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.

PURPOSES

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.

In this standard, uniform applies to the discharge of water from the emitter devices within a managed subunit.

CONDITIONS WHERE PRACTICE APPLIES

On sites where soils and topography are suitable for the 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 irrigation methods could cause excessive runoff and 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 gal/hr at each individual emitter discharge point.

Conservation Practice Standard 442, Irrigation System, Sprinkler applies to systems with design discharge of 60 gal/hr or greater at each individual 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, or degradation in water quality.

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

The design of all items within the system shall be in accordance with and based on sound engineering practices, manufacturer's data and recommendations, and site-specific features.

The system shall include all irrigation appurtenances necessary for proper operation. Appurtenances include but are not limited to totalizing flow measurement devices, check valve, 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 (Reference 2, Chapter 6, Table 12).

Emitter discharge rate. The design discharge rate of applicators shall be determined based on 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 and percent plant wetted area (P_w). Procedures found in Reference 4 shall be used to calculate Pw.

Operating pressure. The design operating pressure shall be in accordance with emitter manufacturer 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) should be used to assess the acceptability of a particular product for a given application. The C_V should be less than 0.07 for point source 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 manufacturer recommendations during any phase of operation.

Manifold and lateral lines shall be designed such that the desired emission uniformity (EU) is obtained.

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 ft/sec during all phases of operation, unless special consideration is given to flow conditions and measures are taken to adequately protect the pipe network against surge.

Main and submain lines shall be designed and installed according to criteria in NRCS, Conservation Practice Standard Irrigation Water Conveyance, Pipeline, High Pressure Plastic, Code 430DD.

Emission Uniformity (EU).

System EU must be no less than 85% when determined based on procedures contained in Reference 3 (EQ 7-33).

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 psi. Maximum design head loss across a filter before cleaning shall be based on manufacturer recommendations. In the absence of manufacturer 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 equal to or larger than one-fourth the emitter opening diameter.

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 shall remain within the manufacturer's specification and not cause unacceptable EU.

Filter/strainer systems designed for continuous flushing shall not have backwash rates exceeding 1.0% of the system flow rate.

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 above ground 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 ft/sec during flushing. The removal of larger particles may require a flushing velocity in excess of 1 ft/sec. During flushing, submain and manifold (pipelines located downstream from a control valve) velocities shall not exceed 7 ft/sec velocity. Each flushing discharge outlet shall include a pressure gauge and/or Schrader valve tap.

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.

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 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.

Minimum system design capacity shall be sufficient to deliver the specified amount of water in 90% of the time available, but not to exceed 22 hours of operation per day.

Subsurface Drip Irrigation (SDI). Tubing depth and spacing are soil and crop dependent. In the design and installation, emitter line depth shall consider the auxiliary irrigation methods used for germination and initial development.

Criteria Applicable to Preventing Contamination of Ground and Surface Water

Chemigation

Backflow prevention devices shall be provided on all microirrigation systems equipped for chemical injection. Backflow prevention shall be installed between the water supply pump and the chemical injection point to prevent backflow of water from the irrigation system to the water source (Reference 2, P. 6-60).

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 consider the timing and rate of chemical applications (see NRCS Conservation Practice Standard 590 and 595). Chemigation should not be initiated if rainfall is imminent.

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 minimum amount necessary, and rate shall not exceed maximum rate recommended by chemical label.

Chemical Water Treatment

Proper maintenance and water treatment shall be followed to prevent clogging based upon dripper and water quality characteristics (Reference 5, Chapter 11).

Chemical treatment of the irrigation water may be required to prevent emitter clogging. This may include acid injection for pH adjustment to prevent or remove scale. Chemical treatment may also involve biocides to prevent or dissolve biological growth within the microirrigation system. If the source is ground water, calcium or iron precipitates are very common and water treatment is often required for long term efficient functioning of the microirrigation system. If the source is surface water, treatment with a biocide is normally required.

Criteria Applicable to Establishing Desired Vegetation

System capacity. The system shall have design capacity adequate to provide supplemental water at a rate that will ensure survival and establishment of planned vegetation. 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 estimated using field application efficiency consistent with the type of microirrigation system planned.

Microirrigation systems installed solely to deliver supplemental water for establishment of windbreaks or riparian vegetation shall be designed to deliver a minimum of eight gallons per tree or shrub per week to assist in the establishment process.

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

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

CONSIDERATIONS

Because of the high potential for emitter plugging, water quality is usually the most important consideration when determining whether a microirrigation system is feasible.

Under climatic conditions where natural precipitation and/or stored soil water is sometimes inadequate to provide crop germination, special provisions should be made for germination (i.e. 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 above or below ground system installation.

Field shape and slope often dictate the most economical lateral direction. Laying laterals down slope 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%, lateral lines should be laid along the field contour and pressure-compensating emitters 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.

Microirrigation systems have the potential to save energy as a result of reduced seasonal irrigation application, and in some situations reduced operating pressures as compared to sprinkler irrigation systems.

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.

OPERATION AND MAINTENANCE

A site specific operation and maintenance (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. Operation and Maintenance Plan should include but is not limited to:

- Install flow meter and regularly monitor and record water flow rates.
- Clean or backflush filters when needed.

- Flush lateral lines at least annually.

Check emitter discharge rate often; if emitter becomes partially clogged, chemical treatment may be required.

- 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.
- Chemical injection equipment should be checked regularly to ensure proper operation.
- 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, 1996.
3. National Engineering Handbook, Part 623, Chapter 7, Trickle Irrigation, 1984.
4. National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Requirements, 1993
5. Microirrigation for Crop Production, (Design, Operation, and Management), Elsevier, 2007.