

**NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD**

OPEN CHANNEL

(ft)

CODE 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 (1.6 km²) 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

General Criteria Applicable to All Purposes

Use of this standard will comply with all applicable federal, state, and local laws and regulations.

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

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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 ensure 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 (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.

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.

Additional Criteria for Conversion to Two-Stage Ditch

Where an existing agricultural drainage ditch will be converted to a two-stage ditch (wider ditch with benches), additional criteria apply.

The low flow channel and vegetation below the bench elevation will not be disturbed unless the NRCS engineer determines it to be necessary in order to provide an outlet for an upstream component.

The total bench width of the two-stage ditch will be between 2 and 4 times the existing low flow channel flow (bank) width. Split the bench width evenly on each side of the low flow channel unless it is necessary to distribute the bench width unevenly, or provide the entire width on one side only. One-sided construction will only be used if it is necessary to avoid protected or inhibitory areas (such as but not limited to trees, wetlands and/or cultural resources).

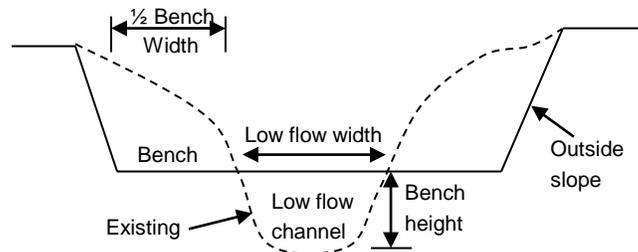


Figure 1. Typical Two-sided Two-stage Ditch

The bench height will be determined by using regional curves or other accepted methods to size the low flow channel to carry between 0.5 and 1-year, 24 hour storms or by approximating the elevation of natural bench formations.

Outside bank slopes will be 2:1 or flatter. Erosion control blanket will be used where

conditions are not suitable for rapid vegetative establishment.

If possible, existing drainage tile outlets will be repaired and outlet onto the newly created bench. Riprap or other erosion protection methods will be installed at outlets to protect the bench. Existing structures or other appurtenances will be reconstructed as necessary to fit the new ditch configuration. Underground outlets and other appurtenances shall meet the requirements of conservation practice standards Subsurface Drainage (606), Underground Outlet (620), or other practices as appropriate.

All bench and bank areas will be seeded according to conservation practice standard Critical Area Planting (342) and mulched or blanketed. All disturbed areas outside of top of bank will be seeded to the appropriate NRCS standard, planted to crop within 30 days or temporary seeded if the areas is to be planted to a crop at a later time.

CONSIDERATIONS

Effects on water quantity and quality will be considered. Concentrating the flow in an open channel may reduce the opportunity of infiltration, increasing runoff. The amount of increase will depend on the extent that surface flows were spread before collection in the channel and the permeability of the soils in the floodplain. Open channels may result in a negligible to major decrease in the ground water recharge quantity.

Open channels will have minor long term impact on surface water quality. This standard specifically requires that water quality impacts be evaluated, and measures taken to overcome any impacts determined. There may be increased erosion and sediment yield from the channel and surrounding areas during and immediately after construction. These should be minimal after the first period of use and establishment of vegetation. Component practices constructed as part of an open channel will significantly reduce soil erosion and improve water quality. There may also be a minor increase in the transport of soluble pesticides from the site due to chemicals used for vegetation control in or along the open channel. The amount of any pesticide leaving the site in surface flow will depend on the type and amount of pesticide used, soil

characteristics, and precipitation patterns at the time of pesticide use.

An increase in temperature may occur due to increased water surface areas subject to solar radiation, especially if associated with decreased vegetative canopy.

There may be minor changes in ground water quality, which result from the infiltration of small amounts of soluble pesticides used to control vegetation in and along open channels.

Consideration will be given to the use of construction materials, grading practices, vegetation, and other site development elements that minimize visual impacts and maintain or complement existing landscape uses such as pedestrian paths, buffers, etc.

Consider rerouting tile drainage outlets entering a two-stage ditch to outlet on top of the bench and onto a riprap pad.

Where phosphorus is of particular concern in a two-stage ditch, refer to the Agricultural Waste Management Field Handbook, Table 6-6 for plant uptake values of alternative plantings.

Consider limiting construction to late summer to allow establishment of appropriate vegetation.

PLANS AND SPECIFICATIONS

Plans and specifications will be prepared for the practice site. Plans will include at a minimum:

- Plan view
- Profile
- Cross section (typical or other)
- Location of spoil
- Seeding rates, dates and establishment procedure

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.

Maintenance access. Travel ways 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 travel way shall be provided on each side of large channels if necessary for use of maintenance equipment. Travel ways must be adequate for movement and operation of equipment required for maintenance of the channel. The travel way 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 travel way. The travel way, 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.

A maintenance program will be established by the landowner/user to maintain capacity and vegetative cover. Items to consider are:

1. Do not graze protected area during vegetative establishment and when soil conditions are wet.
2. Fertilize to maintain a vigorous vegetative cover. Caution should be used with fertilization to maintain water quality.
3. Mulch, spray or chop out undesirable vegetation periodically to prevent growth of large woody stemmed weeds, water plants such as cattails or trees (such as willows) which impede flow.
4. Promptly repair eroded areas.
5. Remove silt and sediment accumulations in the channel cross-section as soon as practical to prevent buildup and growth of undesirable vegetation.
6. Reestablish vegetative cover immediately where scour erosion has removed established seeding.

7. Keep inlets to side drainage structures open.
8. Keep subsurface drain outlet pipes open and protected. Maintain animal guards in proper operation.
9. Periodically inspect area for signs of undermining or instability and, if any are observed, take immediate action to protect from further damage.

PLANNING CONSIDERATIONS FOR QUANTITY AND QUALITY

Quantity

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

Quality

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.

REFERENCES

Technical Release 25 (TR-25) – Design of Open Channels, NRCS 1977

National Engineering Handbook Part 654, NRCS Stream Restoration Design Handbook, August 2007