

Open Channel (Ft.) 582

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 modifications 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 mi² 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.

DESIGN CRITERIA

Open channels shall be planned, designed, and installed to meet all federal, state, local and tribal laws and regulations.

Plan. Channel construction or modification shall be according to an approved plan prepared for the site. TR-25, Design of Open Channels, 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 modifications 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.

Cross section. The required channel cross section and grade shall be determined by the plan objectives, the design capacity, the materials 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.

Channel stability. Characteristics of a stable channel are:

1. The channel neither aggrades nor 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.

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 channel 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 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.

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 of state agency design requirements, whichever is greater. Capacity of some culverts and bridges may need to be increased above the design discharge.

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.

Vegetation of channel. Vegetation shall be established on all channel slopes, berms, spoil, and other disturbed areas according to the NRCS standard for Critical Area Planting (342).

Use vegetation adapted to the site that will accomplish the desired purpose. Preference shall be given to native species in order to reduce the introduction of invasive plant species; provide management of existing invasive species; and minimize the economic, ecological, and human health impacts that invasive species may cause. If native plant materials are not adaptable or proven effective for the planned use, then non-native species may be used. Refer to the Field Office Technical Guide, Section II, Invasive Plant Species for plant materials identified as invasive species.

Maintenance access. Travelways for maintenance generally shall be provided as part of all channel work. This requirement may be met by providing reading 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.

CONSIDERATIONS

Consider the potential effects of installation and operation of open channels on the cultural, archeological, historic and economic resources.

Consider the following water quantity effects:

1. Effects on components of the water budget, especially on volumes and rates of runoff and infiltration.

Consider the following water quality effects:

1. Effects of erosion and the movement of sediment and soluble and sediment-attached substances in runoff during and immediately after construction.
2. Effects of the use of chemicals during vegetation control.
3. Effects of changes in channel vegetation on downstream water temperature.
4. Potential for temporary and long-term effects on the visual quality of downstream waters.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared in accordance with the criteria of this standard and shall describe the requirements for applying the practice to achieve its intended use.

Support data documentation requirements are as follows:

- Inventory and evaluation records
 - Assistance notes or special report
- Survey notes, where applicable
 - Design survey
 - Construction layout survey
 - Construction check survey
- Design records
 - Physical data, functional requirements and site constraints, where applicable
 - Soils/subsurface investigation report, where applicable
- Design and quantity calculations
- Construction drawings/specifications with:
 - Location map
 - Designed by” and “Checked by” names or initials
 - Approval signature
 - Job class designation
 - Initials from preconstruction conference
 - As-built notes
- Construction inspection records
 - Assistance notes or separate inspection records
 - Construction approval signature
- Record of any variances approved, where applicable
- Record of approvals of in-field changes affecting function and/or job class, where applicable.

OPERATION AND MAINTENANCE

An Operation and Maintenance (O&M) plan shall be developed for this practice. The O&M plan shall be consistent with the purposes of the practice, its intended life, safety requirements, and the criteria for the design.