NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

IRRIGATION SYSTEM, SURFACE AND SUBSURFACE

(Acre)
Code 443

DEFINITION

A system in which all necessary earthwork, multi-outlet pipelines, and water-control structures have been installed for distribution of water by surface means, such as furrows, borders, contour levees, or contour ditches, or by subsurface means through water table control.

PURPOSE

This practice is applied as a part of a resource conservation system to achieve one or more of the following:

- Efficiently convey and distribute irrigation water to the surface point of application without causing excessive water loss, erosion, or water quality impairment.
- Efficiently convey and distribute irrigation water to the subsurface point of application without causing excessive water loss or water quality impairment.
- Apply chemicals and/or nutrients as part of an irrigation system in a manner which protects water quality.
- Reduce energy use.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to the planning and design of an irrigation water distribution system or a chemical and/or nutrient application system.

Areas must be suitable for irrigation with water of suitable quality for the purpose intended. Water supplies must be sufficient in quantity and quality to make irrigation practical for the crops to be grown and the application methods to be used.

Topography and soils must be such that irrigation system can be operated without excessive tailwater loss (>10% of gross applied).

This standard does not apply to irrigation systems employing subsurface line-source emitters on buried drip tapes or microirrigation tubing which is addressed with Florida NRCS conservation practice standard Irrigation System, Microirrigation, Code 441.

CRITERIA

General Criteria Applicable to All Purposes

Planned work shall comply with all federal, state, and local laws, rules and regulations. Plans to utilize water resources may need to be permitted by the appropriate water management district in accordance with Chapter 40-2 and Chapter 40-4 Florida Administrative Code (F.A.C.). Additional laws and regulations of particular concern include those involving land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

Impact to cultural resources, wetlands and Federal and state protected species shall be evaluated and avoided or minimized to the

extent practicable during planning, design and implementation of this conservation practice in accordance with established National and Florida policy, General Manual (GM) Title 420-Part 401; Title 450-Part 401, Title 190-Parts 410.22 and 410.26, National Planning Procedures Handbook (NPPH) Florida Supplements to Parts 600.1 and 600.6, National Cultural Resources Procedures Handbook (NCRPH), National Food Security Act Manual (NFSAM), and the National Environmental Compliance Handbook (NECH).

The criteria for the design of components not addressed in Florida NRCS practice standards shall be consistent with sound engineering principles.

Conservation irrigation methods. All irrigation systems must be designed as an integral part of an overall plan of conservation land use and treatment for the farm that is based on the capabilities of the land and the needs of the irrigated area.

All farm irrigation system designs shall be based on the use of sound irrigation water application methods that are suited to site conditions (combination of soil and slope) and crops to be grown. Adapted methods are those methods that will provide efficient use of water without destructive soil erosion or water quality degradation. Detailed design criteria from National Engineering Handbook (NEH), Part 652, National Irrigation Guide, Florida Amendments shall be followed.

Capacity. The irrigation system shall have adequate capacity to meet the intended purpose(s).

If more than one irrigation method will be used on the same field, the system capacity shall be adequate for the method requiring the highest water delivery rate. Likewise, if crops with different peak consumptive use requirements are to be grown, the system capacity shall be based on the crop having the highest peak consumptive use rate.

All structures and water delivery components shall be designed for maximum flow conditions expected and shall have adequate capacity and/or freeboard. All structures and water delivery components shall be designed according to appropriate Florida NRCS conservation practice standards.

Irrigation water management. An irrigation water management meeting the requirements of Florida NRCS conservation practice standard Irrigation Water Management, Code 449 shall be developed for this practice.

Water control. Farm irrigation systems shall include necessary structures required for water control such as: measuring devices, division boxes, checks, turnouts, pipelines, lined ditches, valves, pumps and gates to control and regulate water for efficient application.

Additional Criteria Applicable to Surface Irrigation Systems

Design of physical components shall be in accordance with Florida NRCS conservation practice standards Irrigation Pipeline, Code 430, Irrigation Canal or Lateral, Code 320, Irrigation Field Ditch, Code 388, Structure for Water Control, Code 587, Pumping Plant, Code 533, and other pertinent conservation practice standards.

Capacity. In computing capacity requirements, allowance must be made for reasonable water losses during application and any leaching requirements.

Design application rate. The design rate of application shall be within a range established by the minimum practical application rate for local climatic conditions and the maximum rate consistent with the intake rate of the soil and conservation practices used on the land.

Water surface elevation. All systems for irrigation by surface methods shall be designed so that the water surface elevation at field takeout points is sufficient to provide the required flow onto the field surface. A head of at least 4 inches shall be provided.

Location of delivery ditches or aboveground, multi-outlet distribution pipelines. Delivery ditches or pipelines used for surface irrigation shall be located so irrigation water can be applied uniformly over the entire field without causing erosion. Ditch or pipeline spacing shall be such that irrigation run lengths are not longer than maximums specified in local irrigation guides or those determined acceptable based on field slopes. If more than one crop is to be grown or more than one method of irrigation used, the ditch or distribution pipeline spacing shall not exceed the allowable run length determined for the limiting crop or method.

Aboveground, multi-outlet distribution pipeline.

Working pressure. The maximum working pressure for all aboveground, multi-outlet distribution pipe except for poly irrigation tubing shall be 10 pounds per square inch or 23 feet of head. Appropriate head control appurtenances shall be installed to reduce maximum working pressure to acceptable levels.

For poly irrigation tubing, manufacturer's recommendations for maximum allowable working pressure shall be followed. If the manufacturer's recommendations are not available, the hoop stress formula in NRCS National Engineering Handbook (NEH) Part 636, Chapter 52, shall be used to determine maximum working pressure, using a Factor of Safety of 1.5.

Friction losses. For design purposes, friction head losses shall be no less than those computed by the Hazen-Williams equation, using roughness coefficients of C=130 for aluminum pipe and C=150 for plastic or poly irrigation tubing.

Flow velocity. Velocity in the pipeline when operating at system capacity shall not exceed 7 feet per second unless appropriate surge protection is provided.

Capacity. The design capacity of the pipeline shall be sufficient to deliver an adequate irrigation stream to the design area for the planned irrigation method.

Outlet gates. Individual outlet gates shall have capacity at design working pressure to deliver required flow to a point at least 4 inches above the field surface.

Head requirement. The working head shall not be less than 0.5 foot above outlet gates, unless a detailed design or manufacturer's literature indicates a lower head is adequate to deliver required water to the field.

Where either design working head exceeds 5 feet or stream flows are erosive, an effective method of energy dissipation shall be installed at each gate, or permanent vegetation shall be established and maintained along the pipeline to provide erosion control.

Flushing. A suitable outlet shall be installed at the end of the pipeline for flushing the line free of sediment or other foreign material.

Materials. Pipe shall be aluminum or plastic material certified for above ground use. All fittings and couplers shall equal or exceed the pressure rating of the pipe with which they will be used. They shall be made of material which is recommended by the manufacturer for use with the pipe

Pipe and appurtenances shall be furnished with a coupling system which is compatible with the selected pipe material.

Rubber gaskets shall be according to the manufacturer's standard design dimensions and tolerances for the pipe material selected. They shall be of such size and shape that, after assembly, adequate compressive force is provided against the spigot and socket to affect a positive seal. The gasket shall be a continuous elastomeric ring and shall be the sole element depended upon to make the joint flexible and watertight.

Minimum wall thickness for aluminum gated pipe shall be 0.050 inches for 6 through 10 inches in diameter, and 0.058 inches for 12 inch diameter pipe.

Corrosion protection shall be provided for aluminum pipe when:

- Conveying water with a copper content exceeding 0.02 parts per million.
- In contact with soil having a resistivity of less than 500 ohm-centimeters.
- In contact with soil having a pH less than 4 or greater than 9.

Minimum wall thickness of PVC gated pipe including consideration of any standard manufacturing tolerances shall be not be less than 0.09 inch. The pressure rating of the pipe shall be 22 pounds per square inch or greater, prior to gate installation.

Minimum wall thickness of poly irrigation tubing shall be 6 mil (0.006 inch).

Related structures. An open ditch supply shall include a permanent water control structure as the inlet to multi-outlet pipe.

When the water supply for poly irrigation tubing is greater than 0.5 foot above the ground, a PVC or aluminum fitting shall be used to convey water between the supply outlet and the poly irrigation tubing at ground level.

Erosion control. The design of farm irrigation systems shall provide for conveying and distributing irrigation water without causing damaging soil erosion. All unlined ditches shall have non-erosive gradients. If water is conveyed on slopes steep enough to cause excessive flow velocities, the irrigation system design shall provide for the installation of such erosion-control structures as drops, chutes, buried pipelines, or erosion-resistant ditch linings. Polyacrylamide may be utilized for erosion control according to Florida NRCS conservation practice standard Anionic Polyacrylamide (PAM)-Application, Code 450 in lieu of or in combination with structural measures.

Where needed for erosion control, grade stabilization structures shall be used to convey runoff from the field surface into the outlet ditch. Grade stabilization structures shall meet the requirements of Florida NRCS conservation practice standard, Grade Stabilization Structure, Code 410.

Seepage control. If site conditions require conveyance of water across excessively permeable soils, the irrigation system design shall provide for pipelines, flumes, or lined ditches, as needed, to prevent excessive seepage losses.

Tailwater and excess runoff removal. Irrigation system designs shall include facilities of adequate capacity for safe removal of irrigation tailwater and storm water runoff. If erosion is a hazard, collection facilities (ditches) constructed for this purpose shall be on non-erosive gradients or stabilized by lining or structural measures. If field elevations do not permit non-erosive disposal of tailwater or excess water by gravity flow, the design shall provide for installation of pumping plants and other needed appurtenant structures to remove excess rainfall within a time frame that will not cause crop damage. Ditches shall be protected from bank erosion.

If excess water will be reused for irrigation, the system shall include a tailwater reuse system that conforms to Florida NRCS conservation practice standard Irrigation System, Tailwater Recovery, Code 447.

Pump and power unit. The pump capacity and the power unit shall be adequate to provide the required capacity when being pumped against maximum total dynamic head. Pumps shall be in conformance with Florida NRCS conservation practice standard Pumping Plant, Code 533.

Water control. Farm irrigation systems shall include structures needed for water control such as measuring devices, division boxes, checks, turnouts, pipelines, lined ditches, valves, culverts, flashboard risers, and gates to control and regulate water for efficient application.

Structures shall be sized for the designed flow conditions, shall provide for a freeboard consistent with their size, and according to the Florida NRCS conservation practice standard, Structure for Water Control, Code 587.

Additional Criteria Applicable to Surface Irrigation Systems

Capacity. The system shall have either (1) a design capacity adequate to meet water demands of all crops to be irrigated in the design area or (2) enough capacity to meet the requirements of water application during critical crop growth periods when less than full irrigation is planned.

Location of head ditches or pipelines. Head ditches or pipelines used for surface irrigation shall be located so that irrigation water can be applied uniformly over the entire field without causing erosion. Ditch or pipeline spacing shall be such that irrigation run lengths are not longer than the maximums specified in the local irrigation guide or those determined by field evaluation. If more than one crop is to be grown or more than one method of irrigation used, the ditch or pipeline spacing shall not exceed the allowable run length determined for the limiting crop or method.

Tailwater and Excess Runoff Removal. Irrigation system designs shall include facilities of adequate capacity as needed for the safe removal of irrigation tailwater and storm water runoff from the field surface. Collection facilities (ditches) constructed for this purpose shall be on nonerosive gradients or be stabilized by lining or structural measures if erosion is a hazard. If field elevations do not permit the safe disposal of excess water by gravity flow, the design shall provide for installation of pumping plants and

other needed appurtenant structures. Ditches shall be protected from bank erosion. If excess water will be reused for irrigation, the irrigation system design shall provide for collection facilities so that water does not flow directly from furrows or borders into irrigation head ditches. Tailwater systems shall be designed according to Florida NRCS conservation practice standard, Irrigation System, Tailwater Recovery, Code 447.

Additional Criteria Applicable to Subsurface Irrigation Systems

Subsurface irrigation (subirrigation) systems shall be designed to maintain the water table at or between predetermined elevations below the ground surface at all points in the design area.

Feeder ditches or conduits for subsurface irrigation shall be spaced so that the variation in depth from the land surface to the water table is not greater than is permissible for adequate irrigation of the most limiting crop to be grown.

Design of physical components shall be in accordance with Florida NRCS conservation practice standards Structure for Water Control, Code 587, Pumping Plant, Code 533, and other pertinent conservation practice standards.

Subsurface methods shall be designed with the necessary drainage practices for the removal of excess surface and subsurface water so that the water table does not remain in the root zone long enough to cause crop damage. Main or lateral drainage ditches, field ditches, subsurface drains, and mole drains shall meet the requirements of Florida NRCS conservation practice standard Surface Drainage, Main or Laterals, Code 608; Surface Drainage, Field Ditch, Code 607; Subsurface Drain, Code 606; and Mole Drain, Code 482, respectively.

Soils. Site conditions shall be such that water can move laterally from open ditches or irrigation tiles to form and maintain a water table at the design depth as specified in the irrigation water management plan. Subsurface irrigation shall not be employed unless the irrigated area has a slowly permeable water restrictive layer.

Soil survey information for the irrigated area can be used in preliminary planning. Final design shall be based on on-site lateral hydraulic conductivity measurements or average lateral hydraulic conductivity determined from laboratory tests of each soil layer.

Lateral Spacing. Laterals shall be equally spaced in each subunit. Maximum spacing of irrigation tiles or open ditches shall be no more that one-half the lateral or ditch spacing specified in local drainage guides or no more that one-half the lateral or ditch spacing computed using procedures found in NRCS Part 650, Chapter 14, or NRCS NEH Part 624.

Water Control. Within each managed subunit, the water level control structure shall be of sufficient size to allow adequate flow to meet water requirements of that subunit. The control structures should be set on elevation intervals not to exceed 1 foot. A variation of 0.5 foot in natural ground elevation is desirable. Unless justified by individual field conditions, the natural ground elevation shall not vary more than 0.5 foot along any irrigating field ditch.

Water level control structures must be covered or otherwise protected to prevent accidental entry by animals, livestock, machinery or humans.

All conveyance facilities and other structures shall be of sufficient size to permit the delivery of required quantities of irrigation water without overtopping.

The required capacity of structures shall be provided with a maximum head loss of 0.5 foot depending on vertical intervals of structures and head available.

Capacity. The capacity of the subsurface methods and its components shall be adequate to meet the peak consumptive use requirements of the crops to be grown plus seepage losses. The minimum total capacity shall be based on the system application efficiency. The design application efficiency, E, shall not exceed the values in Table 1. To allow flexibility in irrigation management, the recommended capacity of the system should be equal to or greater than twice the crop peak consumptive use rate.

Table 1 - Design Application Efficiencies, E, for Various Subsuface Methods

Type of Subsurface Method	E (%)
Crown Flood [1]	50
Fully Enclosed	85
Open Channels (Backup) [1]	55
Semi-Enclosed (Flow-through) [1]	65
Underground Conduits	85
Ebb and Flow	90
Capillary Mat	90

[1] Use 80% with tailwater recovery

The system capacity may need to be increased for areas where:

1. It is desired to prevent significant fluctuation of the water table during the 3 or 4 hours of maximum water use (peak consumptive use) at midday,
2. More than normal seepage and peripheral losses occur,
3. Where the water table is allowed to fluctuate,
4. Where the irrigation stream is applied for short durations of time (pulsed).

Land preparation. Excessive irregularities in the land surface should be removed whenever practical by leveling or smoothing so that grades in the direction of the rows are level or uniform, except for minor depressions.

Erosion control. The design of subsurface methods must provide for conveying and distributing irrigation water without causing damaging soil erosion. All unlined ditches shall be located on non-erosive gradients. If water must be conveyed down slopes that are steep enough to cause excessive flow velocities, the irrigation system design shall provide for the installation of such erosion control structures as pipe drops, chutes, or erosion resistant ditch linings. Where needed, ditches shall be protected from bank erosion by a vegetative cover.

Seepage losses. Designs shall provide for minimizing seepage losses. Irrigation supply ditches shall be located so that they do not cross areas of highly permeable soils. If site conditions require conveyance of water across excessively permeable areas, the irrigation system design shall provide for the use of pipelines, flumes, or lined ditches, as needed, to reduce seepage losses.

Additional Criteria For Underground Conduits

Laterals (Underground Conduits). Underground conduits shall meet the material requirements and installation requirements of Florida NRCS conservation practice standard Subsurface Drain, Code 606.

The recommended maximum length of conduits shall be 1300 feet. Consider limiting the length of underground conduits to 660 feet, especially in back-up systems.

Capacity. The capacity of the conduit shall be equal to or greater than the required drainage coefficient or the required irrigation requirement, whichever is greater.

Spacing of mains and laterals. The spacing of main lines and laterals shall be as needed to adequately raise the water table from the lowest expected level to the planned level within 24 hours for the area served or the drainage spacing, whichever is controlling. The maximum spacing of laterals to achieve uniform distribution of irrigation water will be determined by one or more of the following:

1. DRAINMOD computer model analysis.
2. Using the average spacing recommendation from the Florida Drainage guide, specifically for water-table control systems.
3. Comparing the subject site to existing systems with similar soils and crops, where the adequacy of the existing system is known.
4. Small trial areas, where insufficient existing data are available for certain soils.
5. Ellipse equation.

Size of conduits. Conduits must be sized to provide the desired flow, allowing for friction losses and the hydraulic gradients anticipated, for both drainage and subsurface irrigation. The minimum size of conduits shall be 4 inches.

Water table elevation. The water table elevation shall be controlled to allow no more than 1.0 foot variation in the water table elevation along the entire length of the underground conduit. Unless justified by individual field conditions, structures shall be located at not more than 1.0 foot vertical

intervals in the water surface in the underground conduit systems. The required capacity for structural measures shall be provided with a maximum head loss of 0.5 foot or less depending on vertical intervals of structures and head available.

Filter and filter material. Because of the water movement into and out of the conduits in the laterals with fluctuating hydraulic heads, the potential for siltation may be greater than in regular drainage laterals. Suitable filters shall be used where needed to prevent siltation. Determining the need for a filter or selecting a filter is critical.

Properly graded sand and gravel filters, as defined in Florida NRCS conservation practice standard Subsurface Drain, Code 606, can be used as filters around conduits. For fine-textured, poorly graded sands, a geotextile filter material may be used. If geotextile filters are to be used in any other soils, they should be tested to prove they will function satisfactorily. These tests should be made against the soils in which the filters will be installed. These tests are necessary unless sufficient field installations are available in similar soils to indicate that these geotextile filters have not clogged under similar water-table control conditions. In soils where iron oxide problems are known to exist and a filter is needed, a woven geotextile material or sand gravel filter should be used.

Envelopes and envelope material. Envelopes shall be used around subsurface drains if needed for proper bedding of the conduit or to improve the characteristics of flow of ground water into the conduit. See Florida NRCS conservation practice standard Subsurface Drain, Code 606, for envelope material requirements.

Additional Criteria For Open Channels

Mains and laterals. Main and lateral ditches shall meet the requirements of either Florida NRCS conservation practice standard, Irrigation Canal or Lateral, Code 320 and Irrigation Field Ditch, Code 388 or Surface Drainage Main or Lateral, Code 608 and Surface Drainage Field Ditch, Code 607 whichever is controlling. Pipelines may be used to supply the irrigation water to the laterals in lieu of open channels. Pipelines used to deliver irrigation water to the laterals shall meet the requirements of Florida NRCS conservation practice standard, Irrigation Pipeline, Code 430.

Spacing of mains, laterals, and field ditches. The spacing of main, laterals, and field ditches shall be as needed to:

1. adequately raise the water table from the lowest expected level to the planned level within a reasonable time in order to maintain adequate soil moisture in the root zone for the crop and area served, and
2. meet the drainage requirements for the crop and area served.

The maximum spacing of laterals and field ditches to achieve uniform distribution of irrigation water shall be determined by one or more of the following:

1. DRAINMOD computer program analysis.
2. Using the drainage spacing recommendation from the Florida NRCS Drainage Guide.
3. Comparing the subject site to existing systems with similar soils and crops, where the adequacy of the existing system is known.
4. Small trial areas, where insufficient existing data are available for certain soils.
5. Ellipse equation.

Field ditches. The capacity of field ditches shall be equal to or greater than the required drainage coefficient or the required irrigation requirement, whichever is greater. Field ditches shall be constructed on non-erosive grades. Changes in grade should be gradual without drastic changes

The minimum constructed depth shall be 1.25 feet. Greater depths are normally desirable to improve drainage on flat slopes.

The length of ditches supplying irrigation water should normally be 1300 feet or less when water is supplied from one end. Longer irrigation supply ditches may be used provided a uniform water table elevation can be maintained when irrigating and/or draining.

Water table elevation. The water table shall be managed between planned elevations by appropriately locating water control structures. Structures shall be located such that the natural ground elevation for the irrigated area controlled by the structure does not vary more than 1.0 foot. A variation of 0.5 foot in natural ground elevation is desirable. Unless justified by individual field conditions, the natural ground

elevation shall not vary more than 0.5 foot along any irrigating field ditch.

The required capacity of structures shall be provided with a maximum head loss of 0.5 foot depending on vertical intervals of structures and head available.

Additional Criteria For Fully Enclosed

Pipelines. The design of irrigation pipeline mains and manifolds shall ensure that the required quantities of water are conveyed to all lateral lines at the design pressure. Pipelines shall meet the requirements of Florida NRCS conservation practice standard, Irrigation Pipeline, Code 430.

Laterals. Microirrigation tubing installed to convey irrigation water shall meet Florida NRCS conservation practice standard, Irrigation System, Microirrigation, Code 441.

The maximum length of tubing shall be based on the friction loss so as to maintain uniform application of irrigation water.

Spacing of laterals (tubing). The spacing of laterals shall be as needed to uniformly supply irrigation water to the design area.

Size of tubing. Tubing must be sized to provide an emission uniformity (EU) of not less than 80 percent for irrigation units operated simultaneously.

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.

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

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

Additional Criteria For Flow Through

Pipelines. The design of main and lateral irrigation pipelines shall ensure that the quantities of water required are conveyed to all irrigation field ditches at sufficient pressure and flow rate. Pipelines shall meet the requirements of Florida NRCS conservation practice standard, Irrigation Pipeline, Code 430.

Field ditches. Field ditches shall meet the requirements of Florida NRCS conservation practice standard Surface Drainage, Field Ditch, Code 607. The required capacity and velocity shall meet the most stringent requirement of either drainage or irrigation.

The average grade of field ditches in the direction of irrigation should not exceed 0.0055 ft/ft with the maximum grade not to exceed 0.01 ft/ft in any segment of channel. Changes in grade should be gradual without drastic changes. A minimum grade of 0.0005 ft/ft is desirable to ensure drainage. Cross slopes shall be limited to the channel grade unless the size of field ditches is such that "break throughs" from rainfall runoff are prevented. The maximum cross slope shall not exceed 1.00 foot per 100 feet.

The minimum constructed depth should be 0.5 foot or greater below normal ground. Greater depths are normally desirable to improve drainage on flat slopes. Depths may be increased through bedding the crop.

The length of the field ditch should normally not exceed 1300 feet when irrigation water is supplied from one end. Long irrigation field

ditches increase the difficulty of maintaining a uniform water table elevation.

The maximum allowable non-erosive irrigation stream size shall be determined by the empirical formula,

$$Q = \frac{10}{S}$$

Where

Q = maximum allowable stream in gpm

S = slope of channel in feet per 100 feet.

The irrigation stream should be controlled to the extent practical to minimize irrigation tailwater loss unless the water will be collected and reused as irrigation water.

Water table elevation. The irrigation field ditches shall be located and constructed such that the water table depth below natural ground does not vary more than 0.5 foot for the entire length of the ditch.

Spacing of field ditches. The spacing of irrigation field ditches shall be as needed to adequately raise the water table from the lowest expected level to the planned level within 24 hours for the area served or the drainage spacing required for the crop, whichever is controlling.

The maximum spacing of irrigation field ditches to achieve uniform distribution of irrigation water shall be determined by one or more of the following:

1. DRAINMOD computer model analysis.
2. Using the drainage spacing recommendation from the Florida NRCS Drainage Guide
3. Comparing the subject site to existing systems with similar soils and crops, where the adequacy of the existing system is known.
4. Small trial areas, where insufficient existing data are available for certain soils.
5. Ellipse equation.

Additional Criteria For Crown Flood

Crown flood irrigation is applicable only to bedded citrus and to soils suitable for production of citrus. The soil profile should have sufficient soil depth of adequate permeability to allow construction of a bed which can be drained to the extent that at least a 30-inch drained zone, measured from the crown of the bed, can be established and maintained to allow for root system development.

Reuse of tailwater is essential for efficient water use. This can be accomplished with tailwater recovery irrigation systems or irrigation tailwater may be returned to a delivery system where it may be reused for successive irrigation cycles in the surrounding area. Tailwater recovery systems shall meet Florida NRCS conservation practice standard Irrigation System, Tailwater Recovery, Code 447.

Capacity. The capacity of a crown flood irrigation system and its components should be adequate to raise the water level to near the base of the trees in a 24-hour period and shall not exceed 36 hours.

Irrigation water disposal facilities shall provide for the safe removal of excess irrigation water and should be designed to remove the water in 24 hours and shall not exceed 36 hours.

All ditches and other structures shall be of sufficient size to permit the delivery of required quantities of water without overtopping. All structures shall be designed for the maximum flow conditions to be expected and shall provide for a freeboard consistent with their size and construction and according to appropriate standards.

Bedding. Beds shall be constructed with an approximate level grade and crowned to provide for drainage from centerline of the bed into the furrows. It is normally desirable to have a 30-inch minimum settled height of beds above the bottom of furrow and/or above a soil horizon which will perch a water table. The ground elevation at the base of trees should not vary more than 0.5 foot and shall not vary more than 0.75 foot within an area that will be flooded simultaneously. Spacing of beds shall be in conformance with Florida NRCS conservation practice standard Bedding, Code 310.

Furrows shall provide positive drainage and the width between furrows shall not exceed 60 feet.

Location of delivery ditches or pipelines. Ditches or pipelines used shall be located so that irrigation water can be applied uniformly over the entire field without causing erosion.

Additional Criteria For Ebb and Flow or Capillary Mat

Measures shall be taken to collect and recycle nutrient-laden irrigation water used in subsurface irrigation systems to prevent discharge of contaminates to the environment. In fully enclosed greenhouse systems, water shall be 100 percent recycled. Containerized plants shall be placed in bins that are impermeable.

Chlorination or other water treatment methods shall be used where disease spreading problems are a known concern.

Precautions shall be taken to ensure that bin overflow water is routed back to the sump. Sumps shall be sized to hold the complete irrigation volume of the largest bin that the sump serves.

Additional Criteria Applicable to Reduce Energy Use

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

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

Additional Criteria Applicable to Application of Chemicals and/or Nutrients with a Surface Irrigation System

The installation and operation of an irrigation system for the purpose of chemical and/or nutrient application shall comply with all applicable Federal, State and local laws, rules and regulations. This includes backflow and anti-siphon prevention measures to protect surface and ground water sources. Additionally, surface waters shall be protected from direct application and runoff.

Design of physical components shall be in accordance with Florida NRCS conservation practice standards Irrigation Pipeline, Code 430, Waste Transfer, Code, 634, Structure for Water Control, Code 587, Pumping Plant Code, 533, and other pertinent conservation practice standards

Capacity. The system shall have a design capacity adequate to supply the specified amount of chemical and/or nutrients to the design area in the specified operating period.

Nutrient and pest management. Chemicals, fertilizers, waste water, and liquid manure shall be applied in accordance with appropriate Florida NRCS conservation practice standards for Nutrient Management, Code 590; Pest Management, Code 595; and/or Waste Utilization, Code 633.

CONSIDERATIONS

When planning this practice the following items should be considered:

Irrigation land leveling or land smoothing should be applied when the irrigated area contains significant depressions which will pond water or the ground elevation will not permit uniform irrigation water distribution. Irrigation land leveling should meet Florida NRCS conservation practice standard Irrigation Land Leveling, Code 464. Land smoothing should meet Florida NRCS conservation practice standard Land Smoothing, Code 466.

Irrigation land leveling will improve surface drainage, improve the availability of nutrients, uniformity of crop production, and uniformity and efficiency of irrigation.

Plants may need to be grown on raised beds to provide the drained root zone necessary to prevent crop damage where surface and subsurface drainage is a problem.

Consideration should be given to eliminate irrigation runoff to no more than 10 percent of the amount applied. Tailwater recovery systems should be installed to collect and reuse irrigation water when management or structural practices will not prevent excessive irrigation runoff.

Fully enclosed subsurface systems may eliminate irrigation runoff compared to other methods of subsurface irrigation systems.

Depending on the water table management strategy, subsurface irrigation systems may increase outflow rates during wet periods because water table elevations at the beginning of rainfall events will be elevated compared to conventional drainage. Runoff from rainfall can be reduced by managing the water table at the lowest depth that will allow for a sufficient rate of upflux to the crop. This depth will vary during the crop growing season.

Subsurface drainage systems tend to reduce peak flows from stormwater compared to surface drainage on similar soils.

Water table observation wells are recommended to monitor the ground water level.

Where fully enclosed subirrigation systems are used, burying the tube below the cultivation depth can provide for use on a continual basis and eliminates the seasonal requirements of installation, retrieval, and disposal. For the deep burial systems, proper maintenance and water treatment must be followed in accordance with clogging prevention guidelines based upon emitter and water quality characteristics.

Water table control to maintain relatively high field water table levels tends to increase the proportion of surface runoff in total outflow. The higher water table levels tend to increase the potential for denitrification and should result in lower concentrations of nitrate-nitrogen compared to uncontrolled drainage.

Lateral seepage losses can be minimized with good planning and layout. Whenever possible, irrigation supply canals should be located near the center of irrigated fields rather than along the side. Perimeter ditches and outlet canals should also be controlled with structures.

Whenever possible, irrigated field should be laid out in square blocks and adjoining other irrigated fields. This minimizes the length of field boundaries along which seepage can occur.

Water quality is an important consideration when determining whether irrigating with drip emitters or underground conduits 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. The irrigation water supply should be properly tested to determine its feasibility and treatment needed for use in supplying irrigation water. The ground water should be tested to determine the potential for clogging underground conduits.

To reduce phosphorus discharge, subsurface irrigation systems installed in organic soils shall be operated to maintain the water table as high as possible for the crop being grown and with as minimal of fluctuation as possible. Structures shall be designed to provide for storage of rainfall and reduce offsite discharge of drainage water.

Consideration should be given to monitoring recycled irrigation water for weed seed, harmful bacteria and disease. Measures may need to be taken to prevent spreading of these problems.

Ebb and Flow or Capillary Mat subirrigation systems should be considered for use in greenhouse situations. Use of these methods will incur higher initial construction cost and require management skills for disease prevention and other water quality concerns. However, these systems typically require less water and fertilizer compared to overhead irrigation methods since the water is recycled. A single sump may serve as the receptacle of water to be reused for several zones of irrigation.

Due consideration should be given to the economics of the overall irrigation system and water management strategy.

PLANS AND SPECIFICATIONS

Plans and specifications shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose. As a minimum, the plans and specifications shall include:

- Site plan and location of the system.
- Location of pipelines, ditches, etc.
- Profile of all pipelines, ditches, etc.
- Typical cross-sections of ditches, etc.
- Type, quality and quantity of all pipelines, pumps, structures, etc.
- Location of utilities and notification requirements.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance (O&M) plan for use by the landowner or operator responsible for the irrigation system installed. The O&M plan shall document needed actions to ensure that practices perform adequately throughout their expected life. The O&M plan shall reference the requirements of the IWM plan.

O&M requirements shall be included as an identifiable part of the design. Depending on the scope of the project, this may be accomplished by brief statements in the plans and specifications, the conservation plan narrative, or as a separate O&M plan.

The O&M plan shall provide for periodic inspections and prompt repair or replacement of damaged components.

Systems shall be operated without causing excessive water loss or degrading water quality.

As a minimum, the O&M plan shall include provisions to address the following:

- Periodic cleaning and regrading of collection facilities to maintain proper flow lines and functionality.
- Periodic checks and removal of debris as necessary from trash racks and structures to assure proper operation.
- Periodic removal and planned placement of sediment from traps and/or storage facilities to maintain design capacity and efficiency.
- Inspection or testing of all pipeline and pumping plant components and appurtenances, as applicable.
- Routine maintenance of all mechanical components in accordance with manufacturer's recommendations.
- Periodic land leveling or grading of surface irrigated fields is required to maintain uniform field grades for application uniformity.
- A system to monitor and observe the water table for subsurface methods.
- Water table elevations for subirrigation methods.
- A record keeping system of irrigation water added, and observed crop response.

Additionally for subsurface irrigation, the plan shall include:

- Water control structure elevation settings by date required to maintain water table at design depth.
- Critical dates and water table target elevations during planned crop growing season.
- Inclusion of specification and locations of all required groundwater observation wells.

REFERENCES

ASAE EP405.1

Chapters 40-2 and 40-4 F.A.C.
DRAINMOD Computer Model, North Carolina State University
Florida NRCS Conservation Practice Standards
Anionic Polyacrylamide (PAM)-Erosion Control, Code 450
Bedding, Code 310
Grade Stabilization Structure, Code 410
Irrigation Canal or Lateral, Code 320
Irrigation Field Ditch, Code 388
Irrigation System, Tailwater Recovery, Code 447
Irrigation Land Leveling, Code 464
Irrigation System, Microirrigation, Code 441
Irrigation Water Conveyance, Pipeline, Code 430
Irrigation Water Management, Code 449
Land Smoothing, Code 466
Mole Drain, Code 482
Nutrient Management, Code 590
Pest Management, Code 595
Pumping Plant, Code 533
Structure for Water Control, Code 587.
Subsurface Drain, Code 606
Surface Drainage, Field Ditch, Code 607
Surface Drainage, Main or Lateral, Code 608
Waste Utilization, Code 633
Florida NRCS Drainage Guide
General Manual
Title 420-Part 401
Title 450-Part 401
Title 190-Parts 410.22 and 410.26
National Cultural Resources Handbook
National Environmental Compliance Handbook
National Food Security Act Manual
National Planning Procedures Handbook
Florida Supplements to Parts 600.1 and 600.6
NRCS, National Engineering Handbook, Part 623, Irrigation.
NRCS, National Engineering Handbook, Part 624, Drainage.
NRCS, National Engineering Handbook, Part 636, Chapter 52, Structural Design of Flexible Conduits.
NRCS, National Engineering Handbook, Part 650, Engineering Field Handbook, Chapter 14, Water Management (Drainage).
NRCS, National Engineering Handbook, Part 652, National Irrigation Guide.