

Surface Drainage (Feet)

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 mi² 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.

Planning considerations

Water Quantity

1. Effects on the water budget components, especially with regard to effect 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.

Water 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. Effects on the quality of ground water.
5. Potential for changes in downstream water temperatures.
6. Effects on downstream visual quality.

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 mi².
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 evaluation 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 valves 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 mi² 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 alignment, 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 alignment, 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	.040-.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	Min. 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 mi² 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.

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Technical Guide
Section IV
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Design Criteria

Hydraulic Gradient - Channels Outletting into the Sound and Tidal Waters

A study of the frequency and stage of high water is needed for sounds and tidal waters to determine their adequacy as an outlet and to establish the design hydraulic gradient. In most cases the starting point of the design hydraulic grade gradeline at the outlet should not be lower than +1.5 feet (msl) for drainage ditches outletting into the sound. Where ditches outlet into areas affected by lunar tides, the starting point of the hydraulic gradeline shall not be lower than mean sea level elevation. In the area to be benefitted, the hydraulic gradeline must be held at least 6 inches below the design cropland elevations.

Berms and Spoil Banks

Through cultivated or open land where the spoil is to be spread at a later date, spoil may be piled, but temporary berm shall be equal to the depth of the ditch, but not less than 4 feet.

Where spoil is to be placed and shaped through open land or through brush and timber areas:

1. When spoil is uniformly placed on the cleared right-of-way. No berm is required. Spoil should blend to the excavated side slope of the constructed channel. The maximum depth of spoil shall not be more than 4 feet in height above the natural ground surface, except by special design approved by an engineer with appropriate approval authority.

2. On the side opposite from where the spoil is placed, no berm is required, but leaning trees which would affect the stability of the bank should be cut and removed.

Where spoil is to be placed through brush and timber areas: (1) spoil piles shall not exceed 4 feet in height; (2) the distance from the piles of spoil to the edge of the ditch shall be equal to the depth of the ditch, but not less than 4 feet; (3) spoil should not be piled against the base of trees; and (4) sufficient distance shall be left between spoil piles to prevent ponding, except by special design and approval by an engineer with appropriate approval authority.

For group jobs involving more than a property line ditch between two landowners, the following shall apply:

The spoil shall be graded so that it will have a slight slope away from the channel, except when the spoil contains a high percentage of woody material, making grading impractical. In these cases, the material shall be placed so that it will have a slight slope away from the channel and shall be smoothed and compacted by the construction equipment.

Cleared Right-of-Way

Trees, shrubs, brush, stumps, and other woody growth shall be cut as near the ground surface as conventional cutting tools will permit. Unless specified otherwise, this material shall be moved from the cleared right-of-way where spoil is to be placed.

Establishment of Vegetation

Vegetation should be established on all channel slopes, berms, spoil, and other disturbed areas where soil and site conditions will permit. Shaped bucket ditches steeper than 1:1 are not generally practical to seed; however, landusers should be encouraged to establish vegetation on all ditches. The type of protective vegetation will be adjusted to specific site conditions, time of year, and desired benefits such as wildlife habitat, etc. See Code 322, Channel Vegetation, for details.

Filter strips should be installed adjacent to all channels in accordance with Practice Standard Filter Strips (393).

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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 materials shall be disposed of by an acceptable method and 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 such a manner that will not restrict flow from upstream channels. Care must be taken to reduce sediment pollution as much as practical during construction.

Spoil

Spoil shall be disposed of as shown on the plans or as marked in the field. The spoil shall be graded so that runoff water is directed away from the ditch.

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.

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SURFACE DRAINAGE, MAIN OR LATERAL ENGINEERING NOTEKEEPING

Design Survey, Design and Plans

- A. A plan-profile drawing will be prepared for all class II and larger jobs and all jobs involving underground public utilities. Drawings will be prepared on standard sheets or state approved forms. When plan profiles are not required, information to support design will be recorded in the engineering field book or case file as appropriate. The following will be included either on the drawings or in the engineering field book as appropriate:
1. Location map.
 2. Profile of main.
 3. Design grades.
 4. Typical cross section showing side slopes, berm width, bottom width, and method of spoil disposal.
 5. Drainage area.
 6. Group jobs require a drainage area map showing the location of ditches, apparent property lines and ownership along the works of improvement.
 7. Structures where applicable.
 8. Soil borings where applicable.
 9. Yardage calculations when needed for performance certification.
 10. Outlet conditions.
 11. Cross reference to appropriate engineering field books will be made on drawings and plans.
 12. Recommendations for channel vegetation.

Construction Check

- A. A sampling process may be used in obtaining supporting data for a job consisting of a number of similar ditches. The sample should be taken from segments or parts that appear least likely to meet specifications. In such cases the person doing the checking should be satisfied that the entire job meets specifications and record adequate supporting data for the selected sample.

Supporting data and a signed certification may be accepted from qualified contractors. The certification shall include appropriate information and measurements to show that standards and specifications have been met. These backup data need not necessarily follow the format used by SCS but must be understandable and legible. Each year an SCS Construction Check shall be made, recorded, and filed on 5% of the jobs installed by each contractor making his own certifications.

- B. The following information shall be recorded as supporting data when the job is completed.
1. At least one ditch cross section and others as necessary are to be taken to show that side slopes, depth, bottom width, spoil disposal, and berm widths meet specifications.
 2. Show grade of completed ditch. The horizontal interval between profile shots will depend upon the uniformity of the topography and the quality of construction. Generally, readings should be taken at least once every 400 feet. Where layout hubs are still in place, the check may be made from them.
 3. Length of all ditches installed.
 4. Data on all structures installed.
 5. Adequacy of outlet.
 6. Certification that practice meets standards and specifications. Note any exceptions.
 7. Date and signature of persons making the construction check.

- C. When construction checks are made of a system of parallel shaped bucket ditches, check out notes need to be recorded for only one representative ditch. A minimum of one cross section will be taken. Grade checks shall be made as determined necessary by the individual approving the design. Visual inspection may be used as construction checks for all the remaining ditches in the system unless the responsible employee determines that more construction checks are needed. Documentation of this visual check will be made as part of the construction check.

Recording Data

All field survey notes and construction check data will be recorded in a standard engineering field book or other approved forms in accordance with Technical Release 62 and Chapter 1, Engineering Field Manual for Conservation Practices.