OntarioOnsite WastewaterAssociation

OOWA's Guidance Document Series: Flow Distribution

Produced by the OOWA Onsite Technical Committee

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1.0 Overview and Objectives

All onsite wastewater systems include flow distribution. Examples include distributing septic tank effluent to multiple runs in a leaching bed, distributing effluent among multiple cells in a large leaching bed or multiple independent leaching beds, or splitting septic tank effluent among multiple advanced treatment units.

Flow distribution is defined as the process of conveying wastewater or effluent to more than one component of a sewage system.

Proper flow distribution is important, because good flow distribution allows for proper treatment and infiltration of septic tank effluent to occur within leaching beds. Effluent must be split evenly between all runs in a leaching bed in order to utilize the entire bed. On the other hand, uneven or poor flow splitting can lead to overloading portions of the leaching bed and premature failure. Proper distribution of flow among multiple treatment units ensures the system performs as intended.

Typical methods of flow distribution include gravity distribution using symmetrical tee headers, distribution boxes and siphons, and pressure-based distribution using pumps, distribution valves and orifice plates.

The choice of gravity or pressure flow distribution depends on owner preferences, site conditions, and size of the system. In general, small systems tend to use gravity-based distribution methods while larger systems tend to use pump-based (i.e. pressure-based) distribution methods. In some instances, pump-based flow distribution is a regulatory requirement. For example, the Ontario Building Code (OBC) 8.6.1.3.(1) notes that at least one pump or a siphon must be used where the total length of distribution pipe or leaching chamber is 150 m or more. The rationale behind this requirement is that a slug dose by the pump or siphon will improve the movement of effluent throughout a leaching bed as compared to trickle flow (MOE 1982).

For large systems, the Ministry's Design Guide for Sewage Works (MOE 2008) notes that pumps provide the most reliable means of alternately dosing multiple leaching beds, with the pump typically discharging to a distribution box and subsequent gravity flow to the laterals.

This guidance document discusses the recommended ways and means of distributing flow over a physical space. However, flow can also be distributed over time by, for example, using timer control for pumps and balancing tanks to store flow over one or multiple days. Flow distribution over time is not discussed here, and the reader is referred to OOWA's other guidance documents on flow balancing and pump chambers.

Note this document discusses current best practices. Inspection of existing systems may reveal flow distribution techniques which are no longer in common use, such as a header fed from one end or a fantail arrangement. These older configurations which are not in current use are not discussed here.

2.0 Gravity Distribution

Gravity flow distribution considers siphons, distribution boxes and headers. Refer to Appendix II for diagrams illustrating flow splitting configurations.

2.1 Siphons

A siphon is a method of providing a volume-based dose to the leaching bed as an alternative to a pump that does not require any mechanical or electrical components. A siphon works well in situations with sloping sites, where adequate fall can be achieved from the depth of the siphon tank below grade, to the leaching bed, as there is a significant pressure differential required between the siphon and the leaching bed. See Onsite Installer 2014 & 2015 for articles. Historically, siphons were commonly used in larger commercial sewage systems to provide dosing to large in-ground leaching beds, but pump systems are now most commonly used.

The siphon consists primarily of a bell and a trap, and is typically housed in a siphon chamber. As the effluent level rises in the tank, it will eventually provide enough pressure to trip the siphon, which releases the volume of liquid that has accumulated, providing a set volume dose to the bed. The leaching bed must be at a lower elevation than the siphon, which may preclude its use on sites that are relatively flat, or if a raised leaching bed is required.

Considerations for siphon design:

- Is there adequate fall from the location of the siphon to the leaching bed?
- Required dosing volume and size of siphon tank
- Size of siphon and discharge diameter
- Provide venting and a high-level alarm on the siphon chamber
- Provide access for regular inspection and maintenance

It is important to recognize that siphons themselves do not split the flow. The siphon merely doses the leaching bed with a slug of wastewater. It is the larger slug volume which is presumed to push the wastewater to more laterals and flow farther along each lateral as compared to trickle flow.

Although they do not contain mechanical or moving parts, siphons can still malfunction and should be inspected regularly. Siphons can be susceptible to leaking or clogging, and require regular maintenance and cleaning. Older or malfunctioning siphons that are clogged will often function as any other trickle-feed gravity system, which eliminates the dosing benefit they are intended to provide.

2.2 Distribution Boxes

Distribution boxes can be concrete or plastic. The selected size for the distribution box should be appropriate for the daily design flow. A larger distribution box may be advantageous even if all of the outlets are not used, as it is more likely to be installed level, and typically comes with an influent baffle to reduce inflow velocity in pumped systems. One advantage to a distribution box over a header is the ability to equip the box with access at grade for regular inspection and maintenance. Completely buried distribution boxes can sometimes be forgotten and with deterioration over time, can contribute to blockages, uneven distribution or even overflows of effluent. Note that plastic distribution boxes are available if deterioration of concrete is a concern.

Considerations for distribution boxes:

- Install the distribution box on firmly compacted soil, sand, gravel or granular materials to prevent settling which can lead to uneven distribution
- Distribution boxes receiving effluent from a forcemain should include an inlet baffle or flow reducing gravity pipe inlet.
- Each time the flow is split by a distribution box or header, it increases the chances of uneven distribution occurring; keep the number of times flow is split to a minimum if possible. This is particularly important in larger leaching bed systems.
- Flow equalizers should be installed on distribution box outlets to allow adjustments for more even distribution if the box settles over time

There are also some proprietary flow splitting products, such as the Clarus Tru-flow splitter and Quanics flow divider. These products include an ability to manually adjust the flow distribution should the unit become unlevel over time.

2.3 Tee Headers

A header pipe, consisting of non-perforated PVC, can be used as a method of distributing effluent to the distribution piping in the leaching bed, instead of a distribution box. The header has some advantages in that it does not deteriorate over time as compared to a concrete distribution box.

The number of pipes connected to one header should be limited. There are no set rules for a maximum number, but the designer should consider that the more pipes on one single header, the longer the header pipe, and as a result, the more likelihood of pipe settling and/or uneven distribution. Historical guidance in the 1982 MOE Manual of Policy, Procedures and Guidelines for Private Sewage Disposal Systems suggests the maximum number of distribution pipes connected to a single header should be limited to two (2) for trickle feed systems or up to six (6) for dosed beds. The layout and arrangement of piping in the bed will be dependent on the site conditions and constraints.

A “double header” can also be used, which provides an additional safeguard against the possibility of uneven distribution (refer to Figure).

The header must be installed on firmly compacted soil or aggregate and must be level over its entire length. For longer header pipes, consideration can be given to a double header arrangement where the main header is fed by two pipe connections instead of single connection, which can assist in distributing effluent over the increased length.

When connecting an inlet into a header pipe, always offset this connection so that it is between runs i.e. the inlet is a tee connection.

2.4 D-Boxes Versus Tee Headers: Which to Use?

Effluent can be distributed to multiple distribution pipes in a leaching bed using either a distribution box or a header. Often the choice comes down to designer or installer preference or experience. And in larger leaching beds, distribution may use a combination of methods, i.e. a dedicated forcemain to a distribution box with the outlets feeding multiple groups of pipes connected by a tee header and footer.

In general, except for very small leaching beds, OOWA's Onsite Technical Committee recommends the use of distribution boxes assuming they are installed properly. Again, this means the D-box is installed in a manner that minimizes settling and is accessible from grade. The principal advantage of a D-box is the ability to verify flow distribution, post install, while verifying flow distribution in a tee header is not possible. In addition, when flow equalizers are installed on the outlet pipes in the D-box, minor settlement can be compensated for during O&M inspections whereas such is not possible with tee headers.

3.0 Pressure Distribution

Pressure distribution considers how to distribute effluent among multiple leaching beds as well as how to design a single leaching bed that utilizes pressured laterals. Refer to Appendix II for diagrams illustrating flow splitting configurations.

3.1 Distributing by Pressure to Multiple Subsystems

Large leaching bed systems often contain numerous cells or independent beds. It is usually desirable to only dose one cell or bed at a time and rotate between them with each dose. This allows for the use of smaller pumps and smaller pump tanks on larger systems.

There are three general ways that effluent can be distributed by pressure to multiple systems:

- Control valves
- Dedicated pumps
- Automatic distributing valves (indexing valves)

3.1.1 Control Valves

In the control valve approach there is a simplex or duplex pump set that tees off with a forcemain to each subsystem. On each forcemain is a motorized control valve that only opens then it is desired for flow to go to that bed.

The use of control valves tends to be limited to larger systems owing to the need for sophisticated controllers, specialized programming, and cost.

If one valve fails in the closed position, the other valves can still operate as normal. If one valve fails in the open position, that bed will get excessive flow although the other valves can still operate as normal.

3.1.2 Dedicated Pumps

Another approach to distributing flow by pressure to multiple subsystems is to use dedicated pumps. In this approach there is one pump assigned to each subsystem, and the various pumps are activated in sequence.

This approach requires a multiplex control panel to sequence the pump operation. In addition, some level of redundancy can be used, such as one standby pump connected to all beds with manual valves or each bed has duplex pumps, although at the expense of increased cost and complexity.

The dedicated pump approach has excellent control over dosing as it can accommodate different pump sizes for each bed if they are at significantly different elevations or are different sizes. This approach is also resilient during failure because a bed with a failed pump won't be overloaded with excess flow because only the other pumps will continue to operate (unless there is one or more standby pumps, then the system can run as normal). Of course, these benefits must be balanced against the increased cost due to the number of pumps and multiplex panel.

3.1.3 Automatic Distributing Valves

Distribution valves or indexing valves are probably the most common approach used in Ontario to direct the effluent from the final effluent pump chamber to several cells or leaching beds.

Typically, these distribution valves are operated by mechanical means and do not require a power supply. Each distribution valve should be customized to the specific needs of the system. Generally, there are a few base units to select which can be further customized for the number of outlets desired. Distribution valve mechanisms typically consist of a cam, a housing body with components, an inlet, and numerous outlets. They operate using a combination of pressure and flow and are designed to automatically cycle to the next outlet after a pump cycle has completed. It should be noted that the pump cycle (run time and dosing volumes) needs to be calculated specifically for the sewage system and are independent of the workings of the flow distribution valve.

With no power being supplied to the distribution valve there is no recording, monitoring and alarm capabilities on this equipment. An additional piece of equipment, an Intelligent Valve Monitor (IVM), can be installed over top of various distribution valves to record and provide the operator with dosing information including error messages from uneven dosing. When dosing effluent to numerous cells within a distribution system, it is highly recommended to use distribution valve monitoring equipment.

Items for consideration when using distribution valves:

- Maintenance of these valves is critical as small debris can block or prevent proper cycling between outlets. Without proper cycling of the valve, effluent will not be distributed evenly and can lead to all flow going to a single bed and overloading it.
- Check-valves should be appropriately installed to prevent back flow of effluent from high to low elevations.
- Ensure the manufacturers installation methods are followed to ensure a properly functioning distribution valve.
- An IVM can provide valuable information on the performance of the distribution valve.

Some suppliers of distribution valves include: Clarus (Zoeller), K-Rain, Orenco, and Quanics (Anua).

In cold climates where pipe freezing is a risk, systems may be designed to drain the supply pipe back to the pump chamber when the pump turns off. If the drain-back volume is significant, the system becomes less efficient because the pump must move this effluent more than once. Any drain back volume must be considered in the tank size, pump cycle calculation, and pump capacity specification.

3.2 Pressurized Leaching Beds

The alternative to gravity distribution is pressure or pump-based distribution. The OBC does not provide significant information regarding codes and guidelines for constructing pressure-based distribution fields, so a literature review of several other design guidelines was undertaken (Minnesota Pollution Control Agency. 2013. Subsurface Sewage Treatment Systems – Prescriptive Designs and Design Guidance for Advanced Designers.; Connecticut Department of Environmental Protection, February 2006. Guidance for Design of Large-Scale On-Site Wastewater Renovation Systems; Alberta). This Section is intended to cover what is known as "low-pressure distribution" using a pump to distribute effluent to multiple points in the system, but does not cover "pressure-dosed gravity systems" (i.e., siphons) or "drip dispersal" systems which are not addressed under the OBC and are not common in Ontario.

In pressure distribution fields the effluent is applied uniformly over the entire infiltrative surface simultaneously such that each unit of bottom area receives approximately the same amount per dose at a rate less than the saturated hydraulic conductivity of the native soils assessed at the particular site. This application promotes soil treatment performance by maintaining vertical unsaturated flow and also may reduce the degree of clogging in finer-textured soils. This method does not rely on biomat formation as in gravity distribution systems to achieve uniform distribution, and thus optimizes the utilization of the entire infiltrative surface area, especially if the system is time-dosed.

Applications for pressure-based distribution are as follows:

- To achieve uniform application of effluent throughout the soil treatment area;
- To disperse effluent higher in the soil profile;
- To avoid potential contamination of groundwater beneath excessively permeable soils;
- To improve the treatment performance and extend the life expectancy of a drainfield or other components;
- To reduce the potential for breakout or seepage on slopes;
- To distribute effluent to above ground (raised) systems or where the elevation requires it;
- To lower the risk of potential contamination on sites in aquifer-sensitive areas and / or limited soil depth;
- To disperse effluent evenly for larger distribution systems.

Potential disadvantages of pressure-based systems to consider are as follows:

- Systems require a pump tank, pump(s), controls, and an alarm which incur higher installation costs and operational costs related to energy use and maintenance requirements.

- Orifices must be kept clean for the system to work properly which requires (a) the effluent must be highly treated or screened (i.e., effluent screens), and (b) the distribution systems must have a provision for flushing/cleaning if required. The OBC requires additional sampling and testing for systems using certain types of pressure distribution systems [refer to OBC Section 8.9.2.4. Sampling of Treatment Units, and Section 8.9.3.5. Pressurized Distribution Systems].

3.2.1 Design

All pressure distribution systems contain the following four items:

- Pump tank and pump that pressurizes the system;
- Pump controls;
- Pipes to deliver the effluent;
- Orifices that discharge effluent over the infiltrative surface.

Pressurized distribution systems are designed so that effluent flowing out of each orifice of the distribution pipe is nearly identical. Proper design must consider the overall configuration of distribution pipe diameter, length of distribution pipe, number of orifices, orifice size and orifice spacing.

The distribution piping system includes supply pipe (forcemain), which carries effluent from the effluent pump tank to the pressure distribution system, the manifold which distributes the effluent to the laterals, and laterals themselves which distribute the effluent to the soil interface.

The supply pipe (forcemain) delivers the effluent from the effluent pump tank to the manifold. The supply pipe diameter is dependent on the system flow rate. The optimal diameter of the supply pipe should be large enough that the head loss (pressure drop) is relatively low at the given flow rate, but small enough that the velocity of flow is greater than 0.6 m/s (2 ft/s) to scour out any solids. Although a smaller diameter pipe would be more cost effective, the higher head loss may require a larger pump. The size and kind of supply piping determine friction loss, which affects the pressure requirement. The recommended supply pipe should be smooth wall pipe selected in accordance with the OBC such as Schedule 40 PVC or CSA certified high-density polyethylene (HDPE).

Regarding the elevation of the system components, the design should consider if the elevation of the distribution system is higher or lower than the pump system, or if there are any high points in the supply pipe. If the pump system is higher than the distribution, a vacuum release valve (siphon break) should be specified at the high point of the pump discharge assembly to drain the line out to the distribution system when the pump shuts off. Where the pump system is lower, and there is a risk of supply line freezing, it is recommended to either drill a small drain hole (e.g., 4mm or 3/16") in the discharge assembly, or install a small diameter (1/2" or 3/4" trade size) ball check valve upside-down and in such a way that the supply pipe will drain back into the pump tank when the pump shuts off. In the case of using a drain-back system, the designer must account for the volume drained back, as well as any bleed-off during pumping, and add this to the pump cycle timer to ensure the required dose volume plus any return flow is accounted for. In the case of a high point in the supply line itself, the designer should consider specifying an air/vacuum release valve in a chamber at the high point to drain the line in both directions back to the pump chamber and out to the distribution, as well as to ensure an air pocket does not form which constricts the flow (this is generally applicable to large systems only).

After the supply pipe diameter is selected, it should be compared with the chosen manifold diameter. The manifold diameter should be the same size or larger than the supply pipe. The manifold diameter should be selected such that the friction loss in the manifold is less than 5% of the average head at the orifices, and less than 5% difference from the inlet to furthest end. The configuration of the manifold and forcemain will vary for each pressure distribution system. The forcemain may be connected to the center of the manifold, or at one end as long as the above pressure differential conditions are met. A manifold may also be "telescoped", meaning the supply pipe may connect to the largest diameter section, and the diameter may be reduced towards the end(s) of the manifold. The layout of the pressure distribution system may be configured with the manifold perpendicular to one end of the system or aligned along the center of the distribution system. The benefit of a center manifold is that it allows more orifices per lateral while maintaining the required minimum friction loss. The elevation of the manifold should be level with or below the elevation of the distribution laterals.

In a pressure distribution system, small-diameter pipes are used to distribute the effluent. It must be noted that 3" or 4" trade size perforated pipes used in conventional soil absorption systems are not suitable because both the diameter and orifice size are too large, and the orifices are not appropriately spaced to provide even effluent distribution. Generally, the sizing of pressure distribution laterals should be specified between 1" [minimum per OBC Section 8.7.3.3.(4)] and 1-1/2" trade size to achieve optimal flow velocity and be large enough to be flushed/cleaned with commonly available equipment.

The designer needs to balance the diameter of the pipe with the size of the orifices and necessary lateral length to maintain equal distribution across the infiltrative surface. Proper design of orifices is critical to creating a system that uniformly distributes effluent. Key design parameters include the size of the orifices, location, and spacing in the pressure distribution lateral. The larger the orifices and length of pipe, the more flow is necessary to properly charge the pipe resulting in a greater pump capacity requirement. This translates into a maximum length for the laterals based upon the size of orifices and the size (diameter) of the pipe. Large orifices will result in fewer orifices per lateral to achieve even distribution and shorter maximum lateral lengths. Smaller diameter orifices have lower flows, and will result in smaller pump capacity requirements, and increased potential lateral length. All pressurized laterals in a distribution cell or zone should be the same pipe diameter.

The number of laterals, lateral length, pipe diameter, orifice diameter, and orifice spacing must be determined for each pressure distribution system. As the lateral diameter increases, the maximum allowable length increases, but as lateral diameter decreases, the velocity in the pipe increases. Increased velocity is a benefit, as it helps keep solids suspended (and thus the lateral from plugging). The length of the laterals is related to the number and size of the orifices. The maximum lateral length is 30 m [OBC Section 8.7.3.2.(2)]. The parallel spacing of laterals depends on the type of leaching bed (e.g., minimum 1,600 mm for absorption trenches [OBC Section 8.7.3.2.(1)(d)], or 2,000 mm for shallow buried trenches [OBC Section 8.7.3.2.(2)(d)] but should generally be between 600 mm (2') and 1,500 mm (5'), and evenly spaced in area bed and filter bed applications. Maximum spacing in a Type B dispersal bed in 1,200 mm [OBC Section 8.7.8.2.(7)].

A pressurized distribution system should provide as many orifices as reasonably possible, and all orifices should be equally spaced and in a straight line on the lateral. The recommended orifice spacing is not less than 600 mm (2') and not more than 1,200 mm (4'), with 900 mm – 1,000 mm being a typical default. In accordance with the OBC, pressure distribution pipes shall be self-draining to prevent freezing; this is normally done by specifying a combination of top (obvert) orifices, and bottom (invert, drain) orifices. If specific drain orifices are used, it is recommended these be spaced a maximum of 3,000 mm apart and that the flow of these orifices must be included in the overall lateral flow / head loss calculation. The number of orifices may be adjusted to match the available pump capacity and head.

Based on the above considerations, it can be seen that the design of pressure distribution systems is a complex calculation. For uniform distribution, the discharge from any orifice in a lateral connected to the same manifold must not vary by more than 10%. To assure the discharge is within 10%, the friction loss in the pipe should not be greater than 2% of the average operating pressure head. Finally, the design pressure head at the end of each lateral (residual pressure) shall be minimum 600 mm (2') [OBC Section 8.7.6.1.(2)] up to a suggested maximum of 1500 mm (5'). The recommended design residual pressure is 750 mm – 900 mm to provide a safety factor over minimum. The designer's calculation should show both the difference in pressure at each end of the manifold and the difference in discharge at each orifice in the laterals to meet the above criteria.

In the case of using small diameter orifices with higher risk of plugging, several methods of mitigation can be specified, such as:

- Specify an inline wye strainer (pressure screen) on the pump discharge upstream of the pressure distribution system.
- Design for higher pressure at each of the orifices. Increased pressure will increase scouring velocity and minimize the chance that solids will plug the orifice.
- Specify maintenance components such as flushing/cleaning ports at each lateral. Even if all solids are removed from the effluent by filtration/treatment, biofilm growth within the distribution system may still create suspended solids.

In regard to the pump design and dose volume, the designer must specify the volume of each dose sufficient to fill or "charge" the laterals for even distribution. It is recommended that the minimum dose volume be four to five times the empty volume of the piping and manifold system, including any flow that is drained back to the pump tank after each cycle. Also, the characteristics of the underlying soil may also be considered in the dose volume and frequency; one jurisdiction (Connecticut) recommends more frequent dosing for coarse grained soils (minimum 4 cycles per day) vs. less frequent doses for fine grained soils.

In the special case where the pressure distribution system must discharge to laterals at different elevations, the designer must specify a means to control the pressure at each elevation. This may be done using one of four general methods:

- Specify a separate pump for each lateral/zone at a different elevation. This option is generally more applicable with larger flow systems split into several zones. Automated diverter valves may also be used to dose several zones within a system with one pump.
- Specify valves to regulate (throttle) the pressure head in each lateral/zone so it is equal. This option requires squirt height testing at system start up and adjustment over the life of the system. In this case, it is recommended to use full port ball valves, and provide an access chamber at each valve for periodic adjustment and full opening for line flushing.
- Specify manifold orifices at each lateral inlet with opening size varied along the manifold to equalize the inlet pressure. This method requires a complex calculation and custom orifice

fabrication, and thus may favour method 2 above. In this case, it is recommended to have the orifices installed in a removeable union and an access chamber at each union for periodic removal and cleaning.

- Vary the perforation size, spacing, and pipe length to assure even distribution from one lateral/zone to the next. This method also requires a complex calculation and custom fabrication of each lateral.

Some final design items to consider are the use of media or chambers over the laterals and the use of orifice shields. The pressure distribution system may be installed either in septic stone or alternate media in accordance with OBC (except for shallow buried trench systems), or within approved plastic leaching chambers. In either case, the use of orifice shields (specially designed covers that attach over each orifice) should be considered. In the case of using stone media, orifice shields on both top and bottom orifice shields are recommended both to protect from small particles entering the pipe and such that the media does not physically block any orifices. Shields are more beneficial as the orifice size decreases, since the flow would be more impacted by media/clogging with smaller openings. In the case of using chambers, orifice shields are recommended only for the bottom (drain) orifice to prevent scouring of the infiltrative surface. One jurisdiction (Connecticut) recommends for septic tank effluent that orifices be located on the bottom of the pipe with the pipe installed high in the chamber, and for treatment unit effluent (Level III or IV), that orifices be located on top of the lateral and the lateral be located near the bottom of the chamber.

Although designs should be made using calculation spreadsheets or software, the following general steps and tables provide some useful reference data. When performing orifice discharge calculations, it is recommended that an orifice discharge coefficient of 0.62 be used.

The general steps for designing a pressurized distribution system may include the following:

1. Determine the leaching bed area based on design flow, soil type, and bed type.
2. Determine the length and spacing of laterals.
3. Select a lateral pipe size.
4. Calculate the dosing volume to properly charge the pipes and determine dosing frequency based on the daily design flow and number of doses per day.
5. Select an orifice size and average operating pressure to determine the total number of required orifices based on the required discharge flow (per dose).
6. Confirm an orifice diameter and spacing to determine the total number of orifices per lateral (ensuring drain orifices are included).
7. Calculate the pump discharge capacity based on the number and size of orifices.
8. Select a supply pipe and manifold sizing.
9. Calculate pump head loss requirements (operating total dynamic head, TDH, including static head differential at tank low level, friction loss in supply pipe and manifold, and fitting losses) and select pump.
10. Specify any other design features such as manifold configuration, cleanouts, control valves, chambers, air release/vacuum valves, orifice shields, etc.

Appendix 1 provides three reference data tables to assist with design calculations.

3.2.2 Construction

The pressure distribution system consists of the supply pipe, manifold, distribution laterals, and soil absorption system itself; this section will address the piping systems only. For pump systems, refer to the OOWA Guidance Document: Pump Chambers.

In general, the supply pipe (forcemain) connects the pump system to the manifold, and the manifold connects the supply pipe to the distribution laterals. All piping should be smooth, plastic pipe in accordance with the OBC (CSA certification recommended). Although the supply pipe may be flexible HDPE, it is also acceptable to use Schedule 40 PVC or gasketed (SDR/DR designated) PVC rated for pressure applications. All manifold and lateral piping must be rigid PVC, Schedule 40 or 80. The pipe and connections must be able to withstand a pressure of at least 40 pounds per square inch (PSI). All connections must be solvent weld or glued PVC or use suitably rated compression fittings. All piping except for the laterals must be installed on properly compacted soil or granular material to prevent settling.

The manifold connects the laterals and distributes the effluent to each lateral from a tee along the manifold and/or 90-degree elbow fittings on the manifold ends. The manifold needs to be installed level, however it is not as critical as in gravity distribution systems. Installations with significant differences in elevation between areas of the bed need to be considered in the design. Installations on sloping grade should have the manifold below laterals to avoid siphoning.

The connection elevations between the manifold and the laterals and between the manifold and the supply pipe determine how the system drains. If the manifold and laterals are connected at the same elevation, the manifold volume will drain through the lateral orifices. If the manifold is lower than the laterals, the effluent will drain back to the pump tank. The supply pipe should be sloped back to the pump tank so that effluent drains back to the tank between doses if there is potential for freezing.

Connections from the manifold to the laterals (taps) should be spaced to correspond to the trench spacing to eliminate the need for additional elbows that would otherwise increase friction losses, cost, and potential for plugging. With a Schedule 40 PVC manifold, the taps will consist of reducing tees or tees with reducer bushings that are solvent welded or glued together. A Schedule 40 manifold should not be drilled and tapped. A Schedule 80 PVC manifold has a wall thickness sufficient to allow the installer to drill and tap the fittings without compromising pipe strength as an alternate installation method. The correct diameter drill and associated tap is critical for these activities to avoid changing system flow. All burrs should be removed from the drilled and/or tapped orifices, and the assembled network should be flushed through open cleanouts using clean water to remove all debris to prevent clogging of taps in the manifold or orifices after start-up. Where there are valves or orifices to control flow to laterals (such as in the case of long manifolds or sloping sites), these components should be installed in small chambers or valve boxes to provide maintenance access.

Pressurized distribution laterals must be installed level (+/- 25mm maximum), and the orifices must be smooth and free of burrs. All orifices must be drilled perpendicular to the pipe in a straight line, whether on the top (obvert) or bottom (invert) of the pipe. An orifice drilled at an angle creates an oval-shaped opening that has more area than a round one, which would result in increased flow and affect the uniformity of distribution. The smaller the orifice, the more critical it is to use proper drilling techniques, and the use of a drill press is recommended. The orifices should be drilled as uniformly as possible using a sharp drill bit. Any excess plastic material or burrs should be cleaned from inside the pipe and removed from the orifice. Care should be used to keep plastic shavings from entering the system, as these can easily become permanent plugs once effluent begins flowing through the laterals. Sliding a rod or small diameter pipe along the inside of the lateral pipe works to remove burrs. During construction, protect the ends of pipe to keep dirt and rodents out of pipes.

The specification of the orifice direction (up or down), the use of drain orifices, and orifice shields is discussed in the Design Section above. In any case, the pipes must have a means of completely draining out during each cycle, typically using a combination of top and bottom orifices.

Maintenance access at the ends of each distribution lateral is extremely important. The best way to provide access is to bring a pipe off the end of the lateral using sweep 90-degree elbow or two 45-degree-angle elbows ending in a vertical pipe inside a small access chamber. Ideally, each lateral end should be fitted with a ball valve and a threaded cap/plug at the discharge that (a) is removeable for cleanout/flushing, and (b) has an orifice drilled in the center of the same diameter as the lateral orifices so that it may be used for pressure (squirt height) testing. The access chambers should be packed with insulation for freeze protection.

Proper connection of the pipes is a critical element of system construction. All connections in the pressure distribution system must be properly cleaned, glued (with or without primer depending on the adhesive), and joined in order to withstand the operating pressure and prevent leakage or pipe separation. The use of purple primer/cleaner followed by PVC solvent weld adhesive is recommended. The adhesive should be applied within a few minutes of priming/cleaning, and the pipe must be joined and set quickly after applying the adhesive. When joining the pipes, the installer should push the fittings together quickly and apply a ¼ turn of the pipe to ensure the adhesive fills the joint, and then the joint should be held tight for at least 30 seconds to ensure the adhesive sets properly. The installer should also avoid excessive glue since it may leak into the pipe and obstruct flow. When cutting the piping, also ensure that the filings are removed from the pipe as they can cause restriction of the orifices.

Finally, when installing piping in cold weather (generally sub-zero temperatures), the installer should make sure the adhesives are rated for and used in accordance with the temperature. The colder the weather, the longer it takes for the glue to set up. Holding the sections longer allows for a better connection. Cold PVC pipe can also be brittle and crack during cutting and installation.

3.2.3 Maintenance/Management

With any pressure distribution system, there are moving parts such as pumps and floats that may fail and require preventative and emergency maintenance. The distribution laterals also have the potential for solids plugging, even with large orifices and high pressure. Smaller orifices create additional management requirements because they are more subject to plugging. Providing maintenance access is probably the single most important component for long-term operation of a pressure distribution system. If proper access is provided at installation, regular maintenance is greatly simplified. If lateral ends are buried, the system likely won’t be maintained until failure. To ensure long-term system performance, the laterals must be periodically flushed or cleaned. Typically, access for maintenance is provided by putting a valve box at the end of each pressure distribution lateral and bringing it near the surface (see the Design and Construction sections above).

During normal operation, the maintenance valves are turned off, but they can be accessed individually when flushing the distribution laterals. The distal pressure at the end of each lateral can be checked by threading in a cap with an orifice (of the system design size) pointing upwards on each lateral. During a pressure test (recommended annually for large systems, and a minimum of every 3-years for residential systems [OBC Section 8.9.3.5. Pressurized Distribution Systems]). The height to which the effluent squirts up should be the same in each lateral, and should be compared to design (note that the squirt height is measured from the top of the lateral pipe, not the access orifice). If it is higher in one lateral versus another, this indicates that the lateral likely has plugging in some of the orifices and that flushing and cleaning is needed. Partial plugging of the distribution piping may also be detected by shorter squirt heights and/or long dosing times and decreased pump operating capacity (from original settings). In this case, the ends of the distribution laterals should be exposed and the pump activated to flush out any solid material. If necessary, the pipe can be cleaned using a flexible pressure nozzle or scrubber. Any solid material which discharge from the pipe should be collected and disposed of back in the septic tank.

Some pressure distribution systems will also have inspection ports in the media bed or chambers. Under normal operation the inspection ports in pressure distribution system should be dry unless the pump has just delivered a dose to the system. If prolonged ponding exists, further investigation of the system is required to determine if it is being hydraulically or organically overloaded.

4.0 References

MOE (1982) Manual of Policy, Procedures, and Guidelines for Onsite Sewage Systems. Ontario Ministry of the Environment.

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5.0 Appendix I

5.1 Headloss Data Table

The table below may be used to calculate head loss in the supply pipe or lateral at design flow (head losses for fittings should be calculated separately).

Head Loss per 30.48 m (100'), mm (in), C = 130 [adapted from Minnesota, Table 11.3]						
Flow Rate, L/min (USgpm)	**Pipe Diameter (inches trade-size)**					
	1"	**1.25"**	**1.5"**	**2"**	**2.5"**	**3"**
37.9 (10)	231.1 (9.1)	78.7 (3.1)	33.0 (1.3)	7.6 (0.3)		
45.4 (12)	325.1 (12.8)	109.2 (4.3)	45.7 (1.8)	10.2 (0.4)	2.5 (0.1)	
53.0 (14)	431.8 (17.0)	144.8 (5.7)	61.0 (2.4)	15.2 (0.6)	5.1 (0.2)	
60.6 (16)	553.7 (21.8)	185.4 (7.3)	76.2 (3.0)	17.8 (0.7)	7.6 (0.3)	2.5 (0.1)
68.1 (18)		231.1 (9.1)	96.5 (3.8)	22.9 (0.9)	7.6 (0.3)	2.5 (0.1)
75.7 (20)		281.9 (11.1)	116.8 (4.6)	27.9 (1.1)	10.2 (0.4)	5.1 (0.2)
94.6 (25)		426.7 (16.8)	175.3 (6.9)	43.2 (1.7)	15.2 (0.6)	5.1 (0.2)
113.6 (30)		596.9 (23.5)	246.4 (9.7)	61.0 (2.4)	20.3 (0.8)	7.6 (0.3)
132.5 (35)			327.7 (12.9)	81.3 (3.2)	27.9 (1.1)	10.2 (0.4)
151.4 (40)			419.1 (16.5)	104.1 (4.1)	35.6 (1.4)	15.2 (0.6)
170.3 (45)			520.7 (20.5)	127.0 (5.0)	43.2 (1.7)	17.8 (0.7)
189.3 (50)				154.9 (6.1)	53.3 (2.1)	22.9 (0.9)
208.2 (55)				185.4 (7.3)	73.7 (2.9)	25.4 (1.0)
227.1 (60)				218.4 (8.6)	86.4 (3.4)	30.5 (1.2)
246.0 (65)				254.0 (10.0)	99.1 (3.9)	35.6 (1.4)
265.0 (70)				289.6 (11.4)	124.5 (4.9)	40.6 (1.6)
302.8 (80)				370.8 (14.6)	154.9 (6.1)	50.8 (2.0)
340.7 (90)				462.3 (18.2)	190.5 (7.5)	63.5 (2.5)
378.5 (100)					287.0 (11.3)	78.7 (3.1)
473.1 (125)					401.3 (15.8)	116.8 (4.6)
567.8 (150)						165.1 (6.5)
662.4 (175)						218.4 (8.6)
757.0 (200)						281.9 (11.1)

5.2 Orifices per Lateral Data Table

This table may be used to estimate the number and size of orifices to use:

Maximum Number of Orifice per Lateral [adapted from Minnesota, Table 11.5]				
Orifice Diameter, mm (in)	**Orifice Spacing, mm (ft)**	**Pipe Diameter (inches trade-size)**		
		1”	**1.25”**	**1.5”**
6.4 (1/4”)	600 (2’)	10	13	18
	760 (2.5’)	8	12	16
	900 (3’)	8	12	16
4.8 (3/16”)	600 (2’)	12	18	26
	760 (2.5’)	12	17	24
	900 (3’)	12	16	22
3.2 (1/8”)	600 (2’)	21	33	44
	760 (2.5’)	20	30	41
	900 (3’)	20	29	38

5.3 Orifice Discharge Data Table

This table may be used to calculate the discharge of a pressure distribution system based on the orifice size, average operating pressure, and total number of orifices in the system.

Table __: Orifice Discharge by Size, L/min (USgpm) [adapted from Minnesota, Table 11.6]

Pressure, mm (ft)	**Orifice Diameter, mm (in)**			
	3.2 (1/8")	**4.8 (3/16")**	**5.6 (7/32")**	**6.4 (1/4")**
300 (1')	0.68 (0.18)	1.59 (0.42)	2.12 (0.56)	2.80 (0.74)
450 (1.5')	0.83 (0.22)	1.93 (0.51)	2.61 (0.69)	3.41 (0.90)
600 (2')	0.98 (0.26)	2.23 (0.59)	3.01 (0.80)	3.94 (1.04)
750 (2.5')	1.10 (0.29)	2.46 (0.65)	3.37 (0.89)	4.43 (1.17)
900 (3')	1.17 (0.31)	2.69 (0.71)	3.71 (0.98)	4.84 (1.28)
1200 (4')	1.36 (0.36)	3.10 (0.82)	4.28 (1.13)	5.56 (1.47)
1500 (5')	1.55 (0.41)	3.56 (0.94)	4.77 (1.26)	6.25(1.65)

6.0 Appendix II

Flow splitting configurations