# Surface Drainage (ft)

## Main or Lateral

### Definition

An open drainage ditch constructed to a designed size and grade.

### Scope

This standard applies to ditches for disposal of surface and subsurface drainage water primarily collected by drainage field ditches and subsurface drains.

It provides minimum drainage requirements for multiple-purpose channels that provide drainage outlets for agricultural lands. Mains or laterals having a drainage area of more than 1 $mi^2$ must meet the stability and maintenance requirements of the standard for open channels (582). Field ditches for the disposal of surface water (607) are not applicable.

### Purpose

To dispose of excess surface or subsurface water, intercept ground water, control ground water levels, provide for leaching of saline or alkali soils, or a combination of these objectives.

### Conditions where practice applies

All lands to be drained shall be suitable for agriculture after installation of required drainage and other conservation practices.

In areas where an outlet for the drainage system will be available, either by gravity flow or by pumping. The outlet shall provide for the quantity and quality of water to be disposed of. Consideration shall be given to possible damages above or below the point of discharge that might involve legal actions.

### Design criteria

The design and installation shall be based on adequate surveys and investigations.

**Drainage requirements.** Mains and laterals shall be located and designed to serve as integral parts of a surface or subsurface drainage system that meets the conservation and land use needs. The degree of drainage required by the crops shall be determined and expressed in terms of drainage coefficients or depth and spacing of drains.

**Capacity.** The ditch capacity shall be adequate to provide for the removal of excess water, based on climatic and soil conditions and the needs of crops. The required capacity shall be obtained by determining the watershed area; the required topographic, soil, and land use information; and use of the appropriate drainage coefficient curves.

The required capacity of open ditches for subsurface drainage in western irrigated areas shall be determined by evaluating site conditions, including irrigation water deliveries, irrigation canal or ditch losses, soil stratification and permeability, deep percolation losses, field irrigation losses, subsurface drain discharge, and quantity of surface water to be carried by the drainage ditch.

**Hydraulic gradeline.** The hydraulic gradeline for drainage ditch design shall be determined from control points, including elevations of significant low areas served by the ditch and hydraulic gradelines of any tributary ditches and the outlet. If control point elevations are estimated rather than computed from survey data, the hydraulic gradeline shall be no less than:

1. 1 ft below fields that will receive normal drainage from ditches draining more than 1 $mi^2$.
2. 0.5 ft for ditches draining 40 to 640 acres.
3. 0.3 ft for ditches draining less than 40 acres.

For lands to be used only for water-tolerant crops, such as trees and grasses, these requirements may be modified and the hydraulic gradeline set at ground level. These provisions do not apply to channels where flow is contained by dikes.

The effects of hydraulic losses caused by culverts, bridges, or other obstructions in the channel section shall be considered.

**Depth.** Drainage ditches shall be designed deep enough to allow for normal siltation. If needed, the design depth and capacity may be increased to provide adequate subsurface drainage or for normal flow. The increase shall be based on an evalu-

ation of site conditions. Ditches that serve as outlets for subsurface drains shall be designed for a normal water surface at or below the invert of the outlet end of the drain. The clearance between a drain invert and the ditch bottom shall be at least 1 ft for ditches that fill with sediment at a normal rate, except where lower values are specified for a job because of unusual site conditions. The normal water surface is the elevation of the usual low flow during the growing season.

**Cross section.** The design ditch cross section shall be set below the design hydraulic gradeline and shall meet the combined requirements of capacity, limiting velocity, depth, side slopes, bottom width, and, if needed, allowances for initial sedimentation. Side slopes shall be stable, shall meet maintenance requirements, and shall be designed on the basis of on-site conditions.

**Velocity.** The maximum permissible design velocity shall be based on site conditions and shall insure stability of the ditch bottom and side slopes. A desirable minimum velocity is 1.5 ft/s. On flat grades, a channel cross section shall be selected on the basis of the depth and maintenance requirements, which will result in the desirable minimum velocity if possible.

The velocity for newly constructed channels with drainage areas in excess of 1 $mi^2$ shall meet the stability requirements specified for open channels (582).

**Capacity design.** Manning's Formula shall be used in determining the design velocity, and the value of *n* shall be based on alinement, probable vegetative growth expected with normal maintenance, other roughness factors, and the hydraulic radius. Unless special site studies are available to justify other values, the following values of *n*, based on the hydraulic radius of the channel and assuming an aged channel with good maintenance and good alinement, shall be used in solving the Manning Formula for mains and laterals when determining the design for required capacity.

| Hydraulic radius | *n* |
|---|---|
| Less than 2.5 | 0.040—0.045 |
| 2.5 to 4.0 | .035— .040 |
| 4.1 to 5.0 | .030— .035 |
| More than 5.0 | .025— .030 |

**Berms and spoil banks.** Adequate berms shall be provided and shaped, as required, to provide access for maintenance equipment, to eliminate the need for moving spoil banks in future operations, to provide for work areas and facilitate spoilbank spreading, to prevent excavated material from washing or rolling back into ditches, and to lessen sloughing of ditchbanks caused by heavy loads too near the edge of the ditchbanks. The following minimum berm widths shall be provided, except where spoil is spread according to the engineering standard for spoilbank spreading:

| Ditch depth | Minimum berm width |
|---|---|
| *ft* | *ft* |
| 2—6 | 8 |
| 6—8 | 10 |
| More than 8 | 15 |

If spoil material is to be placed in banks along the ditch rather than spread over adjacent fields, the spoilbanks shall have stable side slopes. Provision must be made to channel water through the spoil and into the ditch without causing serious erosion.

**Operation and maintenance.** Requirements for operating and maintaining all drainage mains and laterals having drainage areas in excess of 1 $mi^2$ shall be according to the standard for open channels (582).

**Related structures and ditch protection.** Mains and laterals shall be protected against erosion by chutes, drop structures, pipe drops, other suitable structures or grassed waterway, or specially graded channel entrances where surface water or shallow ditches enter deeper ditches.

Grade control structures, bank protection, or other suitable measures shall be used if necessary to reduce velocities and control erosion.

Culverts and bridges shall have enough hydraulic capacity and depth for drainage needs and to minimize obstruction to flow.

Capacities of pipe or drop structures generally shall be determined by use of the applicable drainage coefficients with the "island-type" of construction used to protect the structure from washout.

Each structure for an open ditch system shall be designed according to SCS standards for the kind of structure and type of construction used.

**Channel vegetation.** Vegetation shall be established according to the standard for channel vegetation (322).

## Plans and specifications

Plans and specifications for constructing mains or laterals shall be in keeping with this standard and shall describe the requirements for constructing the practice to achieve its intended purpose.

# Surface Drainage

## Main or Lateral Specifications

### Clearing

The channel area shall be cleared of trees, logs, stumps, and other materials necessary for construction. Care must be taken to protect all trees to be saved for environmental purposes. All material shall be disposed of by an acceptable method as shown on the plans.

### Excavation

Channels shall be excavated to line and grade as shown on the plans or as staked in the field. The excavated surface shall be reasonably smooth. Construction activities shall be carried on in a manner that will not restrict flow from upstream channels. Care must be taken to reduce and prevent sediment pollution of water.

### Spoil

Spoil shall be disposed of as shown on the plans or as marked in the field.

### Structures

All structures and other related protection devices shall be installed as the work progresses to permit proper functioning of the ditch and to prevent environmental damage during the installation period.

### Vegetation

Vegetation shall be planted at times and rates shown in the plans or in the specifications for each job.

# Surface Drainage, Main or Lateral (ft)

**Planning considerations for water quantity and quality**

*Quantity*

1. Effects on the water budget components, especially with regard to effects on runoff, soil water, and water tables.
2. Potential changes in soil moisture that will affect the growth of desirable vegetation.
3. Effect on ground water recharge.

*Quality*

1. Effects on the detachment and transport of sediment and chemicals and dissolved and sediment-attached substances into water courses.
2. Effects on the salinity of drained soils and downstream water courses.
3. Effects on wetlands.
4. Effect on the quality of ground water .
5. Potential for changes in downstream water temperature.
6. Effects on downstream visual quality.