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SUBSURFACE DRIP IRRIGATION FOR TURF

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BACKGROUND

Historically, subsurface drip irrigation (SSDI) has been successful in agriculture and in landscape shrub, and groundcover applications. The new horizon is turf.

Turf is the most critical crop grown in landscape applications and any system shortcomings become clearly conspicuous. It is not surprising then that the turf industry is looking to agriculture, where demand for effective reliable irrigation tools is a necessity for survival. With budget restrictions and conservation mandates, turf growers, like agricultural crop growers, seek methods to improve yields while controlling costs. Cost savings come in the form of management, labor, maintenance, water, energy, fertigation and chemigation. SSDI is a response to that challenge.

LAYOUT REQUIREMENTS AND COMPONENTS OF SSDI FOR TURF

The turf industry is borrowing information, technology, and products designed originally for agriculture. These are being refined to suit the demands and idiosyncrasies of turf applications.

The critical factor for SSDI to succeed in turfgrass is a well-designed installation with reliable products. Design procedures for SSDI, like even pressure distribution, and installation specifications are similar to traditional drip, but successful installations of SSDI do require a few extra precautions.

A typical system will have the dripline laid out in a grid between the supply manifold on one end and a flush manifold on the other end. The flush manifold provides single point flushing and lateral backflow in the event of tubing damage. Water is slowly applied at relatively low pressure - typically 15 to 35 psi, reducing the energy required for conventional spray systems. Water moves by capillarity through the soil, providing a moist uniform layer under the plants' root zone.

Durability, uniformity and ease of maintenance must be the prime objectives when choosing components. With drip irrigation this means the prevention of clogging. Every single part of the system is designed to prevent clogging, from the choice of filters to driplines and flush valves. Before choosing the hardware, first determine the turf's maximum water needs, availability and quality of water, the soil type and the aeration practices.

<u>Dripline</u>

Start the design in the field itself, since this is where the veins of the system lie. Products that are appropriate for surface drip applications do not always perform adequately when used in the subsurface environment.

A. Dripline placement

"How deep?" and "How far apart?' are the first questions asked when designing turf installations. It is critical to bury the dripline below aeration depth, approximately six to twelve inches below grade. Spacing between emitters is determined by the soil's water holding capacity, ranging from 12 inches for sandy soils to 24 inches for clay-barns. These spacing recommendations are conservative. There are several successful installations with driplines spaced every 36 inches. The further the lines are spaced apart, the more difficult it is to avoid stripes caused by insufficient lateral water movement. For sandy soils 12" between drippers and 18" between rows can provide excellent results at a lower cost.

B. Flow rates

Emitters also come with different flow rates, generally 1/2 gph, 1 gph, or 2 gph. The lower-flow emitters allow manifold line downsizing and the driplines fill more rapidly. Longer run times are required to provide adequate water to the root zone. The net result is a more efficient system because the ratio of startup to run time is very small. However, the higher flow rate emitters with larger flow paths are less susceptible to clogging.

C. Clogging

Clogging underground can occur in three ways: internally from bacterial slime and sediment, externally by root intrusion, or from soil ingestion.
(i) Internal clogging by bacteria is very rare in landscape because of the quality of potable water and tertiary-treated reclaimed water. Clogging can be reduced by using large turbulent flow path emitters. These emitters keep the

water in motion, so that the sediment is suspended in the water until it exits the dripline. With secondary treated water, or pond water, chlorine can periodically be injected into the system to clean out any growth. Filters are used to keep solids from entering the dripline. For secondary treated wastewater applications there are products on the market today with bactericide built into the tube to inhibit bacteria growth.
(ii) Clogging from root intrusion has historically been the major hurdle to SSDI **in** landscape. Tests indicate that for untreated emitters, 10% of the emitters will be blocked by roots in the first three years, 60% in four years, and 95% in six years.[1] There are two solutions available in the market today; chemical or physical barriers.

Chemical Barriers: Treftan®[2] has proven to be the most effective chemical barrier because it is non-systemic, does not migrate in the soil and has a very short half life of 90 - 180 days. Treflan can be poured into the system at regular intervals where it is legal. This method is not registered for use in the United States, Canada, Australia and New Zealand. The quantities used must be carefully monitored and in time, depending on qualified labor and Treflan costs, becomes very expensive.

Emitters are also available which have Treflan® compounded into the plastic polymer during the manufacturing process. Known as ROOTGUARD®[3], the Treflan is slowly released over period of twenty years. This process was developed in 1978 by Battelle Pacific Northwest Laboratories and today it is used to keep roots from growing into nuclear waste sites, sewer lines, sidewalks, and drip emitters. After five years of testing at the Center for Irrigation Technology in Fresno, California, ROOTGUARD® emitters are completely free from root intrusion.[4]

Physical Barriers: Porous pipes which have a multitude of microscopic holes do not suffer the effects of root intrusion, however they have a relatively low application uniformity along the lines averaging 70% for new tubing. Eventual clogging from small particles that pass through the filters reduce their effective field life. Membranes or labyrinth flow paths in point source emitters have also been claimed to prevent root intrusion. Evidence from the Center for Irrigation Technologies tests indicate that these emitters initially show no effects of root intrusion on turf, but examination after five years shows 22% of the emitters have root intrusion affecting the flow.
(iii) Clogging from soil ingested into emitters when a vacuum is created in the lines is eliminated by placing vacuum relief valves at the highest point of each zone.

D. Pressure-compensating vs. non-pressure-compensating
Choosing point source, large turbulent flow path, root intrusion protected emitters will deter clogging. The next choice is whether to use pressure-compensating emitters or non-pressure-compensating emitters. Pressure-

compensating emitters have short, turbulent flow paths with rubber diaphragms which open and close to allow uniform distribution of water through each emission point. This allows for longer runs than non-pressure-compensating emitters, and it makes hill designs much simpler. The down side to pressure-compensating dripline is that the life expectancy of the rubber component can limit the integrity of the product. Rubber, unlike the polyethylene and plastic components of the dripline, is more susceptible to aging and chemical degradation and it can attract bacterial build-up.

Once the field output is determined, the rest of the system can be sized.

<u>Main line</u>

Mainlines are pressurized piping that deliver the water supply to the irrigation system. With SSDI a site can be irrigated any time during a 24-hour day. This is very relevant for treated wastewater where spray irrigation is restricted to times in which human contact is unlikely and where demand during peak consumption periods affects pressure.

<u>Fertilizer Injector (optional)</u>.

One of the main advantages of SSDI is that fertilizer can be safely applied through the system. Beginning in November 1994, the Center for Irrigation Technology will commence testing of various fertilizers and application techniques.

<u>Filters.</u>

Most turf applications will use city treated water, in which case a 150-mesh screen filter that filters out particles larger than about 100 microns will suffice. When water is comparatively dirty then more sophisticated screen filters or sand media filters are required. A single filter can be used to screen particles for all valves, and/or subfilters can be used in the field at the start of the supply manifold. The subfilters serve to keep any particles from entering dripline if there is a break between the primary filter and the feeder manifold, but in areas with a lot of traffic too many valve boxes in the field become hazardous and unsightly.

<u>Pressure or flow regulator</u>.

Pressure in the drip lines generally fall between 15 and 45 psi, as specified by the manufacturer. This is controlled by a pressure regulator located inline, following the filter.

Electric solenoid valves.
These allow you to irrigate one or more zones at a time, either because the water requirements of a zone are different, or because there is not enough water volume available to irrigate everything at once. These are automated by controllers.

Irrigation controller.
Controllers are used to maximize the efficiency of the entire irrigation system. An automatic controller station can open one or more valves at a time, allowing precise and frequent applications. Some controllers accommodate rain or moisture sensors or can give the user water use and pressure feedback which can be used to detect errors or to plan future irrigation cycles.

Vacuum relief vent
A crucial element of SSDI systems, the vacuum relief valve is placed at the highest point of each valve. It prevents soil from siphoning into the lines when the system is turned off.

Supply manifold
The driplines are connected with tees to the supply manifold which is generally PVC pipes, but often polyethylene tube is used. These lines should be buried deeper than the driplines to keep them from draining every time the system is shut off. As in any irrigation system the accuracy of the entire system is dependent on correct supply manifold sizing.

Flushing lines
To clean the system and equalize pressure, the ends of the emitter lines are connected together into a common flushing line with either a manual or automatic flush valve in the center.

OPERATION AND MAINTENANCE

The user must learn how to work with the system to ensure a long life, and maximize efficiency. With this new irrigation tool the user must learn to irrigate without seeing the water and by watching the quality of the turf. This requires confidence in the system.

Watering to field capacity will maintain moisture at the root level of the plants without over saturating. Turfgrass needs both water and air at the root level. Watering with a drip system only requires a few minutes daily, or every second or third day. The application rate is determined by dripline and emitter spacing and the emitter discharge rate. The volume of water applied is simply proportional to the time the system is running. Evapotranspiration values for turf are used as a guideline. SSDI water application, measured in gallons per hour, can be converted to inches with the following equation:

$$A = \frac{38.5 \times Q}{(S_R \times S_D)/144}$$

Where:

A (inches/acre)	= Application of water per 24 hour day
Q (gallons/hour)	= Emitter discharge rate
S_R (inches)	= Spacing between drip rows
S_D (inches)	= Spacing between emitters

The filters must be checked and the lines flushed out at regular intervals.

RECLAIMED WATER

There is a worldwide trend toward the use of reclaimed water in urban landscapes. Until the development of ROOTGUARD® protected emitters, SSDI with reclaimed water has been extremely difficult due to the well-known attraction of roots to the nutrient rich water.

Most of the major reuse schemes use the bulk of reclaimed water in landscape, because of the high cost of distributing the effluent to more distant agricultural areas. Reclaimed water, which is produced continuously year round, has a relatively consistent customer in turfgrass. Large turfgrass areas lend themselves to using reclaimed water as the cost and availability of potable water increases. Turfgrass also absorbs high quantities of nitrogen often found in reclaimed water. Reclaimed water may contain high salt levels which can be managed by maintaining adequate moisture in the soil. When distributed below ground, the potential risk of disease caused by bacteria and viruses is virtually eliminated.

COST BENEFIT ANALYSIS

Before a decision whether or not SSDI is the best tool, an evaluation of both the pros and the cons must be considered.

Risk management is an important factor in the economic evaluation of an irrigation system when the general public may have access. In the case of SSDI in sports fields, the risk of injury caused by sprinklers is eliminated, and the risk of vandalism is limited. Perceived health risks associated with the use of reclaimed water are reduced dramatically as well as the environmental and political risks associated with reducing contamination of the aquifer by fertilizers.

SSDI delivers water and nutrients directly to the root zone precisely when and where the grass needs them. This reduces fertilizer waste which is often leached into the aquifer when excess is applied. It also reduces water consumption, which becomes more critical as the cost of water increases. Compared to sprinklers, water consumption is reduced due to less runoff, less evaporation, no wind interference and a more uniform distribution. Claims of +30% in water savings have been documented. This number is directly affected by the efficiency of the alternative systems.

Reduced surface water maintains the soil profile, which reduces compaction and diseases for healthy plant growth. The grass can be irrigated while in use without compaction compounded by foot traffic on wet surfaces. We are finding very deep root structures with SSDI.

Long term cost savings from reduced water use, maintenance and fertilizers make SSDI a cost effective tool. According to Dennis Hansen, landscape architect and certified irrigation designer who started experimenting with lawns in 1985:

> “Even on large projects initial installation costs for drip irrigation can come in comparable to a well designed properly installed overhead system. Over the long range, SSDI installation and water usage will result in savings”.

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[1] *Pearce, Vaughan. Subsurface Drip Irrigation in Landscape and Turf Applications. Australian Irrigation Association meeting 1994.*

[2] *Treflan is a registered trademark of Dow Elanco.*

[3] *ROOTGUARD® is a registered trademark of A.I. Innovations.*

[4] *Zoldoske, D. Subsurface Drip Irrigation for Turfgrass: Emitter Observations, Center for Irrigation Technology, Fresno, CA, June 1994.*