Natural Resources Conservation Service
Conservation Practice Standard

IRRIGATION SYSTEM, MICROIRRIGATION
(No. and Ac.)
Code 441

DEFINITION

An irrigation system for distribution of water directly to the plant root zone by means of surface or subsurface applicators.

PURPOSE

To apply chemicals or to efficiently and uniformly apply irrigation water directly to the plant root zone to maintain soil moisture within the range for good plant growth and without excessive water loss, erosion, reduction in water quality, or salt accumulation.

CONDITIONS WHERE PRACTICE APPLIES

On sites where the soils and topography are suitable for irrigation and proposed plants and where a microirrigation system has been determined to be the most desirable method of irrigation.

Microirrigation systems, including subsurface drip irrigation (SDI), shall consist of bubblers (generally 60 gal/hr), drip or trickle emitters and tapes (generally 2 gal/hr), or spray or spinners (generally 45 gal/hr).

Microirrigation is suited to orchard and row crops, windbreaks, greenhouse crops, and residential and commercial landscape systems and on steep slopes where other methods would cause excessive erosion or on areas where other application devices interfere with cultural operations.

General

Planned work shall comply with all federal, state, and local laws and regulations.

The system shall be designed to uniformly apply water and/or chemicals directly to the plant root zone to maintain soil moisture within the range for good plant growth without excessive water loss, erosion, reduction in water quality, or salt accumulation.

Depth of application. The net depth of application shall be sufficient to replace the water used by the crop during the peak use period or critical growth stage without depleting the soil moisture in the root zone of the crop below the minimum level established for optimum growth. The gross depth shall be determined by using field application efficiencies consistent with the conservation use of water resources and shall include water required for leaching to maintain a steady state salt balance. The net depth of application shall be expressed as inches per day per unit of design area.

$$F_n = 1.604 \frac{QNTE}{AF}$$

Where:

- F_n = net application depth, in in./day
- Q = discharge rate in gal/h/emitter
- N = number of orifices or emitters
- T = hours of operation per day
- E = field application efficiency, expressed as a decimal
- A = ft^2 of field area served by N (number of emitters)
- F = the design area as a percentage of the field area, expressed as a decimal
- 1.604 = units conservation constant (12 in./ft/7.48 gal/ft^3

Field application efficiency assumed for design purposes shall not exceed 90 percent.

Capacity. The design capacity of trickle irrigation systems shall be adequate to meet moisture demands during peak use period of each and all crops to be irrigated in the design area. The capacity shall include an allowance for reasonable water losses during application periods. The system shall have the capacity to apply a stated amount of water to the design area in a specified net operating period. The design area may be less than 100 percent of the field area but not less than the mature crop root zone area.

DESIGN

Application rate. The design rate of application shall be within a range established by the minimum practical discharge rate of the applicators (orifices, emitters, porous tubing, perforated pipe) and the maximum rate consistent with the intake rate of the soil. The application rate shall be expressed in gallons per hour per emitter or orifice or per foot of porous tubing or perforated pipe.

The discharge rate of orifices, emitters, porous tubing, or perforated pipe may be determined from the manufacturer's data relating to discharge and operating pressure. Emitters shall be located to provide an overlap of the wetting pattern within the root zone.

Lateral lines. Lateral lines shall be so designed that when operating at the design pressure, the discharge rate of any applicator served by the lateral will not exceed a variation of $\pm$ 15 percent of the design discharge rate.

Main lines. Main lines and submains shall be designed to supply water to all lateral lines at a flow rate and pressure not less than the minimum design requirements of each lateral line. Adequate pressure shall be provided to overcome friction losses in the pipelines and in all appurtenances, such as valves and filters. Main lines and submains shall be designed and installed according to the provisions of the standard for Irrigation Water Conveyance, Pipelines (430).

Manifold and lateral lines. Manifold and lateral lines shall be so designed that when operating at the design pressure, the discharge rate of any applicator served by the lateral or by any laterals in an irrigation subunit operated simultaneously will not exceed a total variation of 20 percent of the design discharge rate. Pressure shall conform to manufacturer's recommendations and should not cause "misting" when spray type applicators are used.

Filters. A filtration system shall be provided at the system inlet. Under clean conditions, filters should be designed for a head loss of 5 psi or less. Manufacturer's recommendations and data should be used to design sand separators.

The filter element, strainer, or filtration media must be sized to prevent the passage of solids in sizes or quantities which would obstruct the emitter openings. Recommendations of the emitter manufacturer shall be used in selecting the filtration system. However, filtration systems shall be designed to remove solids equal to or larger than one-fourth the diameter of the emitter opening or the emitter manufacturer's recommendations, whichever is more stringent.

The filter system shall provide sufficient filtering capacity so that backwash time does not exceed 10% of the system operation time. Within this 10% time period, the pressure loss across the filter must remain within the manufacturer's specification and shall not cause unacceptable emission uniformity.

Filter/strainer systems designed for continuous flushing should have backwash rates not exceeding 1.0% of the system flow rate. These systems must not exceed the manufacturer's specified operational head loss across the filter/strainer.

All injectors, such as fertilizer injectors, shall be installed upstream of the system filter, except for systems having injectors equipped with separate filters.

Pressure regulators. The use of pressure regulators should be avoided where practical and economically feasible. Topography and the type of applicator may dictate their use but in no case may pressure regulators be planned to compensate for improperly designed pipelines.

Chemical water treatment. Proper maintenance and water treatment must be followed in accordance with clogging prevention guidelines based upon dripper and water quality characteristics. ASAE EP405.1 contains guidelines for chemical water treatment.

System flushing. Fittings that can be readily operated shall be installed above ground at the ends of all mains, submains, and laterals to facilitate flushing. A minimum flow velocity of 2 ft/sec is recommended for adequate flushing.

Chemigation. The emission uniformity (EU), as defined in NEH 15, Chapter 7, should be not less than 90 percent for any crop where fertilizer or pesticides are applied through the system.

Injectors (chemical, fertilizer or pesticides) and other automatic operating equipment shall be located adjacent to the pump and power unit and placed in accordance with manufacturer's recommendation, where automatic equipment or injectors (chemical, fertilizer, pesticide) have been planned for the system. Irrigation systems, into which chemicals are injected, must incorporate back flow prevention equipment.

Weather conditions must be considered before applying chemicals. Chemigation should not be applied if rainfall is imminent. Application of chemicals will be the minimum length of time to deliver the chemicals and flush the pipelines. Irrigation application amount shall be limited to the amount necessary to apply the chemicals to the soil depth recommended by the chemical label. The pest or nutrient management plan shall be followed on the timing and rate of application.

CONSIDERATIONS

Water quantity

- Effect on the water budget, especially on volumes and rates of infiltration, evaporation, transpiration, deep percolation, and ground water recharge.
- Potential for a change in plant growth and transpiration because of changes in the volume of soil water.
- Effects on the water table in maintaining a suitable root zone for the desired crop.
- Potential ability for irrigation water management of difficult soils and terrains through control of water within the root zone.

Water quality

- Effects of nutrients and pesticides on surface and ground water quality.
- Effects on the movement of dissolved substances below the root zone or to ground water.
- Effects of water management on salinity of soils, soil water, or aquifers.
- Potential for development of saline seeps or other salinity problems resulting from increased infiltration near restrictive layers.

CONSIDERATIONS

Where natural precipitation and/or stored soil water is not sufficient for germination, special provisions shall be made for germination, or the microirrigation system shall apply water at a rate sufficient to adequately wet the soil to germinate seeds or establish transplants. The depth of a subsurface system for use on annual crops shall be limited by the ability of the system to germinate the seeds, unless it is stated in writing that other provisions will be made for this function.

Water quality is usually the most important consideration when determining whether a microirrigation system is feasible. Well and surface water often contain high concentrations of undesirable minerals (chemicals). Surface water can contain organic debris, algae, moss, bacteria, soil particles, etc. Well water can also contain sand. The irrigation water supply shall be properly tested to determine feasibility and treatment needed for use in microirrigation systems.

Microirrigation can influence runoff and deep percolation by raising the soil moisture level and decreasing available soil water storage capacity, increasing the probability of runoff or percolation below the root zone from storm events. Surface water quality may be affected by the movement of sediment, soluble chemicals, and sediment attached substances carried by runoff. Ground water quality may be

affected by the movement of dissolved substances below the root zone.

Microirrigation may affect downstream flows or aquifers and the amount of water available for other water uses.

Chemigation may or may not be required at the same time the plant requires irrigation, which may affect the economics of chemigation. Weather conditions should be considered before applying chemicals. Chemicals should not be applied if rainfall is imminent. Pest or nutrient management planning should address the timing and rate of chemical applications.

On systems where chemicals are injected, care shall be taken so the injected nutrients do not react with other chemicals in the irrigation water to cause precipitation and plugging.

Microirrigation will effect a change in plant growth and transpiration because of changes in the volume of soil water.

There may be a potential for development of saline seeps or other salinity problems resulting from increased infiltration near restrictive layers.

Field shape and slope frequently dictate the most economical lateral direction. Whenever possible, laterals should be laid downslope for slopes of less than 5 percent if lateral size reduction can be attained. For steeper terrain, lateral lines should be laid along the field contour and pressure compensating emitters should be specified or pressure control devices used along downslope laterals.

P_W is not required on high water table soils when the water table is managed at a depth where capillary action (upflux) will supply a portion or the entire daily consumptive use rate.

PLANS AND SPECIFICATIONS

Plans and specifications for the trickle irrigation system shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

Permanently installed mains and laterals shall be designed and installed according to the standard for irrigation pipelines (430).

Chemigation shall be applied in conformance with NRCS conservation practice standards Nutrient Management, Code 590 and Pest Management, Code 595.

OPERATION AND MAINTENANCE

An operation and maintenance plan must be prepared for use by the owner or others responsible for operating the system. The plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly. It should also provide for periodic inspections and prompt repair or replacement of damaged components.

All trickle irrigation systems shall be operated in accordance with an irrigation water management (IWM) plan. IWM plans shall be in accordance with NRCS conservation practice standard, Irrigation Water Management, Code 449.

Frequent maintenance is essential to keep emitters functioning at design flow. Maintenance items include:

- Clean or backflush filters when needed
- Flush lateral lines regularly
- Check emitter discharge often; replace as necessary
- Check operating pressures often; a pressure drop (or rise) may indicate problems
- Inject chemicals as required to prevent precipitation buildup and algae growth
- All operations shall be performed in a safe manner and according to all applicable safety regulations.

REFERENCES

ASAE EP405.1
NEH, Section 15, Chapter 7
NRCS Conservation Practice Standards:
Irrigation Water Conveyance, Pipeline,
Code 430
Irrigation Water Management, Code 449
Nutrient Management, Code 590
Pest Management, Code 595
Pumping Plants for Water Control, Code 533