

# FARM WATER QUALITY PLANNING MANAGEMENT PRACTICE

**Irrigation System,  
Microirrigation  
#441**

*University of California Cooperative Extension  
Natural Resources Conservation Service*



Microirrigation is sometimes referred to as 'trickle' or 'drip' irrigation. Microirrigation is a planned irrigation system in which all necessary facilities are installed for efficiently applying water directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe) operated under low pressure. The applicators can be placed on or below the surface of the ground. The purpose is to efficiently apply water directly to the plant root zone to maintain soil moisture within the range for good plant growth and without excessive water loss, erosion, or salt accumulation.

## **Advantages**

- Reduces erosion
- Reduces insect, weed and fungus problems
- Efficient water distribution
- Reduces water use
- Possible crop production increase
- May decrease labor
- Less soil crusting and compaction
- Reduces required cultivation
- Precise chemical application (chemigation)
- Can reduce the size of or eliminate the need for additional practices such as a sediment basin or tailwater recovery system

## **Disadvantages**

- High maintenance
- May cause salt deposition problems
- Leaks may go undetected
- Requires a water filtration system

**Practice Effectiveness for Reducing Water Quality NPS Pollution Potential**

<b>Erosion-sheet &amp; rill</b>	<b>Erosion-streambank</b>	<b>Pesticides-leaching</b>	<b>Pesticides-dissolved in runoff</b>	<b>Pesticides-adsorbed to sediment</b>	<b>Nutrients-leaching</b>	<b>Nutrients-surface waters</b>
negligible	negligible	moderate	significant	significant		slight to significant

Empty boxes indicate information not yet collected for this practice

**Additional sources of information regarding microirrigation:**

UC Sustainable Agriculture Research and Extension Program <http://www.sarep.ucdavis.edu/>

UC Weed Research and Information Center <http://wric.ucdavis.edu/>

The picture and some of the information in this management sheet has been taken from the Natural Resource Conservation Service (NRCS) Handbook of Conservation Practices practice #441. Contact your local NRCS office or visit <http://www.nrcs.usda.gov> for more information.

NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE SPECIFICATION

## 441 - IRRIGATION SYSTEM, MICROIRRIGATION

### I. SCOPE

The work will consist of furnishing and installing materials as required to provide for a complete microirrigation system for the tract of land as shown on the drawings.

### II. SOURCE OF WATER

The source of water shall be as shown on the drawings, and as previously determined by the landowner. Water rights for the use of the water are the responsibility of the landowner. The source shall provide the full capacity as may be needed for the system being installed.

### III. INSTALLATION

The materials shall be fabricated in accordance with the manufacturer's instructions. The system shall be tested to determine if the system is in proper working order, and will deliver the required capacity to meet the crop consumptive use, and the specified uniformity distribution rate.

### IV. BASIS OF ACCEPTANCE

The basis of acceptance shall be the ability of the system to deliver the required amount of water to meet the peak consumptive use of the crop, with a distribution uniformity rate of 80 percent or greater.

### OPERATION AND MAINTENANCE ITEMS

A properly operated and maintained microirrigation system is an asset to your farm. This irrigation system was designed and installed to apply irrigation water to meet the needs of the crops without causing excessive erosion or runoff. The estimated life span of this installation is at least 10 years. The life of this system can be assured and usually increased by developing and carrying out a good operation and maintenance program.

This practice will require you to perform periodic maintenance and may also require operational items to maintain satisfactory performance. Here are some recommendations to help you develop a good operation and maintenance program.

Only operate system when needed to furnish water for plant growth, the soil may also be used to store moisture within the rooting depth of the plant.

Operate the system according to the parameters for the area.

Check to make sure that all connections are watertight and all valves are working properly.

Make sure that the filter system is working, even if it is automatic it needs constant monitoring, make adjustments if needed.

Periodically examine each emitter for proper operation and replace if defective.

Exclude all livestock from the equipment or irrigated areas.

Monitor the crop noting areas of moisture stress and repair or adjust system operation.

During non-seasonal use place the system in an area where it will not be damaged but secure, if necessary.

Maintain all pumps, agitators, piping, valves and other electrical and mechanical equipment in good condition following the manufacturers' recommendations.

Eradicate or otherwise remove all rodents or burrowing animals. Immediately repair any damage caused by their activity.

Immediately repair any vandalism, vehicular or livestock damage.

Other items specific to your project are listed on the "Practice Requirements" sheet.

NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD

**IRRIGATION SYSTEM, MICROIRRIGATION**

(No. and Acre)

**CODE 441**

**DEFINITION**

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

**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 optimum plant growth.
- To apply chemicals.

**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.

**CRITERIA**

**General Criteria Applicable To All Purposes**

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** - 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 without depleting the soil moisture in the root zone of the plant below the management allowed depletion (MAD). Gross depth of application shall be determined by using field application efficiencies consistent with the conservation use of water resources. Applications shall include adequate water 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/day/design area

Q = discharge rate, gal/hr/emitter

N = number of orifices or emitters

T = hours of operation per day, 22 hours maximum

E = field application efficiency, expressed as a decimal, not greater than 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

**System capacity** - The system design capacity shall be adequate to meet the intended water demands during the peak use period for all plants to be irrigated in the design area. 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.

The system should have a minimum design capacity sufficient to deliver the peak daily irrigation water requirements in 90% of the time available, but not to exceed 22 hours of operation per day. 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. Field application efficiency ( $E$ ) for design purposes shall not exceed 90 percent.

**Emitter discharge rate** - The design discharge rate of applicators shall be determined from manufacturer's data for the expected operating range. The discharge rate shall not create runoff within the immediate application area. For bubbler irrigation, a basin beneath the plant canopy is required for water control, with applications confined to the basin area.

**Number and spacing of emitters** - The number and spacing of emitters along the lateral line shall be adequate to provide water distribution to the plant root zone and percent plant wetted area ( $P_w$ ). National Engineering Handbook (NEH), Section 15, Chapter 7, shall be used to determine the  $P_w$ .

**Operating pressure** - The design operating pressure shall be in accordance with 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 ( $C_v$ ) shall 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 operated simultaneously such that they will not exceed a total variation between any applicators of 20 percent of the design discharge rate. Pressure shall conform to manufacturer's recommendations.

**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.). Pipe sizes for mains and submains shall maintain flow velocities and emission uniformity (EU) within recommended limits as determined by procedures contained in NEH Section 15, Chapter 7.

Economic considerations shall include both installation and operating costs. Main and submain lines shall be designed and installed according to NRCS conservation practice standard Irrigation Water Conveyance, Pipelines, Code 430.

**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 a head loss of 5 psi or less.

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, 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 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.

**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.

**Chemical water treatment** - Proper maintenance and water treatment shall be followed to prevent clogging based upon dripper and water quality characteristics. ASAE EP405.1 contains guidelines for chemical water treatment.

**System flushing** - Appropriate fittings shall be installed above ground at the ends of all mains, submains, and laterals to facilitate flushing. A minimum flow velocity of 1 ft/sec is considered adequate for flushing.

**Subsurface Irrigation** - 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.

Water flow in the dripline shall be level to 2 percent downgrade with a maximum length of 660 feet. If these conditions are not met, the design shall be supported by engineering (hydraulic) documentation that show EU of 85 percent or greater.

**Chemigation** - System EU shall not be less than 85 percent 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, placed in accordance with manufacturer's recommendation 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 the minimum amount necessary, as recommended by the chemical label.

## 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 contains 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. The movement of sediment, soluble chemicals, and sediment-attached substances carried by runoff may affect surface water quality. The movement of dissolved substances below the root zone may affect groundwater quality.

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% 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.

#### **Endangered Species Considerations**

Determine if installation of this practice, along with any others proposed, will have an effect on any federal or state listed Rare, Threatened or Endangered species or their habitat. NRCS's objective is to benefit these species and others of concern, or at least not have any adverse effect on a listed species. If the Environmental Evaluation indicates that the action may adversely affect a listed species or result in adverse modification of habitat of listed species which has been determined to be critical habitat, NRCS will advise the land user of the requirements of the Endangered Species Act and recommend alternative conservation treatments that avoid the adverse effects. Further assistance will be provided only if the landowner selects one of the alternative conservation treatments for installation; or at the request of the landowners, NRCS may initiate consultation with the U.S. Fish and Wildlife Service, National Marine Fisheries Service and/or California Department of Fish and Game. If the Environmental Evaluation indicates the action will not affect a listed species or result in adverse modification of critical habitat, consultation generally will not apply and usually would not be initiated. Document any special considerations for endangered species in the Practice Requirements Worksheet.

#### **Cultural Resources Considerations**

NRCS's objective is to avoid any effect to cultural resources and protect them in their original location. Determine if installation of this practice will have any effect on any cultural resources.

Document any specific considerations for cultural resources in the design docket and the Practice Requirements worksheet.

GM 420, Part 401, the California Environmental Handbook and the California Environmental Assessment Worksheet provide guidance on how the NRCS must account for cultural resources. The Field Office Technical Guide, Section II contains general information, with Web sites for additional information.

#### **Water Quantity**

1. Effects on the water budget, especially the volume and rate of runoff, infiltration, evaporation, transpiration, and deep percolation, and ground water recharge;
2. Potential for changes in plant growth and transpiration because of changes in the volume of soil water;
3. Effects on downstream flows or aquifers that would affect other water uses or users;
4. The effect on the water table of the field in providing suitable rooting depth for anticipated land uses;
5. Potential ability to manage irrigation water through control of water in the root zone.

#### **Water Quality**

1. Effects on erosion and the movement of sediment, and soluble and sediment-attached substances carried by runoff;
2. Effects of nutrients and pesticides on surface and ground water quality;
3. Potential effects on the movement of dissolved substances below the root zone or to ground water;
4. Effects of soil water levels on such nutrient processes as nitrification and denitrification;
5. Effects of soil water levels in controlling the salinity of soils, soil water or downstream water quality;
6. Effects on the visual quality of downstream water resources.

#### **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**

An operation and maintenance (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. Typical maintenance items include:

- Clean or backflush filters when needed;
- Flush lateral lines regularly;
- 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.