pipe. Do not allow the cement to puddle or run down the inside of the fitting. The pieces must be assembled quickly while the cement is still wet. If it dries before you have connected the pieces, then you must reapply the glue.

Push the pipe fully into the fitting while turning a quarter turn to distribute the cement evenly. The twist breaks up insertion lines and helps to spread the glue. The connection must be held firmly for 15 to 30 seconds to prevent the joint from pushing apart, providing the glue a chance to begin to harden. Wipe the excess bead of glue that forms on the outside of the connection to prevent the glue from continuing to dissolve the pipe.

The joint should not be disturbed until it has initially set. The amount of time the joint needs to initially set is dependent on the air temperature and humidity. Be sure to use a primer and cement that is appropriate for the weather conditions. Table 6.4 provides the recommended initial set times.

TABLE 6.4 Initial set time for a cemented PVC joint (Charlotte, 2007)

Temperature Range	Pipe Size	Pipe Size
	1/2 to 1 1/4 in.	1 1/2 to 3 in.
60° - 100° F	15 min	30 min
40° - 60° F	1 hr	2 hr
0° - 40° F	3 hr	6 hr

The joint should not be pressure tested until it has fully cured. The exact curing time varies with temperature, humidity, and pipe size. Table 6.5 indicates suggested curing times.

The cement and primer should be stored with the lid sealed and away from heat or open flames. The glue should only be used in a well ventilated area. The glue should be used

within one year of the date stamped on the container. Most importantly, all manufacturer recommendations must be followed.

TABLE 6.5 Minimum curing times for cemented PVC joints (Charlotte, 2007) with relative humidity 60* of less

Pipe Size	1/2 to 1 1/4 in.		1 1/2 to 3 in.	
Temperature Range	PSI		PSI	
	≤180	180-370	≤ 180	180-315
60° - 100° F	1 hr	6 hr	2 hr	12 hr
40° - 60° F	2 hr	12 hr	4 hr	24 hr
0° - 40° F	8 hr	48 hr	16 hr	96 hr

* For humidity above 60%, allow 50% more cure time.

Threaded Connections

Threaded connections are often needed when installing components in the pipeline. Male and female adapters are used to transition to threaded fittings. Schedule 40 and SDR pipe should not be threaded. Threading this material reduces the wall thickness, and the pressure rating of the pipe is reduced by 50 psi. If pipe nipples are needed, Schedule 80 has a thicker wall and can be threaded without significant loss of strength.

All pipe threads need to be sealed. Teflon tape is commonly used for wastewater piping systems. Pipe joint compounds, pastes, or other thread lubricants must be approved for use with PVC.

Threaded connections should be hand-tightened. At most, a strap wrench can be used for tightening. Over-tightening should be avoided as this can cause thread or fitting damage. When combining plastic and metallic threaded systems, it is recommended that plastic male threads be screwed into metallic female threads to prevent the plastic from being cracked by the expanding metal threads.

Mechanical Joints

Mechanical joints have four parts: a flange cast with a bell; a rubber gasket that fits in the bell socket; a gland, or follower ring, to compress the gasket; and tee head bolts and nuts for tightening the joint. Joint assembly is labor-intensive but very simple and requires only one tool- an ordinary ratchet wrench. The mechanical joint is flexible, with the amount of deflection dependent on pipe diameter. The mechanical joint is used mainly with fittings rather than pipe. This is due to the predominant use of push-on joints, which are more economical, faster to install, more trouble-free, and offer better service than mechanical joints.

Lubrication of the plain end, socket, and gasket during assembly of mechanical joint is typically recommended. Use soapy water or approved pipe lubricant during mechanical joint assembly to improve gasket sealing and long-term performance. Do not use PVC glue or petroleum-based lubricants.

Gaskets

Some types of PVC pipe are connected with gasket joints. Sometimes the gaskets are part of the pipe (bell-end) while other times they are separate fittings. The gaskets must

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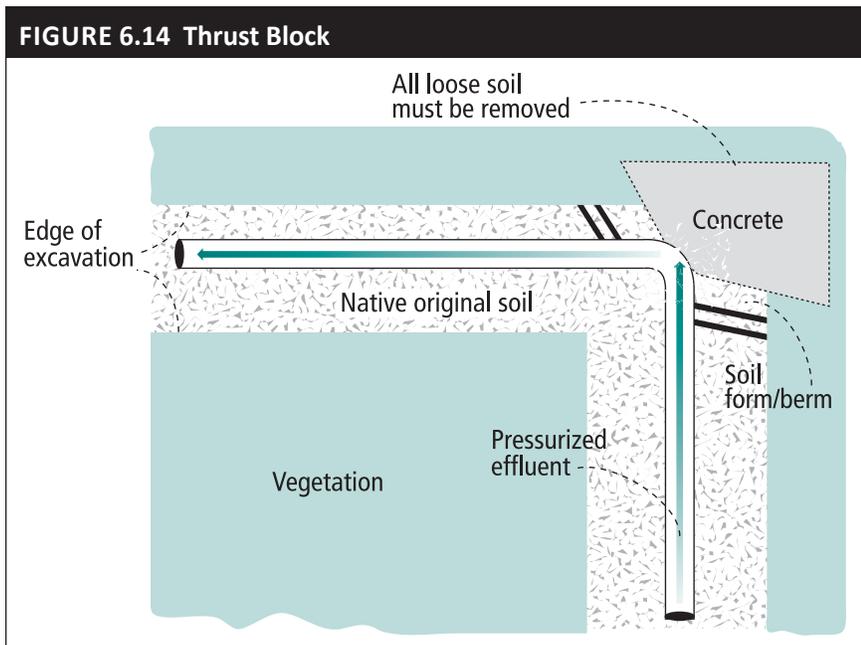
be clean and dry before installing. Both the gasket groove and the spigot should be clean and dry prior to making the connection. A lubricant is needed to make the connection based on the manufacturer recommendations. The lubricant is applied to the spigot end of the pipe. A good joint is made when the insertion line of the spigot end of the pipe is lined up with the edge of the bell that the spigot is inserted.

Thrust Blocks

In pressurized applications, the initial force caused by starting a pump can stress pipe connections. When effluent initially flows through an empty pipe, air is the only restriction to water flow. The air moves quickly and the effluent is typically flowing at a greater than normal velocity. When the effluent reaches an elbow, it must change direction. The effluent hits the back wall of the elbow which absorbs the force and directs the effluent around the corner and further along the pipe. This initial impact of the flow can cause tremendous forces on elbows and junctions in the system, and as a result they need to be reinforced with thrust blocks. Basically a thrust block is a rough block of

poured concrete which braces the pipe and helps prevent ruptures in the line, as shown in Figure 6.14. The concrete is poured on the outside of an angle fitting and extends back to native soil. The purpose is to prevent surges in flow through a pipe from flexing the fitting and wiggling it in the ground. This would over time form a larger and larger underground space, possibly allowing the pipe fitting to pull apart.

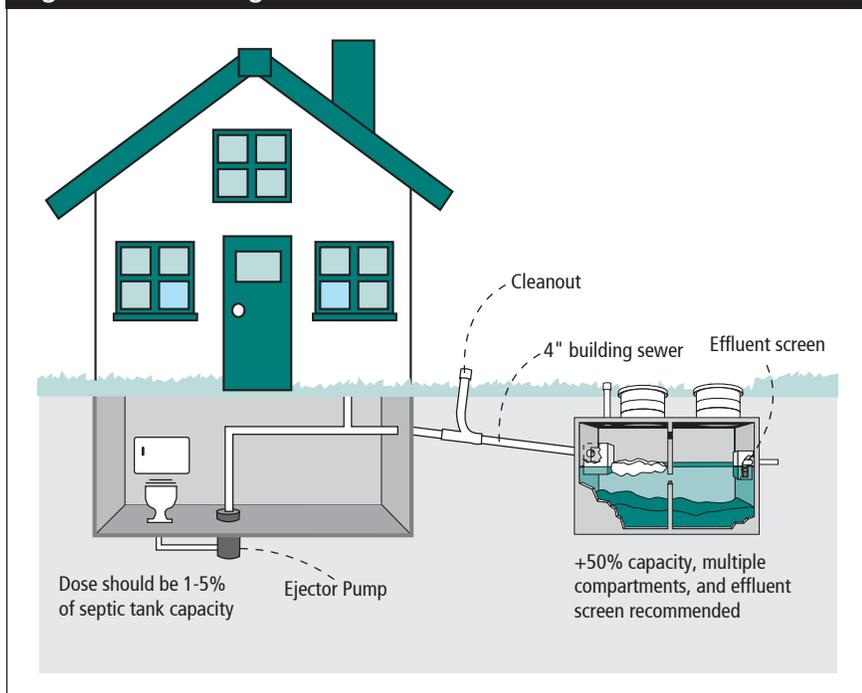
Gasketed pipe and fittings must have thrust blocks or mechanical connections. The size and location of thrust blocks should be provided in the design. Consult with the system designer if you are unsure.



O&M and Troubleshooting

Long-term management of this pipe requires access to the pipe. If there's a problem, this access is used to clean the piping. These cleanouts can be located either near the house or near the tank. Many maintainers would appreciate having a cleanout in both locations, but if there is easy access into the piping in the septic tank, the location at the house may not be necessary. A cleanout near the house is beneficial for cleaning and other work. The clean out should be made of the same materials as the pipe. It should be the same size and a sanitary "Y" for easy access to the pipe. It should be a threaded plug or cap that is easy to take off. In Figure 6.15 (next page), the injector (sewage) pump must meet the requirements of MN Rules Chapter 4714 Section 710.3 and be connected to the plumbing venting system (MN Rules Chapter 4714, Section 710.10). The key for operating the building sewer is to assure that effluent drains through the pipe by preventing buildup plugging and freezing. Good management can maintain and extend the life of the system.

Figure 6.15 Building Sewer Maintenance



Plugging

The first issue, plugging, is related to use. Large solids that do not belong should be kept out of the piping, and toilet paper use should be minimized. Powder detergent can add to clogging problems in cast iron piping by actually precipitating caking inside the piping. A common location of plugging in new systems is at the inlet baffle in the septic tank. This is created when the piping is installed against the baffle. Be sure to have at least a six-inch separation between the pipe inlet and the baffle.

An issue related to plugging is the impact of roots on the piping. This is typically related to pipe materials and installation. If the proper plastic piping is selected, properly bedded, and installed with watertight joints, the roots will have a difficult time entering the system. If the system has older (clay, cast

iron, Orangeburg) materials, replacement of the piping is the right answer for long-term performance.

Other major management concerns include the following installation issues. As the pipe is installed close to structures or decks, it becomes more difficult to maintain the pipe at proper slopes and to make good connections. The need to clean and replace pipe is the reason for specifying setback requirements from structures. Typically, 10 to 12 feet will allow the excavator to work on the piping around the structure. Decks become bigger problems because they are often built after the pipe is installed. The pipe can be crushed or broken during installation of the footings. Installers must work with homeowners to understand the importance of avoiding the pipes and planning for access in case future repairs are needed.

Freezing

In addition to plugging, freezing is a common problem that can be avoided with good management. In cold-weather areas, pipe needs to be protected from freezing. Methods to minimize freezing include making sure that the pipe is properly installed and insulated if the system is placed under a pathway or drive. This installation can take the form of purchasing insulated pipe or installing the insulation over the top of the excavation with the proper insulating products. Insulated pipe has two benefits: the insulation surrounds the pipe, and the insulation gives the pipe some additional resistance to settling. Some engineers will design the pipe at a deeper depth. This may help with the insulation; however, it may also create system issues and is not the recommended solution for cold weather. It drives the rest of the system deeper and creates a higher potential for the system to be in saturated soil conditions where leakage becomes more critical.

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In city sewer systems, freeze protection is often accomplished by making sure the pipe is installed deep underground (6 to 8 feet), but in onsite systems this depth is not always available. If the bury depth is shallow, or if the pipe is under a driveway or sidewalk, it should be insulated. Traffic over the system will drive the frost deeper, increasing the potential for freezing.

There are two methods to insulate pipe. You can buy pipe with insulation attached, which is more expensive than standard piping. The other option is to install foam sheets over the pipe. Make sure you choose insulation designed for use underground. Fiberglass batting is not designed for such applications. In addition to providing insulation, it also gives the pipe more rigidity, preventing settling that results in bellies or low spots in the pipe where freezing can occur.