GEOFLOW
SUBSURFACE DRIP SYSTEMS

## SUBSURFACE DRIP SYSTEMSAS APPLIED TO ONSITE EFFLUENT DISPOSAL OF WASTEWATER IN CALIFORNIA

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**Introduction** Subsurface drip disposal (SSDD) of effluent was first used in Hawaii, Georgia and Texas. As summer rainfall areas, these soils in general are very different from those in California. In Georgia and Texas most applications are in very heavy clay soils where conventional drainfields would not function. However, conditions in California are sufficiently different to warrant discussion.

In California, either deliberately or accidentally, all drainfields contribute to vegetative growth. Effluent disposal and irrigation are hydraulically similar but the design requirements are not identical. With effluent disposal, the aim is to dispose of the product within a minimum area, as quickly and safely as possible, and at an approximately uniform rate throughout the year. A disposal system must operate in the rain, while an irrigation system does not. With irrigation, the aim is to optimize the use of water over as large an area as possible, with an allowance made for a wide range of water usage between seasons.

### The advantages of using SSDD for effluent disposal are many.

- Health risks are minimized.
- Pollution of storm water runoff is minimized.
- It can be used under difficult circumstances of high water tables, tight soils, steep slopes or wind,
- Disposal of water by means of evapotranspiration by the plants is maximized.
- Opportunities to re-use the cleaned water are increased.
- Deep percolation is minimized.
- Consumption of nitrates by the plant material is increased.
- Has invisible and vandal-proof installations,
- The systems are durable and have a long life expendency.
- It is non–intrusive and allows use of the space while irrigating.
- The system is easily automated.

### Principles of SSDD

A single pulse of water is applied subsurface, which moves out by capillary action, laterally and vertically as well as downwards. The wetted volume for subsurface (on the left) is 40% larger than the wetted area for surface (on the right). The same amount of water was applied; hence, there is more air in the pores with subsurface compared to surface. If the biological loading rate is less than the ability of the soil to absorb the pathogens, there will never be a buildup of a biological mat around the emitter, and the system will operate indefinitely. If the instantaneous application rate is low enough never to saturate the soil, the capillary movement will be more important than gravity. Of course, the total application must be less than the ability of the soil to percolate downwards through the underlying layers in the soil. If one applies the effluent in short pulses with adequate rest periods in between pulses, one can view each emitter as a single sewage treatment plant.

**Pretreatment**

Most SSDD is used with effluent treated to a minimum standard of BOD/TSS < 20 mg/l. Disinfection with chlorine is not encouraged because it kills the useful soil bacteria and may damage roots. U.V. disinfection does not present this problem; however, U.V. disinfection is not usually required. The bactericide lined dripline does not require chlorine to prevent slime buildup in the tubing.

SSDD with filtered septic effluent taken directly from a septic tank is permitted in several states. With special precautions this does work well. Because this is not a common practice in California, this article will not cover that technique.

**System Components**

A typical drip system installation consists of the following elements.

- **Vacuum relief valves**

  Vacuum breakers installed at the high points protect the system from sucking dirt back into the drip line. Due to back-siphoning or back-pressure, this is an absolute necessity with underground drip systems.

- **Pressure regulator**

  Under normal operating conditions, pressure in the drip lines should be between 10 and 45 psi for pressure compensating emitters and between 15 and 25 psi for non-compensating emitters. The need for a pressure regulator will depend upon pump characteristics.

- **Filters**

  A filter is absolutely required. A 150 mesh (100 micron) filter is suitable.

- **Controllers**

  A programmable logic controller (PLC) is recommended for large systems or for any system with a BOD > 20 mg/l. This can be linked by modem to the engineer in charge in order to continuously monitor the system.

- **Electric solenoid valves**

  These valves control the automatic flushing of the filter and field, and can also be used to segregate multiple zones on larger systems. Manual operation can be used, instead of automation, on small systems with high quality effluent.

- **Emitter lines**

  There are two types of emitters.

  Non-compensating (often called classic or turbulent flow) emitters operate best at between 15 and 25 psi. Commercially available for SSDD with a 1.3 gph flow rate, they use a very well proven technology with over 20 years experience. They have no moving parts and are lower in cost than pressure compensating emitters.

Pressure compensating emitters give the same flow from 10 – 60 psi. They are available in 1 gph flow rates. They are valuable for working on slopes, long lateral runs and the designed gph flow rate is suitable for very heavy or very sandy soils.

Root intrusion into a buried emitter is a risk. There are two techniques offered on the market which are guaranteed to inhibit root intrusion. One company offers a herbicide impregnated emitter (ROOTGUARD®) with a 10– year guarantee against root intrusion.

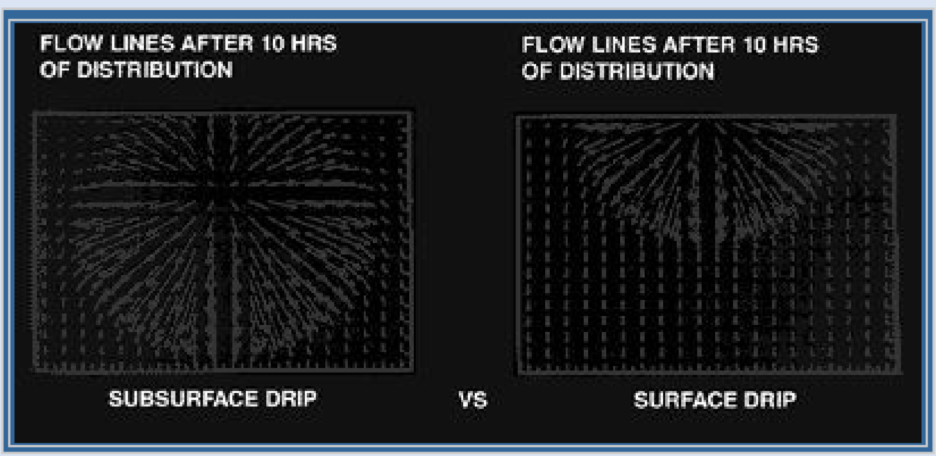
Another company offers a filter (Techfilter®) which slowly releases a vegetation control chemical (trifluralin) through each emitter which inhibits root intrusion into the system. A replaceable Techfilter Cartridge allows renewal of protection for a life-time extended warrantee.

Bacterial slime can grow in the polyethylene emitter lines. Tubing lined with a bactericide is available. Alternatively, a vigorous scour rate of 2 ft/sec is recommended.

- **Flushing manifold**

  In order to help clean the system, the ends of the drip lines are connected together into a common flushing line. This line will help equalize pressures in the system. Periodic flushing will guarantee a long system life. It should be done frequently during the installation and start up period. To control any health hazard, this flush water should return to the treatment plant.

Figure 1




**SYSTEM DESIGN**

Design parameters for a typical drip system are as follows.

*Area Selection*

Select the area with careful consideration of the soil and the terrain Be sure the field is not in a flood plain or bottom of a slope where excessive water may collect after rain.

**Soil Application Design**

The instantaneous water application rate of the system must not exceed the water absorption capacity of the soil. A determination of the instantaneous water absorption capacity of the soil is difficult, however, since the value varies with the water content of the soil. As the soil approaches saturation with water, the absorption rate reduces to an equilibrium rate called the "saturated hydraulic conductivity." Wastewater application rates should be less than 10 percent of this saturated equilibrium.

Table 1

| Soil Class | Soil Type | Soil Absorption Rates: Est. Soil Perc. Rate minutes/in | Soil Absorption Rates: Hydraulic Co n-ductivity inches/hr | Design Hydraulic Loading Rate gal / sq. ft. per day | Total Area Required sq. ft./ 100 gallons per day |
|---|---|---|---|---|---|
| I | Coarse - sand | <5 | >2 | 1.400 | 71.5 |
| I | Fine sand | 5-10 | 1.5-2 | 1.200 | 83.3 |
| II | Sandy loam | 10-20 | 1.0-1.5 | 1.000 | 100.0 |
| II | loam | 20-30 | 0.75-1.0 | 0.700 | 143.0 |
| III | Clay loam | 30-45 | 0.5-0.75 | 0.600 | 200.0 |
| III | Silt-clay loam | 45-60 | 0.3-0.5 | 0.400 | 250.0 |
| IV | Clay non-swell | 60-90 | 0.2-0.3 | 0.200 | 500.0 |
| IV | Clay - swell | 90-120 | 0.1-0.2 | 0.100 | 800.0 |
| IV | Poor clay | >120 | <0.1 | 0.075 | 1334.0 |

Table 1 For guidance only
Consult with the RWQCB and/or County Health Department

Table 1 shows the recommended hydraulic loading rates for various soil conditions. These loading rates assume a treated effluent with BOD and TSS values of less than 30 mg/l is produced in the pre-treatment system.

**Depth and Spacing**

Systems usually have emitter lines placed on 2 foot (600 mm) centers with a 2 foot emitter spacing such that each emitter supplies a 4 sq. ft (0.36 m2) area. These lines are best placed at depths of 6-10 inches (150 - 250 mm) below the surface. This is a typical design for systems on sandy and loamy soils with a cover crop of lawn grass. Closer line and/ or emitter spacing of 12 inches may be used on heavy clay soils or very coarse sands where lateral movement of water is restricted. Using closer spacing should not reduce the size of the field.

**Soil layers and types**

The shallow depth of installation is an advantage of the subsurface dripfield 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 rainfall event and will maintain the highest water absorption rate. The quality and homogeneity of the soil may present a problem. If the soil was not properly prepared and there are pieces of construction debris, rocks and non-uniform soils, it is very difficult to obtain uniform water spread. In all cases, but particularly if the soil is compacted, soil properties can be greatly improved by ripping and disking.

**Adding Soil Fill**

Some disposal sites require additional soil be brought in for agronomic reasons or to increase separation distances from the restrictive layer. Placing drip lines in selected fill material above the natural soil provides an aerated zone for treatment. Disposal however still occurs in the natural soil and the field size must be based on the hydraulic capability of the natural soil to prevent hydraulic overload.

Any time fill material is to be used, the area to receive the fill should have all organic material removed or it must be incorporated into the natural soil to prevent an organic layer from forming and restricting downward water movement.

The fill material should be applied in shallow layers with the first 4 to 6 inches incorporated into the natural soil to prevent an abrupt textural interface. Continue this process until all fill has been incorporated.

The fill area should be left crowned to shed surface water and may need diversion ditches or some other devices to prevent surface water from infiltrating. The entire fill area should have a vegetative cover to prevent erosion. If possible allow the fill to set at least seven to ten days before installing.

**HIGH POINTS, SIPHONING AND SLOPES**

A potential problem with buried drip lines is siphoning dirt into the emitters when the pump is switched off. Drip lines should either have a fairly constant slope, or where practical run driplines along a contour.

At least one vacuum breaker should be installed at the highest point in each zone.

Avoid installing lines on rolling hills where you have high and low points along the same line. If this is unavoidable, connect the high points together and install a vacuum breaker on the connecting line. Driplines should be connected to a common return line with a flush valve.

**Excessive Level Differences**

If the level variation within a zone exceeds six feet, individual pressure regulators should be placed for each six–foot interval or a pressure compensating emitter should be used.

At the end of each dosing cycle water, in the dripline will flow down to the bottom lines within the drip zone. This is called "lowhead drainage". On a slope site install small manifolds with a maximum of 1500 ft of dripline within each zone or sub-zone to offset lowhead drainage.

**Slopes**

Concentrate drip lines at the top of the hill with wider spacing towards the bottom. In the case of compound slopes consult a professional irrigation designer or engineer.

**Reuse for Irrigation**

In addition to the water saving aspect of re–use, a good vegetative cover is an advantage to prevent erosion from the field and consume both water and nitrogen applied to the rooting zone. Sites should be planted or seeded immediately after installation. Grasses are particularly suitable for this application. Most lawn grasses will use 0.25" to 0.35" (6.3 – 8.9 mm) of water per day during the peak-growing season. This calculates to be about 0.16 to 0.22 gal/ft2/day, a significant part of the daily effluent loading. By over-seeding lawns with winter ryegrass, this use efficiency can be continued through much of the year.

For vegetation using 0.16 to 0.22 gal/ft2/day by evapotranspiration, a sewage flow of 1000 gallons per day would supply the water needs of a landscaped area of 4600 to 6400 sq. ft. without having to add fresh water. For areas larger than this, the plants will suffer water stress during the hot months unless additional fresh water is applied. While

California has been one of the last states to adopt SSDD of effluent, for over 25 years it has been the pioneer in using subsurface drip irrigation systems in both agriculture and landscaping. This slow adoption of SSDD could be connected with the regulatory structure.

Figure 2