

OPEN CHANNEL (FT.)

Definition

Constructing or improving a channel either natural or artificial, in which water flows with a free surface.

Scope

This standard applies to construction of open channels or modification of existing streams or ditches. Design criteria for channel stability and maintenance of floodwater diversions, (400), floodways (404), or surface drainage, main or lateral (608), having a drainage area in excess of 1 sq. mi. (1.6 km<sup>2</sup>) shall be in accord with this standard for open channels. It does not apply to diversions (362), grassed waterways (412), irrigation field ditches (388), surface drainage, field ditches (607), or irrigation canals or laterals (320).

Purpose

To provide discharge capacity required for flood prevention, drainage, other authorized water management purposes, or any combination of these purposes.

Conditions Where Practice Applies

This standard applies to all earth channel construction or modification except as noted under "Scope".

It also applies where stability requirements can be met, where the impact of the proposed construction on water quality, fish and wildlife habitat, forest resources, and quality of the landscape is evaluated and the techniques and measures necessary to overcome the undesirable effects are made part of any planned work, where an adequate outlet for the modified channel reach is available for discharge by gravity flow or pumping, and where excavation or other channel work does not cause significant erosion, flooding, or sedimentation.

Current Soil Conservation Service policy concerning wetlands shall be adhered to, and all earth channel construction or modification shall be performed in accordance with current policy. Earth channel construction or modification on streams with a base flow on drainage areas in excess of one square mile shall be reviewed by a SCS biologist before work is started. Open channel work on smaller drainage areas having a base flow shall be reviewed by the area agricultural engineer.

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Tennessee

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Care shall be taken, where feasible, to design and construct to provide for maintenance of such wildlife habitat features as riparian vegetation, wet cover, pools and riffles. Care shall be exercised to avoid elevating water temperatures and creating erosive conditions.

### Design Criteria

Plan. Channel construction or modification shall be according to an approved plan prepared for the site. TR-25 shall be used in surveys, planning, and site investigations for channel work. Design criteria in TR-25 shall be followed, using the procedure best adapted to site conditions.

In selecting the location and design of channels careful consideration shall be given to minimizing water pollution, damage to fish and wildlife habitat, and to protecting forest resources and the quality of the landscape. In considering requirements for construction and operation and maintenance, selected woody plants must be preserved. The overall landscape character, prominent views, and fish and wildlife habitat requirements must be considered.

Planned measures necessary to mitigate unavoidable losses to fish or wildlife habitat shall be included in the project. The quality of the landscape shall be maintained by both the location of channel works and plantings, as appropriate.

The alignment of channels undergoing modification shall not be changed to the extent that the stability of the channel or laterals thereto is endangered.

Capacity. The capacity for open channels shall be determined according to procedures applicable to the purposes to be served and according to related engineering standards and guidelines in handbooks. The water surface profile or hydraulic gradeline for design flow shall be determined according to guidelines for hydraulic design in TR-25. The "n" value for aged channels shall be based on the expected vegetation, along with other retardance factors, considering the level of maintenance prescribed in the operation and maintenance plan prepared with the owners or sponsors. The required capacity may be established by considering volume-duration removal rates, peak flow, or a combination of the two, as determined by the topography, purpose of the channel, desired level of protection, and economic feasibility.

Channels to be utilized for quick removal of runoff and/or flood control shall be designed for removal rates determined by National Engineering Handbook No. 4 (NEH-4) or other appropriate methods. Any level of protection shall be compatible with the value and importance of protected feature.

Open channels may be utilized to provide removal of excess water after flood flows have ceased. Open channels may also provide drainage or outlets for drainage. The minimum capacity of channels to remove excess flow or provide drainage benefits shall be in accordance with Table 1.

The minimum channel capacity for removal of excess water shall be in accordance with the following Table 1:

Table 1 - Minimum Ditch Capacity (cubic feet/second/square mile)

<u>Drainage Area</u> <u>(Sq. Mile)</u>	<u>Hill</u> <u>Area</u>	<u>Coastal</u> <u>Area</u>	<u>Delta</u> <u>Area</u>
0-1	77	45	40
2	77	41	37
3	77	38	34
4	62	36	32
5	55	35	31

#### Cross Section

The required channel cross section and grade shall be determined by the plan objectives, the design capacity, the materials, soil and/or rock in which the channel is to be constructed, the vegetative establishment program, and the requirements for operation and maintenance. A minimum depth may be required to provide adequate outlets for subsurface drains, tributary ditches, or streams. Urban and other high-value developments through which the channel is to be constructed must be considered in the design of the channel section. The side slopes of constructed or modified channels shall not be steeper than one and one-half horizontal to one vertical. The bottom width shall not be less than four feet. When the channel construction or modification is for drainage, the minimum depth shall be three feet except at the outlet end, through minor low areas, or where rock is encountered. However, a depth of four feet is recommended where possible.

#### Channel Stability.

Characteristics of a stable channel are:

1. The channel neither aggrades or degrades beyond tolerable limits.
2. The channel banks do not erode to the extent that the channel cross-section is changed appreciably.
3. Excessive sediment bars do not develop.
4. Gullies do not form or enlarge because of the entry of uncontrolled surface flow to the channel.

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All channel construction and modification (including clearing and snagging) shall be according to a design that can be expected to result in a stable channel that can be maintained at reasonable cost. Vegetation, riprap, revetments, linings, structures, or other measures shall be used if necessary to insure stability.

The method applicable to site conditions in TR-25 shall be used in determining the stability of proposed channel improvements.

Bankfull flow is the flow in a channel that creates a water surface at or near the normal ground elevation, or the tops of dikes or continuous spoil banks that confine the flow for a significant length of a channel reach.

Channels must be stable under conditions existing immediately after construction (as-built condition) and under conditions existing during effective design life (aged condition). Channel stability shall be determined for discharges under these conditions as follows:

1. As-built condition - Bankfull flow, design discharge, or 10-year frequency flow, whichever is smallest, but not less than 50 percent of design discharge.

The allowable as-built velocity (regardless of type of stability analysis) in the newly constructed channel may be increased by a maximum of 20 percent if:

- (a) The soil and site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation,
  - (b) Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known, and
  - (c) The channel design includes detailed plans for establishing vegetation on the channel side slopes.
2. Aged condition - Bankfull flow or design discharge, whichever is larger, except that it is not necessary to check stability for discharge greater than the 100-year frequency.

Stability checks that are flow related are not required if the velocity is 2 ft/s (0.6 m/s) or less.

For newly constructed channels in fine-grained soils and sands, the 'n' values shall be determined according to procedures in Chapter 6 of TR-25, and shall not exceed 0.025. The 'n' value for channels to be modified by clearing and snagging only shall be determined by reaches according to the expected channel condition upon completion of the work.

The minimum 'n' values for aged-condition channel stability check will be in accordance with the following guide.

<u>Channel Hydraulic Radius</u>	<u>Value of 'n'</u>
Less than 2.5	0.045
2.5 to 4.0	0.040
4.0 to 5.5	0.035
More than 5.5	0.030

#### Appurtenant Structures

The channel design shall include all structures required for proper functioning of the channel and its laterals, as well as travelways for operation and maintenance. Inlets and structures needed for entry of surface and subsurface flow into channels without significant erosion or degradation shall be included in the channel design. The design also shall provide for necessary flood gates, water-level-control devices, bays used in connection with pumping plants, and any other appurtenances essential to the functioning of channels and contributing to attainment of the purposes for which they are built. If needed, protective structures or treatment shall be used at junctions between channels to insure stability at these critical locations.

The effect of channel work on existing culverts, bridges, buried cables, pipelines, irrigation flumes, and inlet structures for surface and subsurface drainage on the channel and laterals thereto shall be evaluated to determine the need for modification or replacement.

Culverts and bridges that are modified or added as part of channel projects shall meet reasonable standards for the type of structure and shall have a minimum capacity equal to the design discharge or state agency design requirements, whichever is greater. Capacity of some culverts and bridges may need to be increased above the design discharge.

Culverts shall have adequate hydraulic capacity and be placed at a depth to meet drainage requirements. The culvert size shall be such that it handles the design flow with not more than a 0.8 foot head above the top of the upstream end of the pipe.

The bottoms of bridge stringers shall be set a minimum of 0.5 foot above the hydraulic gradient.

Capacities of pipe or other drop structures shall be determined by use of applicable drainage coefficients and the "island" type of construction shall be used to protect the structure from washout. Pipes shall be designed in accordance with the standard for Grade Stabilization Structure (410).

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Disposition of Spoil

Spoil material from clearing, grubbing and channel excavation shall be disposed of in a manner that will:

1. Not confine or direct flows so as to cause instability when the discharge is greater than the bankfull flow.
2. Provide for the free flow of water between the channel and flood plain unless the valley routing and water surface profile are based on continuous dikes being installed.
3. Not hinder the development of travelways for maintenance.
4. Leave the right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses.
5. Direct water accumulating on or behind spoil areas to protected outlets.
6. Maintain or improve the visual quality of the site to the extent feasible.

The spoil must be placed and shaped in a manner that prevents excessive side drainage directly over the channel bank. Inlets for surface water shall be left in the soil at all draws or significant depressions.

Through cultivated or open land, the spoil shall be spread to a maximum depth of three feet with a minimum ten-foot berm between spoil and channel bank. The spoil shall be sloped away from the channel and left so ordinary farm equipment can operate over the area. Side slopes of the finished spoil shall not be steeper than three to one.

When the spoil material is to be temporarily stacked along a channel through open land for "conditioning" of the soil before spreading, a minimum of 10-foot berm shall be left between spoil and channel bank to facilitate the delayed spreading operation.

Through woodland, the spoil may be uniformly stacked with a minimum 10-foot berm between spoil and channel bank or may be spread in accordance with requirements through open land. When all spoil is placed on one side of the channel, a minimum three-foot berm shall be cleared on the side opposite where the spoil is placed.

Spoil bank shall be designed so that out-of-bank flow may utilize the total floodplain. Re-entry water shall be directed to side water inlets.

### Vegetation of Channel

Vegetation shall be established on all channel slopes, berms, spoil, and other disturbed areas according to the SCS standard for Critical Area Planting (342) except that mulch shall not be required on channel slopes.

### Operation and Maintenance

Plan. An operation and maintenance plan must be prepared for each channel system. Minimum requirements for operation, maintenance, and replacement shall be consistent with the design objectives. This includes consideration of fish and wildlife habitat, quality of the landscape, water quality, mitigation features, methods, equipment, costs, stability, function for design life, frequency, and time of year for accomplishing the work. Detailed provisions for operation and maintenance must be made if complex features, such as water-level-control structures and pumping plants, are required. The operations and maintenance plan shall comply with and meet the objectives of the NATIONAL OPERATION AND MAINTENANCE MANUAL (NO&MM).

Maintenance-Access. Travelways for maintenance generally shall be provided as part of all channel work. This requirement may be met by providing ready access points to sections of the channel if this will permit adequate maintenance in conformance with the operation and maintenance plan.

A travelway shall be provided on each side of large channels if necessary for use of maintenance equipment. Travelways must be adequate for movement and operation of equipment required for maintenance of the channel. The travelway may be located adjacent to the channel on a berm or on the spread spoil. In some places the channel itself may be used as the travelway. The travelway, including access points, must blend into the topography, the landscape, and adjacent land uses.

Safety. Open channels can create a safety hazard. Appropriate safety features and devices should be installed to protect people and animals from accidents such as falling or drowning.

### Plans and Specifications

Plans and specifications for constructing open channels shall be in keeping with this standard and shall describe the requirements for properly installing the practice to achieve its intended purpose.

Soil Conservation Service  
Construction Specifications  
for  
582 - Open Channel

Scope

This specification shall include all work, material and services necessary for the construction of an open channel. The completed channel will conform to the lines, grades and dimensions shown on the drawings, staked in the field or approved by the responsible official. All work shall be performed in a skillful and workmanlike manner. The completed job shall present a workmanlike appearance.

Site Preparation

All trees, brush, stumps, and other objectionable material that will interfere with construction or proper functioning of the channel shall be removed and disposed of in an environmentally sound manner by burning, burying, or removal from the construction area.

Dimensions of Installation

The channel shall be constructed to equal or exceed the width, depth, and cross sectional area dimension specified on the furnished drawings or as staked in the field. The depth shall be at or within 0.5 foot below the line and grade as staked in the field and have a positive slope in the downstream direction. Excessive overexcavation should be avoided to prevent greater than design velocity in the channel when larger than design storms occur.

Excavation

Channels shall be excavated to a reasonably smooth surface. Spoil material shall be placed at locations shown on the plans and shall be spread to blend with the field surface. Spoil through wooded areas may be left unspread to promote wildlife habitat diversity. Permanent grass seed shall be applied to designated channel and adjacent spoil areas.

Construction activities and spoil placement shall be carried on in a manner that will not restrict flow from upstream channels. Care must be taken to reduce and prevent, where possible, sediment pollution of water.

Structures

Non-erosive entry of concentrated surface water flow into the channel shall be provided for by shaping and grading or by constructing an appropriate

