ON-SITE DISPOSAL OF TREATED WASTEWATER WITH WASTEFLOW® SUBSURFACE DRIP IRRIGATION

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Abstract

In this paper we discuss the advantages & benefits of using Geoflow Wasteflow® for the on-site sub-surface disposal / reuse of treated effluent, in particular the elimination of human contact, wind interference, runoff and its adaptability to the landscape. Emphasis is placed on displacing common misconceptions regarding sub-surface drip irrigation, and the importance of correct design, installation and maintenance of a sub-surface drip irrigation system.

Starting with the single house residential market we explain the advantages in relation to health risk, useable areas and the long term financial benefits of such a system, and explain in detail the kits developed by Triangle Filtration, to simplify the process.

In addition we look at case studies where Geoflow Wasteflow® systems have been installed for commercial treatment systems (2,000 to 30,000 L/day). A case study refers to the disposal of treated effluent with the installation of Geoflow Wasteflow® onto a golf course in New Zealand.

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Keywords

on-site disposal, reuse, subsurface, Wasteflow®

1 Introduction

The demand for on-site disposal / reuse of treated effluent via subsurface drip irrigation has increased significantly over the past five years as consultants, regulators, wastewater treatment specialists and consumers understand the many advantages of installing subsurface drip irrigation.

The key advantages of subsurface drip irrigation when used for on-site disposal / reuse of treated effluent are-:

- Elimination / limiting, problems associated with penetration into the soil, run off or pooling associated with surface systems.
- Uniform distribution of treated wastewater over the disposal area.
- Suitable for playing fields, residential landscaping, parks, and other applications where traditional forms of above ground spraying are unacceptable.
- Plants and vegetation will consume nitrates and nutrients present in treated effluent.
- No treated water is directly discharged into water bodies, reducing environmental pollution.

- Can be used in difficult circumstances such as steep slopes or prevailing wind conditions.
- Economical, invisible and vandal proof installation resulting in cost savings.
- Non-intrusive, allows for use of space while in operation.
- Long lasting system with few moving parts, and can be fully automated.

2 Factors in Designing a Sub-Surface Drip Irrigation System

When designing an on-site disposal / reuse system using treated effluent, a number of factors need to be considered.

- Health hazards (human contact)
- Plugging of the system due to bacteria growth and root intrusion
- Suitability of the reclaimed water for the vegetation
- Salt management
- Heavy metal concentration in the soil
- Effect on soil permeability
- Pollution of the aquifer
- Reliability and system life
- The economic cost

Health hazards will vary from insignificant to critical, depending on the quality of the source of reclaimed wastewater, the vegetation and soil.

Sub-surface drip irrigation systems have been installed using secondary and tertiary treated municipal wastewater, commercially packaged sewage treatment plants and domestic treatment plants (AWTS) with effluent and greywater.

3 System Components

A typical Wasteflow® wastewater sub-surface disposal / reuse system will comprise the following components.

3.1 Wasteflow®

Wasteflow® is a 16mm OD extruded polyethylene piping with an inline drip emitter spaced every 60 cm. The drip emitters are labyrinth style "in line" with large flow paths to prevent clogging. Historically the difficulties with sub-surface disposal has been incorrect design principals, root intrusion and bio-slime build up on the inside of the pipes. The patented process developed by Geoflow™, whereby minute amounts of the non toxic herbicide Trifluralin are moulded into the emitters, creating an invisible barrier directing root growth away from the emitter and guaranteeing against root intrusion.

Wasteflow® is coated on the inside wall with a bactericide lining Ultra Fresh DM-30 to inhibit bacterial growth on the inside walls of the tube, and in the emitters. Wasteflow® drip-line is supported with a ten-year warranty against manufacturing defects and root intrusion.

The Wasteflow® Classic non-pressure compensating system has 4.3 L/h turbulent flow emitters. The pressure compensating Wasteflow® system used specifically for hilly and undulating terrains has 2.4 L/h emitters. In both products the emitters are spaced at 60 cm intervals.

3.2 Filters

Effective filtration for each system is essential. A 120 micron (120 mesh) primary filter is required on the supply line of the sub-surface drip irrigation system. This will ensure removal of any particles that may enter the sub-surface disposal / reuse system and block the emitters. This filter also acts as a diagnostic's tool if the system has high levels of total suspended solids (TSS) being emitted to the disposal area, whereby it reduces the risk of the soil turning anaerobic.

3.3 Controllers

Larger systems can incorporate irrigation controllers connected to solenoid valves. Control for residential systems can range from a hydraulically controlled rotor valve to ball valves.

3.4 Pressure Regulating Valves

The pump pressure required at the Wasteflow® drip lines needs to be between 100 to 175 kPa for classic non pressure compensating Wasteflow® and between 50 to 300 kPa for the pressure compensating to ensure even distribution. Outside of this criterion a pressure regulating valve can be installed.

3.5 Vacuum Breakers

Sub-surface disposal systems require vacuum breakers and must be installed at the highest point in the disposal field to prevent the system from sucking dirt back into the drip-line, due to back siphoning or back pressure when the system shuts off.

3.6 Chemical Injectors

This allows chlorine and alkalis to be safely applied through the system. This is to safeguard any system with a BOD> 20mg/L, and optional for BOD< 20mg/Ll.

3.7 Main and Sub-Main Manifold Lines

The delivery mainline from the pump to the Wasteflow® manifold can be either rigid PVC or polyethylene piping. Sizing of this main pipeline is determined by the system flow and hydraulic calculation. In smaller residential systems with flows under 1600 L/h the Wasteflow® pipe can be used as a reticulated system to simplify the installation.

3.8 Flushing Manifold

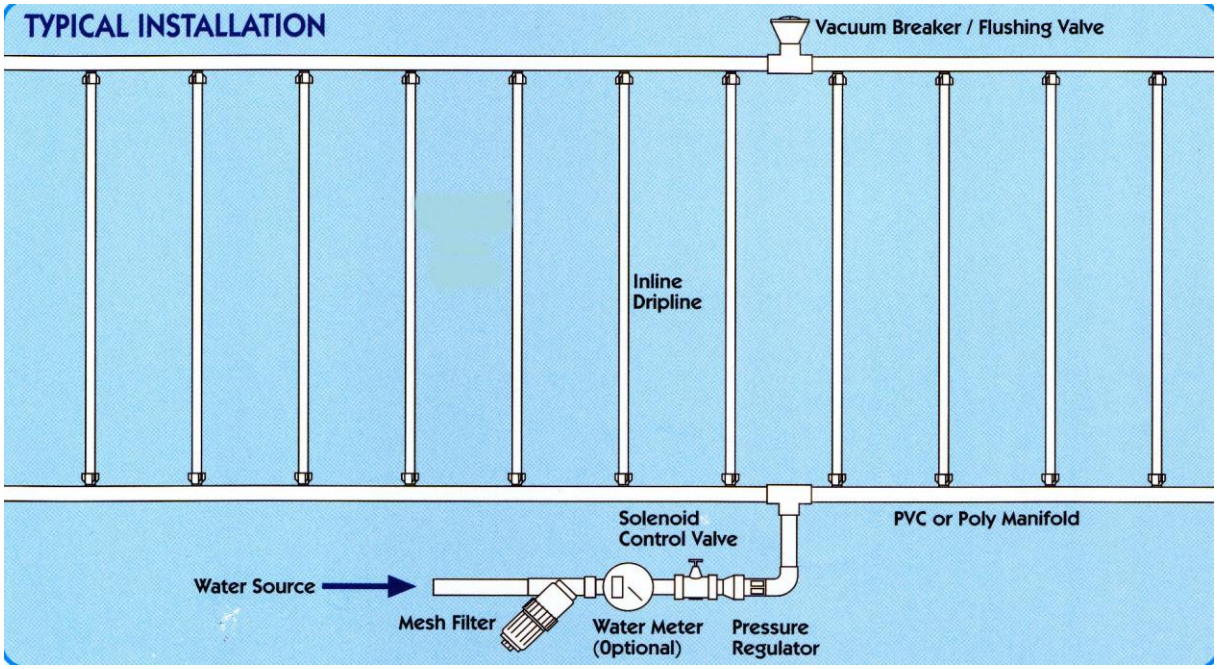
A flushing valve allows you to flush the system out after installation and also maintain periodical maintenance. This line may be plumbed back to the treatment plant.

3.9 Pumps

To ensure that the disposal area has a uniform distribution of $\pm$ 5% you require a drip line pressure of between 100 to 175 kPa for non-pressure compensating Wasteflow® and 50 to 300 kPa for pressure compensating.

*****Triangle Filtration have put together complete Wasteflow® kits to simplify the process that include all of the above components required for an on-site disposal system of 200, 400 and 600 m²(excluding pump). These complete kits are available for both Classic and Pressure compensating applications.

Figure 1. Typical Installation of Drip Line



4 Design Parameters

4.1 Select the Area

In selecting the disposal area, careful consideration to soil types, terrain, vegetation and the local and state regulations must be undertaken.

4.2 Soil Application Design

Table 1: Minimum Surface Area Guidelines to Dispose of 1000 L/day

Soil Type	Est. Soil Perc. Rate Min/25mm	Hydraulic Conductivity mm/h	Design Loading Rate mm/m² per day	Total area required m²/1000 L/day
Coarse-Sand	<5	>50	81	13
Fine Sand	5-10	38-50	65	16
Sandy Loam	10-20	25-38	53	19
Loam	20-30	19-25	37	27
Clay Loam	30-45	12.5-19	24	42
Silt-Clay Loam	45-60	7.6-12.5	16	63
Clay non-swell	60-90	5-7.6	8	125
Clay-swell	90-120	2-5.5	4	250
Poor Clay	>120	>2.5	3	334

Note: This table is extracted from *Subsurface Trickle Irrigation Systems for On-Site Wastewater Disposal and Reuse* by BL Carlile and A Sanjines

- These loading rates assume a treated, disinfected effluent with BOD and TSS values of less than 20mg/L is produced in the pre treatment system.
- The correct use of ASNZS 1547:2000 as per section 4.2C water table balancing.
- Table 1 is provided as a guide only. Always refer to your local authorities that may have different guidelines
- Surface area of disposal field calculation:

- Water use for vegetative cover to survive and work as an evapotranspiration bed is 6-9 L/m²/day.
- Design flow divided by loading rate total area (m²) of disposal field.

Example of a Disposal Field Calculation

To calculate the disposal area required you must know the following-:

1. The volume of water per day (LPD) to be disposed of
2. The long-term design hydraulic loading rate – mm/m²/day

   Product: Wasteflow® Classic 16mm x 4.3

   System Flow: 2000 L/day

   Hydraulic Loading: 5 mm/m²/day

   a) Area Required = $\frac{2000\ \text{LPD}}{5\ (\text{Hydraulic Loading})}$ = 400 m²

   b) Wasteflow® required with laterals 1 m spacing

   Flow = $\frac{400\ \text{m}^2}{1\ \text{m (spacing)}}$ = 400 lineal metres

   c) Capacity of system flow rate with 4.3 L/h emitters @ 600 mm emitter spacing

   Capacity = $\frac{400\ \text{L / metres} * 4.3\ \text{L/h}}{0.6\ \text{m (emitter spacing)}}$ = 2,866 L/h

   d) Running time = 0.69 hours per day

4.3 Soil Layers and Types

The installation depth of between 150 – 200mm is an advantage of the sub-surface drip irrigation field, since the topsoil or surface soil is generally the most biologically active and permeable soil for accepting water. The topsoil also dries the fastest after a rain fall event and will maintain the highest water absorption rate.

4.4 High points, Siphoning

A potential problem with buried sub-surface drip irrigation lines is syphoning dirt into the emitters when the pump is switched off. For this reason:

- Drip lines should have a fairly constant slope and always installed along the contour;
- Install a minimum of one vacuum breaker at the highest point in each zone;
- Drip lines should be connected at the end to a common manifold with a flush valve / vacuum breaker; and
- Avoid installing lines along rolling hills where you have high and low points along the same line. If this is the case, connect all the high points together and install a vacuum breaker on the highest point on the line.

4.5 Slopes

When designing on a slope the drip lines are installed to follow the contour. If the slope over a disposal block is more than 2 m, the pressure-compensating Wasteflow® must be used.

4.6 Positioning of Vacuum Breakers / Flush valves

Ensure that these valves are installed at a point high enough to prevent the system from draining through these valves when the water pressure is switched off.

5 System Installation

Handle your Wasteflow® drip line with care, as it is temperature sensitive.

To ensure a long life, store the drip line out of direct sunlight avoiding hot temperature extremes.

1. Excavation, filling and grading should have been completed before installation of the sub-surface drip system.
2. For ease of installation before opening trenches pre-assemble as much as practical.
3. Install head works first: pump, valves, filters, pressure-reducing valves, chemical injection equipment etc. Then install the mainline buried to between 300-450mm.
4. Open trenches for sub-mains, manifold and flush lines buried to 200-250mm.
5. Install Wasteflow® to a depth of 150-200 mm. Wasteflow® can be installed by hand trenching or with a vibrating plough.
6. Cover all open ends including drip-line ends to avoid getting debris into the system.
7. Leave enough tail at the beginning and end of each drip-line connection to manifolds.
8. Do not bend Wasteflow® tubing below a 0.6 m radius as pipe may kink.
9. Backfill the trenches early in the morning when temperatures are low as polyethylene elongate in high temperatures.
10. Connect drip lines to sub-main and flush system. Open flush valves.
11. Run the system before completing backfilling of trenches and check connections for any leaks.

6 System Maintenance

To assure a trouble-free system, monitor and perform regular maintenance functions. For large systems or systems with BOD >20 mg/L, automation of maintenance is essential. For systems with a BOD < 20 mg/L, quarterly inspection and maintenance is required.

1. Filters require cleaning when the pressure differential between the inlet and outlet reaches 50 kPa. A larger filter may be required if filter clogs in less than three months.
2. Flush the system under pressure. The velocity in the pipes should be as high as possible to remove any deposits or scale.
3. Clean and check that all valves are working.
4. Clean flush valves and vacuum release valves.

7 Technical Differences

Wasteflow® is a pressurised sub-surface on-site effluent disposal system and is specially manufactured for the purpose of disposing effluent and has many differences to systems being used presently.

1. Most importantly Wasteflow® SSD is coated with a bactericide along the entire inside wall of the tube to protect against bacterial build up that can in time dislodge itself and block the emitter from the inside.
2. Rootgurd® also protects Wasteflow® against root intrusion, simply and safely, by the use of Treflan impregnated into the emitter. The Rootguard® emitters have a 10 year guarantee, but from extended trials conducted in the US, can have an expected life of 40+ years.

3. Wasteflow® has two types of emitters: Classic, which has a flow rate of 4.3 L/h; and Pressure Compensating, with a flow rate of 2.4 L/h. The use of turbulent path labyrinth emitters with two larger orifices at each emitter ensures that it will be unlikely to become clogged by effluent water.
4. Wasteflow® is the only system that publishes a comprehensive design, installation and maintenance manual, compiled from studies and research, including the University recognised by the USQ, UQ, USX, and many other authorities as the safest and most technically superior effluent disposal system available.

8 Case Study - Omaha Golf Course, New Zealand

The installation of Wasteflow® sub surface drip irrigation system at Omaha Golf Course, Bay of Plenty in New Zealand was designed by Peter Gearing of URS New Zealand and installed by Ivor Jones of IC Jones and Co. Ltd.

Recycled water from Omaha's wastewater treatment plant is pumped to the golf course and disbursed via 200 kilometres of Wasteflow® buried throughout the course's fairways.

The golf course borders on two sides with ocean and estuary, and built on a combination of sand dunes and wetlands, so it was imperative any risk of wind interference or run off were eliminated.

The rich green fairways are visual proof of sub-surface reuse at its best, enabling lush irrigated grass to survive all year round despite its harsh location.

9 Conclusion

The installation of a Wasteflow® on-site disposal system is a sound economical investment taking into account the important ecological advantages obtained, combined with potable water savings, safe wastewater disposal and significant reduction of pollution.

Subsurface on-site disposal systems are practical, economical and complement wastewater recycling programs and wastewater disposal systems.

Water savings, combined with a substantial reduction in pollution of the aquifer and a low perceived health risk, makes on-site sub-surface disposal / reuse the best solution for many conditions.

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