NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, MICROIRRIGATION

(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 [1].

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
- Reduce energy use

CONDITIONS WHERE 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 gal/hr at each individual lateral discharge point.

NRCS Conservation Practice Standard (442) Irrigation System, Sprinkler, applies to systems with design discharge of 60 gal/hr 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 emitter (drip, trickle, and bubbler), surface or subsurface line-source emitter, basin bubbler, and spray or mini sprinkler systems [2].

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 [3].

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. [4]

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 [1].

Number and spacing of emitters. The number and spacing of emitters along a lateral line (tubing) shall be adequate to provide water distribution to the plant root zone and percent plant wetted area (P_w). Procedures found in NRCS National Engineering Handbook (NEH) Part 623, Chapter 7, Trickle Irrigation, shall be used to calculate Pw.

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

Emitter manufacturing variability. The manufacturers coefficient of variation (Cv) shall be obtained and used to assess the acceptability of a particular product for a given application [1].

The C_V shall be less than 0.07 for point source emitters and less than 0.20 for line source emitters.

Allowable pressure variations.

<u>Manifold and lateral lines</u>. 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.

<u>Main and submain lines</u>. 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 taken to adequately protect the pipe network against surge [3].

Main and submain lines shall be designed and installed to meet the applicable criteria in NRCS Conservation Practice Standard, Irrigation Pipeline (430).

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 NEH, Part 623, Chapter 7, Trickle Irrigation.

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 10 psi before filter cleaning is required [1].

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 emitter manufacturer recommendations. In the absence of manufacturer data or recommendations, filtration systems shall be designed to remove solids equal to or larger than one-tenth the emitter opening diameter [2].

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 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 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. During flushing submain and manifold (pipelines located downstream from a control valve) velocities shall not exceed 7 ft/sec velocity [4]. Each flushing discharge outlet (excluding lateral (tubing) ends) shall include a pressure gauge and/or Schrader valve tap.

Water Management Plan. An Irrigation Water Management Plan meeting the requirements of NRCS Conservation Practice Standard, Irrigation Water Management (449), shall be developed for use with this practice.

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 [2, 4, & 5].

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

Where: F_n=net application depth, in/day/design area

Q=discharge rate, gal/hr/emitter

N=number of emitters or orifices

T=hours of operation per day, 22 hours maximum

E=field application efficiency, expressed as a decimal, not greater that 0.90 for design purposes.

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 conversion constant

Gross depth of application shall be determined by using field application efficiencies consistent with the type of microirrigation system planned [2]. 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 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% of the time available, but not to exceed 22 hours of operation per day [4].

Flow Measurement. A method of flow measurement (i.e. a meter) shall be in place or installed to facilitate irrigation scheduling and for ongoing evaluation of system performance. Multiple flow measurement locations may be necessary. For the area served by the system, the producer must have the capability to measure water applications to each field larger than five acres that may be managed differently (i.e. crop type, planting/harvest dates, etc.). Flow measuring equipment shall display flow rate (i.e. gpm, cfs) and total volume (ac-ft). Manufacturer's recommendations must be followed regarding proper location in the system to achieve required flow conditions for accurate readings.

Flow measurement is not required under this standard for temporary applications such as in establishing vegetation for windbreaks and critical area treatment.

Subsurface Drip Irrigation (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 vineyard and orchard crops. EU shall be designed for a minimum of 85 percent.

Criteria Applicable To Preventing Contamination of Ground and Surface Water.

Backflow Prevention. Backflow prevention devices such as air gaps or check valves shall be provided on all microirrigation systems to protect wells and public water sources. Wells without air gaps shall be protected by spring-loaded check valves. Each check valve must have a low pressure drain (which opens and drains any remaining liquid onto the ground when the pressure drops) on the bottom of the upstream section. A large volume air vent/vacuum relief valve must be installed upstream of each check valve [6]. Check valves are not required for systems used for vegetation establishment if not equipped for chemical injection.

Chemigation and Chemical Water Treatment. System EU shall not be less than 85 percent where fertilizer or pesticides, or treatment chemicals are applied through the system.

Injectors (chemical, fertilizer or pesticides) and other automatic operating equipment shall be located and installed in accordance with manufacturer's recommendations and 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 minimum amount necessary, and rate shall not exceed maximum rate recommended by chemical label.

Proper maintenance and water treatment shall be followed to prevent clogging based upon dripper and water quality characteristics [1, 2, & 4].

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 design capacity adequate to provide supplemental water at a rate that will insure 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 eight 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. Above ground drip line shall be pinned or anchored to prevent the line from being dislodged or moved away from the trees or shrubs.

Windbreaks shall be planned, designed, and installed according to NRCS, Conservation Practice Standard, Windbreak-Shelterbelt Establishment (Code 380).

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

Operation and maintenance items specific to vegetation establishment are included in NEH, Part 652, National Irrigation Guide, Chapter 6.

Additional Criteria Applicable to Reduce Energy Use

Provide analysis to demonstrate reduction of energy use from practice implementation.

Reduction on energy use is calculated as average annual or seasonal energy reduction compared to previous operating conditions.

CONSIDERATIONS

In the absence of local experience field application efficiency (E) of 90% should used to estimate system capacity [2].

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 (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.

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 down slope can allow for longer lateral run lengths and/or lateral size reduction. Uneven topography may require use of pressure compensating emitters.

Where practical, valves are recommended at lateral (tubing) inlets to facilitate system maintenance.

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.

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

Media filters should be followed by secondary screen filters or a rinse cycle valve if carryover of contaminants following the backwashing process is possible.

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.

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 Flowmeter 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, 1996.

3. NRCS, Conservation Practice Standard Irrigation Water Conveyance, Pipeline, High Pressure Plastic, Code 430DD, 1988.

4. National Engineering Handbook, Part 623, Chapter 7, Trickle Irrigation, 1984.

5. National Engineering Handbook, Part 623, Chapter 2, Irrigation Water Requirements, 1993.

6. Drip and Micro Irrigation for Trees, Vines, and Row Crops, Charles Burt and Stuart Styles, Cal Poly, San Luis Obispo, CA.