

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSERVATION PRACTICE STANDARD**

**IRRIGATION SYSTEM, SURFACE AND SUBSURFACE**

(No. and Ac.)

**CODE 443**

**DEFINITION**

A system in which all necessary water control structures have been installed for the efficient distribution of water by surface means, such as furrows, borders, contour levees, or contour ditches, or by subsurface means.

If the system being planned and designed is a subsurface irrigation system, the site condition shall be such that a water table can be created and maintained within reasonable limits of water applied. There should be evidence of a seasonal water table or a limiting soil horizon that can support a water table.

**PURPOSE**

This practice is applied as part of a conservation management 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.

This standard does not apply to detailed design criteria and construction specifications for individual structures or components of the system.

This standard does not apply to NRCS conservation practice standard, Irrigation System, Microirrigation (441).

**CRITERIA**

**General Criteria Applicable to All Purposes**

This practice shall conform to all federal, State, and local laws and regulations. Laws and regulations of particular concern include those involving water rights, land use, pollution control, property easements, wetlands, preservation of cultural resources, and endangered species.

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

**Utilities and Permits.** The landowner shall be responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

The landowner shall obtain all necessary permissions from regulatory agencies, including the Illinois Department of Agriculture, US Army Corps of Engineers, US

**CONDITIONS WHERE PRACTICE APPLIES**

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.

Surface and subsurface irrigation applies to fields that are relatively flat (2 percent or less slope).

If the system being planned and designed is a surface irrigation system, the site condition shall be such that the soils have low to medium intake capacity.

Environmental Protection Agency, Illinois Environmental Protection Agency and Illinois Department of Natural Resources – Office of Water Resources, or document that no permits are required.

**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 degradation of water quality. Detailed design criteria from local irrigation guides shall be followed where available.

**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 rate of water delivery.

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 NRCS conservation practice standards.

**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 control.** Farm irrigation systems shall include structures needed for water control such as measuring devices, division boxes, checks, turnouts, pipelines, lined ditches, valves, and gates to control and regulate water for efficient application. Water level control structures must be covered or otherwise protected so to prevent accidental entry by animals, livestock, machinery or humans.

**Irrigation water management.** An irrigation water management plan meeting the requirements of Conservation Practice Standards 449 – Irrigation Water Management shall be developed for this practice.

### **Additional Criteria Applicable to Surface Irrigation Systems**

**Soils.** Furrow irrigation systems are best suited to soils that have a moderate to low intake capacity. Furrow irrigation systems are not general not suitable for very sandy soils. For contour levee irrigation, the soil should contain a restrictive layer with a permeability rate of not more than 0.02 inch/hr.

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

**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 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.

**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.

**Seepage Control.** For surface irrigation systems, ditches shall not traverse highly permeable soils without adequate measures for seepage control. If site conditions require conveyance of water across excessively permeable areas, 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 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 non-erosive 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 installed according to NRCS conservation practice standard, Irrigation System, Tailwater Recovery (447).

#### **Additional Criteria Applicable to Subsurface Irrigation Systems**

Subsurface irrigation 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.

Design of physical components shall be in accordance with Conservation Practice Standards Subsurface Drain (606), Structure for Water Control (587), Pumping Plant (533) and other pertinent conservation practice standards.

**Soils.** Site condition shall be such the water can move laterally from the open ditches or

from the irrigation tiles to form a water table and meet the water requirements of the crop. Subsurface irrigation is not economically feasible on very slowly permeable (high clay content soil). The soils should be from rapidly permeable to moderately permeable.

**Capacity.** Pumping capacity should be sized to supply at a minimum the water required for the planned crop at the critical growth period with an application efficiency not to exceed 75%.

**Lateral Spacing.** Laterals shall be equally spaced unless soil permeability varies sufficiently to dictate different spacing. Maximum spacing of the irrigation tiles or open ditches shall be no more than one-half the lateral spacing specified by the Illinois Drainage Guide for drainage of the design soil.

**Water Control.** Within each managed subunit, the water level control structure shall be of sufficient size to allow enough water flow to meet the water requirements of that subunit. The control structures should be set on elevation intervals not to exceed 1 ft.

#### **CONSIDERATIONS**

When designing a sub-irrigation system, consider orienting the lateral lines along the contours to maximize the area influenced by each water level control structure.

When planning a subsurface irrigation system, consider the additional pumping capacity needed to raise a water table during drought periods.

When planning this practice, the following items should be considered, where applicable:

- Effects of nutrients and pesticides and other dissolved substances on surface and ground water quality.
- Effects of water level control on downstream water quality.
- Effects of water levels on such soil nutrients.
- Effects of the water budget, especially volumes and rates of runoff, infiltration, evaporation, transpiration, deep

percolation, and ground water recharge.

- Effects on plant growth and transpiration because of changes in the volume of soil water.
- Effects of an elevated water table on erosion and the movement of sediment, soluble and sediment-attached substances carried by runoff.
- Effects on aquatic and wildlife communities, wetlands or water-related wildlife habitats.
- Effects on cultural resources.

### **PLANS AND SPECIFICATIONS**

Plans and specifications for surface and subsurface irrigation systems shall be in keeping with this standard and shall describe the requirements for applying the practice to achieve its intended purpose.

For subsurface irrigation systems, the plan should specify and include locations of groundwater observation wells.

### **OPERATION AND MAINTENANCE**

An operation and maintenance plan specific to the facilities installed shall be prepared for use by the landowner or operator responsible for operation and maintenance. The plan should provide specific instructions for operating and maintaining facilities to ensure they function properly. The 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 smoothing or grading of surface irrigated fields is required to ensure non-negative field row grades in the direction of flow.

Additionally for subsurface irrigation, the management plan shall include, as a minimum:

- Field water table depth sufficient to provide a suitable aerated rooting depth for the anticipated crops
- Critical dates and target elevations for the water table during the growing season.

### **REFERENCES**

USDA, NRCS, National Engineering Handbook Section 15, Irrigation, Chapter 3, Planning Farm Irrigation Systems.

USDA, NRCS, National Engineering Handbook Section 15, Irrigation, Chapter 6, Contour Levee Irrigation.

ASAE, EP479 (R2005). Design, Installation and Operation of Water Table Management Systems for Subirrigation/Controlled Drainage in Humid Regions.

Illinois Drainage Guide, Circular 1226, University of Illinois or On-Line Drainage Guide: <http://www.wq.uiuc.edu/dg/>.