Water Table Control (Acre)

Definition

Water table control through proper use of subsurface drains, water control structures, and water conveyance facilities for the efficient removal of drainage water and distribution of irrigation water.

Scope

This standard applies to underground conduits installed to a planned spacing, depth, and grade and to the related facilities and structures needed to regulate water table depths for efficient crop production.

Purpose

To improve the soil environment for vegetative growth by regulating the water table to remove excess runoff and subsurface water, facilitate leaching of saline and alkali soil, and regulate or manage ground water for subirrigation.

Conditions where practice applies

This practice applies to areas where:

1. A high water table exists, either natural or induced.

2. The topography is relatively smooth, uniform, and flat to gently sloping.

3. Subsurface conditions are such that a water table can be maintained without excessive water loss.

4. An adequate water supply is available.

5. Benefits of subirrigation, in addition to controlling ground water and surface runoff, justify installation of the system.

6. Soil depth and permeability will permit effective operation of the control system.

7. Saline or sodic soil conditions can be maintained at an acceptable level for efficient production of crops.

8. A suitable outlet exists.

9. Improvement of off-site water quality is needed and may be provided by controlling the water table.

Planning considerations

Water Quantity

1. Effects on the water budget, especially effects on volumes and rates of runoff, infiltration, evaporation, transpiration, deep percolation, and ground water recharge.

2. Effects on the movement of dissolved substances below the root zone and to ground water.

3. Potential effects on wetlands or water related wildlife habitats.

4. Effects of pesticides and nutrient use on surface and ground water quality.

Water Quality

1. Effects on erosion and the movement of sediment, pathogens, organic material and soluble and sediment-attached substances carried by runoff.

2. Effects on the movement of dissolved substances below the root zone and to ground water.

3. Potential effects on wetlands or water-related wildlife habitats.

4. Effects of pesticide and nutrient use on surface and ground water quality.

Design criteria

General

Designs are to be made in accordance with all other pertinent Engineering Standards such as *Subsurface Drain (606); Mole Drain (482); Surface Drainage, Field Ditch (607); Surface Drainage, Main or Lateral (608); Structure for Water Control (587); Irrigation System, Surface and Subsurface (443); Irrigation Field Ditch (388); Irrigation Canal or Lateral (320); Irrigation Water Conveyance (428);* and the additional special design criteria contained in this standard.

Capacity

The overall facilities designed and all component parts shall have the capacity to deliver or remove the flow of water required for irrigation or drainage, whichever is greater.

1. Drainage capacity

Combined capacity of the surface and subsurface facilities shall be adequate to satisfy the appropriate drainage coefficient for the crops to be grown.

Where it is necessary to admit surface water through surface inlets to the drain, an adjustment in the required capacity of the drain should be made if needed to compensate for increased inflow soon after rainfall.

2. Irrigation capacity

The facilities should be sized to supply the peak period consumptive use rate for the crops to be grown. Local consumptive use tables or irrigation guides should be consulted.

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 continuous, except for minor depressions. Otherwise, surface inlets shall be provided in the depressions for surface water removal. Silt traps should be provided, as needed, depending on the type of surface inlet. From a maintenance standpoint, it is advisable to have as few surface inlets as practical.

Plan

A plan based on soils, topography, and crops to be grown shall be prepared. The plan shall show the location elevation, spacing, size, and grade of all conduits, control structures, and outlet channels.

Grade of mains and laterals

The grade of mains may be level or constantly sloping toward the outlet and may be either open ditches or closed conduits. Laterals should be planned on grades as nearly parallel to the ground surface as possible and sloping towards the normal outlet. The grade of laterals should generally be in accordance with the conservation practice standard for Subsurface Drain (606). Lateral grades may be reduced to 0.05 percent if essential for effective water table control and precautions are taken to minimize sedimentation problems.

Length of laterals

Providing adequate capacity for drainage and irrigation should be considered in planning lateral length. Lateral length may be restricted by the requirements for lateral depth relative to desired water-table elevations at the upper end of individual laterals. Laterals should normally not exceed 1,200 feet.

Depth of laterals

The subsurface drain should be deeper than the maximum and minimum levels of the desired water table throughout the length of the lateral. It is desirable to place laterals within the soil layer having the highest hydraulic conductivity.

Spacing of mains and laterals

The spacing of main lines and open supply or drainage ditches should be as needed to enable lateral lines to adequately serve the field area. The maximum spacing of laterals to achieve uniform distraction of irrigation water will be determined by one or more of the following:

1. DRAINMOD program analysis.

2. Using the average spacing recommendation from the local 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.

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 subirrigation. The minimum size of conduits is 4 inches.

Filter and filter materials

Because of the water movement into and out of the conduits in water-table control lateral with fluctuating hydraulic heads, the potential for siltation may be greater than in regular drainage laterals. Suitable filters should be used where needed to prevent siltation (for guidance see Engineering Field Manual p. 14-70). Determining the need for a filter or selecting a filter is critical.

Generally, only properly graded sand and gravel filters, as defined in the subsurface drain standard (606), should be used as filters around conduits in water-table control systems. For coarser textured, well-graded sands, filters may not be necessary. 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 installation is available in similar soils to indicate that these geotextile filters have not clogged under simulated water-table control conditions. In soils where iron oxide problems are known to exist and a filter is needed, a knitted 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 Subsurface Drain standard (606) for envelope material requirements.

Water control structures

Water control structures should be installed as necessary to insure that the water table is held within 1.0 ft of the desired elevation.

Water control structures should be sized to provide the required drainage flow over the flashboard or otherwise throughout the control structure with a minimum head of 0.5 ft for normal operations. In all cases, the drainage flow elevations should be controlled so that crop damages do not occur as a result of an extended period of saturation in the root zone. Structures should be designed so that control can be quickly removed when return to the drainage mode is desired.

Operation and maintenance

An operation and maintenance plan should be provided to inform the owner of operation and maintenance needs.

1. Operation

Operation of the facilities should be such that prolonged saturation of the root zone does not occur. For very shallow rooted crops, such as vegetables, the best method of operation may be to raise the ground water to near 12 inches of the ground surface for a short period until the surface layer of the soil reaches its water-holding capacity. Once this condition is reached the water table is then allowed to recede by evapotranspiration to some predetermined level until the crop needs to be irrigated again. Additional water is then applied and the cycle is repeated. This procedure allows air to move into the soil and plant root zone for optimum root development.

For deeper rooted crops, it is customary to maintain the water control structures at a predetermined level for the various crop stages; thus, variations in the water table will result only from rainfall and differing consumptive use rates during any particular crop stage.

Water control structures should be designed so that adjustments may be easily made to facilitate removal of large storm discharges. Trafficability in the spring and during harvest can also be facilitated by timely lowering of the water table. Flashboard type structures normally allow for adequate management of the water table.

2. Maintenance

Maintenance items should be addressed as appropriate for the materials and system used.

Specifications guide

Plans and specifications for installing water table control facilities shall be in keeping with this standard and shall describe the requirements for applying all components of the facility to achieve its intended purpose. Incorporate, by reference, appropriate conservation practice standards and specifications required to install the facility.

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Conditions Where Practice Applies

This practice applies to areas where a natural high water table exists or an induced water table can be maintained without excessive water during extended dry periods.

In general, in North Carolina it would not be considered practical to install water table control systems on soils that do not require artificial drainage to successfully grow crops.

Capacity of the System

Irrigation Capacity

The system should be sized to supply the peak consumptive use rate for the crops to be grown. For soils with slowly permeable underlying layers (sandy clay to clay) an efficiency of up to 90% may be used. For other soils that would have greater seepage losses, irrigation efficiencies should not exceed 75%. Care must be exercised in evaluating seepage losses since deep percolation can often be sufficiently great to prevent successful operation of a water table control system.

Evaporation losses from sub-irrigation are generally not considered a primary concern, especially where water is supplied from underground mains.

Water conservation should be considered when setting water table levels. The way to maximize this is to set the structure control elevation at the highest level consistent with the rooting characteristics of the crop and soil during the expected water deficient period. When supplemental water is added to the system, however, this water level should be maintained at the lowest level consistent with the upward movement of water in the soil to supply adequate water for the crop needs. The greater the difference between these two elevations, the greater the amount of available soil storage for any rains that may occur. Storing rainfall in the soil for future crop use reduces irrigation pumping costs and conserves ground water for other uses. The irrigator should be consistently alert, however, to unanticipated wet periods and to promptly lower the structure elevations accordingly.

System Plan

A plan of the system based on soils topography and crops to be grown shall be prepared. The size and slopes of the fields are key considerations in the system layout. The plan shall show the location, spacing, size and grade of all conduits, control structures and outlet channels and supplemental water sources.

Grade, Depth and Length of Main and Lateral Lines

Mains and laterals should be planned on grades as nearly parallel to the ground surface as practical. Laterals normally do not exceed 0.1 ft./100 ft. Level lines may be used for up to 300 feet for a main. Laterals should extend no more than 1200 feet, with 1000 feet being the normal maximum. The grade of the main lines may be level or constantly sloping. Where the main lines are sloping, a water control structure will normally be placed in the line at no more than 1.0 ft. vertical intervals. The minimum depth of cover over all conduits should be 24 inches in mineral soils or 30 inches in organic soils. All lines should be deeper than the maximum and minimum levels of the desired water table. It is desirable to place laterals within the soil layer having the greatest hydraulic conductivity.

Envelopes and Envelope Material

Envelopes shall be used around subsurface drains, if they are needed for proper bedding of the conduit. Envelopes are sometimes used to improve the characteristics of flow of ground water into and out of the conduit, but the economics of this undertaking should be carefully evaluated.

Operation and Maintenance

In order to properly set the elevation of the flashboards, it is necessary to know the respective levels of the water table in the various parts of the field served by the structure. This can be accomplished by installing small open perforated pipes (wells) about 4.0' long in several selected locations. Once the relationship of the water level at the structure and the water table levels at key locations in the field are established (under both wet and dry conditions) only a single indicator pipe well may be needed. This indicator well can then be effectively used to manage the flashboards throughout the growing season.

THE WATER LEVEL SHOULD BE MAINTAINED WITHIN 30 INCHES OF THE GROUND SURFACE DURING THE WINTER MONTHS IN ORDER TO REDUCE NITRATE LOSSES AND MAXIMIZE WATER QUALITY BENEFITS.

Maintenance

Maintenance items, such as land smoothing, structures, channels, silting of pipe conduits, wells, and pumps, should be addressed as appropriate in the plan for the materials and system used.