NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

(No. and Ac.)

CODE 441

DEFINITION

An irrigation system for frequent application of small quantities of water on or below the soil surface as drops, tiny streams, or miniature spray through emitters or applicators placed along a water delivery line.

PURPOSE

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- To efficiently and uniformly apply irrigation water and maintain soil moisture for plant growth
- To prevent contamination of ground and surface water by efficiently and uniformly applying chemicals
- To establish desired vegetation

CONDITIONS WHERE PRACTICE APPLIES

This practice applies on sites where soils and topography are suitable for irrigation of proposed crops and an adequate supply of suitable quality water is available for the intended purpose(s).

Microirrigation is suited to vineyards, orchards, field crops, windbreaks, gardens, greenhouse crops, and residential and commercial landscape systems. Microirrigation is also suited to steep slopes where other methods would cause excessive erosion and areas where other application devices interfere with cultural operations.

Microirrigation is suited for use in providing irrigation water in limited amounts to establish desired vegetation such as windbreaks, living snow fences, riparian forest buffers, and wildlife plantings.

This practice standard applies to systems with design discharge less than 60 gallons per hour at each individual lateral discharge point.

Conservation Practice Standard 442, Irrigation System, Sprinkler, applies to systems with design discharge of 60 gallons per hour or greater at each individual lateral discharge point.

CRITERIA

General Criteria Applicable to All Purposes

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

Microirrigation systems consist of point-source emitters (drip, trickle, and bubbler); surface or subsurface line-source emitters; basin bubblers; and spray or mini-sprinkler systems.

The system shall include all irrigation appurtenances necessary for proper operation. Appurtenances shall be sized and positioned in accordance with sound engineering principles and site-specific features.

Appurtenances include but are not limited to totalizing flow measurement devices, water filtration, air vent valves, vacuum relief valves, pressure relief valve(s), water control valve(s), pressure gauges, pressure regulators, and pressure reducers.

Water quality. The irrigation water supply shall be tested and assessed for physical, chemical, and biological constituents to determine suitability and treatment requirements for use in a microirrigation system.

Emitter discharge rate. The design discharge rate of applicators shall be determined based on the manufacturer's data for expected operating conditions. The discharge rate shall not create runoff within the immediate application area.

For bubbler irrigation, a basin beneath the plant canopy shall be required for water control, and applications shall be confined to the basin area.

Number and spacing of emitters. The number and spacing of emitters along a lateral line shall be adequate to provide water distribution to the plant root zone based on percent plant wetted area (P_w). Procedures found in Reference 4 shall be used to calculate P_w.

Operating pressure. The design operating pressure for both irrigating and flushing shall be in accordance with the manufacturer's published recommendations. The system operating pressure must compensate for pressure losses through system components and field elevation effects.

Emitter manufacturing variability. The manufacturer's coefficient of variation (C_v) shall be obtained and used to assess the acceptability of a particular product for a given application.

The C_V shall be less than 0.07 for point source emitters, 0.11 for subsurface drip irrigation (SDI) emitters, and less than 0.20 for line source emitters.

Allowable pressure variations.

Manifold and lateral lines. Manifold and lateral lines, operating at the design pressure, shall be designed to provide discharge to any applicator in an irrigation subunit or zone operated simultaneously such that they will not exceed a total variation of 20 percent of the design discharge rate. Internal pressure shall not exceed the manufacturer's recommendations during any phase of operation.

Main and submain lines. Main and submain lines shall be designed to supply water to all manifold and lateral lines at a flow rate and pressure not less than the minimum design requirements of each subunit. Adequate pressure shall be provided to overcome all friction losses in the pipelines and appurtenances (valves, filters, etc.) Mains and submains shall maintain flow velocities less than 5 feet per second during all phases of operation unless special consideration is given to flow conditions and measures taken to adequately protect the pipe network against surge.

Main and submain lines shall be designed and installed according to criteria in Reference 3.

Emission uniformity. Pipe sizes for mains, submains, and laterals shall maintain subunit (zone) emission uniformity (EU) within recommended limits as determined by procedures contained in Reference 4.

Filters. A filtration system (filter element, screen, strainer, or filtration) shall be provided at the system inlet. Under clean conditions, filters shall be designed for maximum head loss of 5 pounds per square inch (psi). Maximum design head loss across a filter before cleaning shall be based on the manufacturer's recommendations. In the absence of the manufacturer's data, maximum permissible design head loss across a filter is 7 psi before filter cleaning is required.

The filter shall be sized to prevent the passage of solids in sizes or quantities that might obstruct the emitter openings. Filtration systems shall be designed to remove solids based on the emitter manufacturer's recommendations. In the absence of the manufacturer's data or recommendations, filtration systems shall be designed to remove solids equal to or larger than one-tenth the emitter opening diameter.

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

Filter/strainer systems designed for continuous flushing shall not have backwash rates exceeding 1.0 percent of the system flow rate or exceeding the manufacturer's specified operational head loss across the filter.

Air/vacuum relief valves. Vacuum relief shall be designed and installed to prevent ingestion of soil particles if there are summits in system laterals.

Air/vacuum relief valves shall be installed on both sides of all block or manifold water supply control valves.

Pressure regulators. Pressure regulators shall be used where topography and the type of applicator dictate their use. Pressure regulators

shall not be planned to compensate for improperly designed pipelines.

System flushing. Appropriate fittings shall be installed aboveground at the ends of all mains, submains, and laterals to facilitate flushing. The system shall be designed and installed to provide a minimum flow velocity of 1.5 feet per second during flushing. During flushing submain and manifold (pipelines located downstream from a control valve), the velocities shall not exceed 7 feet per second. Each flushing discharge outlet shall include a pressure gauge and/or Schrader valve tap.

Criteria Applicable to Efficiently and Uniformly Apply Irrigation Water

Depth of application. Net depth of application shall be sufficient to replace the water used by the plant during the plant peak use period or critical growth stage. Gross depth of application shall be determined by using field application efficiencies consistent with the type of microirrigation system planned. Applications shall include adequate water for leaching to maintain a steady state salt balance.

System capacity. The system shall have either (1) a design capacity adequate to meet peak water demands of all crops to be irrigated in the design area or (2) enough capacity to meet water application requirements during critical crop growth periods when less than full irrigation is planned. The rationale for using a design capacity less than the peak daily irrigation water requirement shall be fully explained and agreed upon by the end user. Design capacity shall include an allowance for reasonable water losses (evaporation, runoff, and deep percolation) during application periods.

The system shall have the capacity to apply a specified amount of water to the design area within the net operation period. Minimum system design capacity shall be sufficient to deliver the specified amount of water in 90 percent of the time available, but it is not to exceed 22 hours of operation per day.

SDI. Tubing depth and spacing are soil and crop dependent. Emitter line depth shall consider the auxiliary irrigation methods used for leaching, germination, and initial development. Maximum lateral line distance from the crop row shall be 24 inches for annual row crops and 48 inches for perennial (pasture and alfalfa), vineyard, and orchard crops. Zone EU shall be designed for a minimum of 88 percent.

Criteria Applicable to Preventing Contamination of Ground and Surface Water

Chemigation and chemical water treatment. Zone EU shall not be less than 88 percent where fertilizers, pesticides, or treatment chemicals are applied through the system.

Backflow prevention devices shall be provided on all microirrigation systems equipped for chemical injection.

Injectors (chemical, fertilizer, or pesticide) and other automatic operating equipment shall be located and installed in accordance with the manufacturer's recommendations and shall include integrated back flow prevention protection.

Chemigation shall be accomplished in the minimum length of time needed to deliver the chemicals and flush the pipelines. Application amounts shall be limited to the minimum amount necessary, and the rate shall not exceed the maximum rate recommended by the chemical label.

Proper maintenance and water treatment shall be followed to prevent clogging based upon dripper and water quality characteristics.

Irrigation water supply tests shall be used to plan for addressing or avoiding chemical reactions with injected chemicals to prevent precipitate or biological plugging.

Criteria Applicable to Establishing Desired Vegetation

System capacity. The system shall have a design capacity adequate to provide supplemental water at a rate that will ensure survival and establishment of planned vegetation for a period of at least 3 years. The system shall have the capacity to apply the specified amount of water to the design area within the net operation period.

Gross application volume per plant shall be determined using field application efficiency consistent with the type of microirrigation system planned. If a need is indicated by water test results, applications shall include adequate water for leaching to maintain a steady state salt balance.

Microirrigation systems installed solely to deliver supplemental water for establishment of windbreaks or riparian vegetation shall be designed to deliver a minimum of 8 gallons per

tree or shrub per week to assist in the establishment process. Design net application volumes per plant are dependent on the species of tree or shrub and the age (first, second, or third year).

Drip lateral lines installed on the ground surface shall be placed along the plant row(s) in a serpentine pattern to allow for expansion and contraction of the line while keeping the emitter close to the tree or shrub. Aboveground drip lines shall be pinned or anchored to prevent the lines from being dislodged or moved away from the trees or shrubs.

Windbreaks shall be planned, designed, and installed according to Conservation Practice Standard 380, Windbreak/Shelterbelt Establishment.

When lateral emitter spacing or capacities vary with each row, the laterals must be designed separately.

Operation and maintenance (O&M) items specific to vegetation establishment are included in Chapter 6 of Reference 2.

A filtration system (filter element, screen, strainer, or filtration) shall be provided at the system inlet. The filter shall be designed to retain any material larger than 100 mesh size. Filter/strainer systems designed for continuous flushing shall not have backwash rates exceeding 1.0 percent of the system flow rate or exceeding the manufacturer's specified operational head loss across the filter. Two pressure gages should be installed near the filter (one before and one after the filter) to provide an indication if the filter is clogged or partially blocked.

Air release and vacuum relief. A method of air release shall be installed at the summit of the main and submain and end of flush lines to release air upon filling of the system. Vacuum relief valves shall be installed at the high points on the main and submain flush lines and along the lateral lines as needed to relieve vacuum from developing during drainage and to avoid the potential plugging problem from soil being drawn into the emitters within the lateral tubing.

Pressure regulators. A 15 psi pressure regulator shall be placed in the mainline or submain between the filter and the connection to the first lateral line.

System flushing. In addition to the general criteria, a minimum of 5 feet of tubing length shall be added to all manifolds and lateral lines for temporary sediment storage. The main line and submain only require flushing at the time of initial installation.

Subsurface irrigation design. Tubing depth shall be between 12 and 18 inches. The emitter spacing shall be no less than 12 inches nor more than 24 inches apart based on the plant spacing within the row.

EU for the system (zone) shall be designed for a minimum of 85 percent.

Surface drip irrigation design. The maximum pressure drop across any lateral shall be limited to 10 psi. The lateral tubing shall be placed on the ground so that the line has 5 percent additional length to account for contraction and expansion due to temperature changes.

The number and spacing of emitters, drippers, applicators, orifices, micro-tubing, etc., along the lateral line shall be adequate to provide water distribution to the plant root zone. Size and flow rate depend upon desired application rate and time.

CONSIDERATIONS

In the absence of local experience, field application efficiency (E) of 90 percent should be used to estimate system capacity.

In arid climates with subsurface systems, natural precipitation and/or stored soil water is sometimes inadequate to provide crop germination. Special provisions should be made for germination (for example, portable sprinklers), or the microirrigation system should apply water at a rate sufficient to adequately wet the soil to germinate seeds or establish transplants. The depth of subsurface systems on annual crops should be limited by the ability of the system to germinate seeds, unless other provisions are made for this function.

Potential rodent damage should be considered when selecting materials and deciding on aboveground or belowground system installation.

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. Pest or nutrient management planning should address the timing and rate of chemical applications.

Field shape and slope often dictate the most economical lateral direction. Laying laterals downslope can allow for longer lateral run lengths and/or lateral size reduction. Uneven topography may require use of pressure-compensating emitters.

For terrain slopes steeper than 5 percent, lateral lines should be laid along the field contour and pressure-compensating emitters should be specified or pressure control devices used along downslope submains at lateral inlets.

Economic assessments of alternative designs should include equipment and installation as well as operating costs.

Longer, less frequent irrigations of windbreaks during establishment are recommended to encourage deeper root development which increases drought tolerance.

Chemicals should not be applied if rainfall is imminent.

Installation and operation of microirrigation systems have the potential to save energy as a result of reduced seasonal irrigation application and, in some situations, reduced operating pressures.

PLANS AND SPECIFICATIONS

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

O&M

A site-specific O&M plan shall be developed and reviewed with the landowner/operator. The O&M plan shall provide specific instructions for operating and maintaining the system to ensure that it functions properly, including reference to periodic inspections and the prompt repair or replacement of damaged components. The O&M plan should include (but is not limited to) the following:

- Install flow meter and monitor water application
- Clean or backflush filters when needed
- Flush lateral lines at least annually
- Check applicator discharge often; replace applicators as necessary
- Check operating pressures often; a pressure drop (or rise) may indicate problems
- Check pressure gauges to ensure proper operation; repair/replace damaged gauges
- Inject chemicals as required to prevent precipitate buildup and algae growth
- Check chemical injection equipment regularly to ensure it is operating properly
- Check and assure proper operation of backflow protection devices

REFERENCES

1. Design and Installation of Microirrigation Systems, American Society of Agricultural Engineers (ASAE), ASAE EP405.1, February 2003.
2. National Engineering Handbook Part 652, *Irrigation Guide*.
3. Conservation Practice Standard 430DD, Irrigation Water Conveyance, High-Pressure, Underground, Plastic Pipeline, Code 430DD.
4. National Engineering Handbook Part 623, *Irrigation*, Chapter 7, “Trickle Irrigation.”
5. National Engineering Handbook Part 623, *Irrigation*, Chapter 2, “Irrigation Water Requirements.”