United States Department of Agriculture

Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

OPEN CHANNEL

CODE 582

(ft)

DEFINITION

An open channel is a natural or artificial conduit in which water flows with a free surface at atmospheric pressure.

PURPOSE

This practice is used to accomplish the following purpose:

- Construct, improve, or restore an open channel to convey water required for flood prevention.
- Provide outlets for drainage systems.
- Protect or enhance wildlife habitat.
- Meet other authorized water management requirements.

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to the construction of open channels or modifications of existing streams or ditches with drainage areas exceeding 1 square mile (2.6 square kilometers). This standard does not apply to NRCS Conservation Practice Standards (CPSs) Diversion (Code 362), Grassed Waterway (Code 412), Irrigation Field Ditch (Code 388), Surface Drain, Field Ditch (Code 607), or Irrigation Canal or Lateral (Code 320).

CRITERIA

General Criteria Applicable to All Purposes

Use NRCS Engineering Technical Release (TR) (Title 210), Number 25, “Design of Open Channels”; NRCS National Engineering Handbook (NEH) (Title 210), Part 653, “Stream Corridor Restoration: Principles, Processes, and Practices”; and NRCS 210-NEH, Part 654, “Stream Restoration Design,” as applicable, in surveys, planning, site investigations, and design of channel work.

Do not modify the horizontal or vertical alignment of a channel to the extent of endangering the stability of the channel or its laterals.

Capacity

Determine the capacity for open channels according to procedures applicable to the purposes of the channel and according to related engineering standards and guidelines in approved references and handbooks. Designs must consider low flows, average flows, frequent storm flows, and high (infrequent) storm flows.

Determine the water surface profile or hydraulic grade line for design flow using guidelines for hydraulic design in NRCS 210-TR-25 and/or NRCS 210-NEH-654. Select a Manning’s *n* value for the condition representing an aged channel. Base the selection on the expected vegetation and other factors such as

the level of maintenance prescribed in the operation and maintenance plan. Establish the required flow capacity 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. Design conditions cannot result in flood impacts to adjacent properties without addressing through the appropriate authorities.

Cross section
Determine the required channel cross section and grade by the plan objectives, the design capacity, the channel materials, the vegetative establishment program, and the requirements for operation and maintenance. As necessary, provide a minimum depth to allow adequate outlets for subsurface drains, tributary ditches, or streams.

Channel stability
A stable channel has the following characteristics:

- The channel neither aggrades nor degrades beyond tolerable limits.
- The channel banks do not erode to the extent that an appreciable change in channel cross section results.
- Excessive sediment bars do not develop.
- Gullies do not form or enlarge because of the entry of uncontrolled surface flow to the channel.

Design all channel construction and modification to result in a stable channel with reasonable maintenance costs. Use vegetation, riprap, revetments, linings, structures, or other measures if necessary to ensure stability.

Use the methods in NRCS 210-TR-25 and/or NRCS 210-NEH-654 to determine the stability of proposed channel improvements.

Bank-full flow is the discharge that fills a channel to an elevation where flow begins to spill onto the active floodplain.

Channels must be stable under conditions existing immediately after construction (as-built condition) and under conditions existing during effective design life (aged condition).

Determine channel stability for discharges under the following conditions:

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

- The designer may increase the allowable as-built velocity (regardless of type of stability analysis) in the newly constructed channel by a maximum of 20 percent if—
    - The soils at the site in which the channel is to be constructed are suitable for rapid establishment and support of erosion-controlling vegetation.
    - Species of erosion-controlling vegetation adapted to the area and proven methods of establishment are known.
    - The channel design includes detailed plans for establishing vegetation on the channel side slopes.
- Aged condition.—Bank-full 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 feet per second (0.6 meters per second) or less.

For newly constructed channels in fine-grained soils and sands, determine the Manning's *n* values according to procedures in NRCS 210-TR-25, Chapter 6, "Stability Design." Use caution selecting values

greater than 0.025. In channels modified by clearing and snagging, determine the Manning's *n* value according to the expected channel condition following completion of the work. Guidance is also available in NRCS 210-NEH-654.

Appurtenant structures
Include all structures required for proper functioning of the channel and its laterals, as well as travel ways for operation and maintenance. Minimize the erosion or degradation from inlets and structures needed for entry of surface and subsurface flow into channels. Provide necessary floodgates, water level control devices, bays used in connection with pumping plants and any other appurtenances essential to the functioning of the channels. If needed, use protective structures or treatment at junctions between channels, to ensure stability at these critical locations.

Evaluate the effect of channel work on existing culverts, bridges, buried cables, pipelines, irrigation flumes, inlet structures, surface drainage systems, and subsurface drainage systems.

Ensure that culverts and bridges modified or added as part of a channel project meet applicable NRCS standards for the type of structures and have a minimum capacity equal to the design discharge or state agency design requirements, whichever is greater. Increase the capacity of culverts and bridges above the design discharge as necessary to ensure the channel and associated floodway meet design capacity.

In natural channels, evaluate the effect of the grade control structure on channel and bank stability. Determine backwater effects and the effects of modification of sediment transport through the reach.

Disposal of spoil
Dispose of spoil material from clearing, grubbing, and channel excavation in a manner that will—

- Not modify flows or cause channel instability when the discharge is greater than the bank-full flow.
- Provide for the free flow of water between the channel and floodplain unless continuous dikes are present to establish the basis for the valley routing and water surface profile.
- Not hinder the development of travel ways for maintenance.
- Leave the right-of-way in the best condition for the project purposes and adjacent land uses.
- Direct water accumulating on or behind spoil areas to protected outlets.
- Maintain or improve the visual quality of the site to the extent feasible.

Spoil disposal should also be in accordance with CPS-572 Spoil Disposal.

Vegetation of channel
Establish vegetation on all channel slopes, berms, spoil, and other disturbed areas according to NRCS CPS Critical Area Planting (Code 342) or Streambank and Shoreline Protection (Code 580).

[Heading 3 Title]
CONSIDERATIONS

Carefully consider the visual design of channels in areas of high public visibility and those associated with recreation. The underlying criterion for all visual design is appropriateness. The shape and form of channels, excavated material, and plantings are to relate visually to their surroundings and to their function.

This practice may influence important fish and wildlife habitats such as streams, creeks, riparian areas, floodplains, and wetlands. Evaluate aquatic organism passage concerns (e.g., velocity, depth, slope, air entrainment, screening, etc.) to enhance positive impacts and minimize negative impacts.

Select project location and construction methods that minimize impacts to existing fish and wildlife habitat.

Include measures necessary to mitigate unavoidable losses to fish or wildlife habitat in the design. Maintain the quality of the landscape by both the location of channel works and plantings, as appropriate.

Stockpile topsoil for placement on disturbed areas to facilitate revegetation.

Consider placement and selection of vegetation to improve fish and wildlife habitat and species diversity.

In urban areas, consider the design impacts on high-value developments.

Consider the effects of—

- Erosion and the movement of sediment, pathogens, and soluble and sediment-attached substances that runoff carries.
- Short-term and construction-related effects of this practice depend on the quality of downstream watercourses.
- Wetlands and water-related wildlife habitats.

PLANS AND SPECIFICATIONS

Prepare plans and specifications that describe the requirements for applying the practice according to this standard.

As a minimum, include the following items:

- A plan view of the layout of the channel and appurtenant features.
- Typical profiles and cross sections of the channel and flood plain, as needed.
- Appurtenant features, as needed.
- Structural drawings, as needed.
- Requirements for vegetative establishment and/or mulching, as needed.
- Safety features.
- Site-specific construction and material requirements.

OPERATION AND MAINTENANCE

Prepare an operation and maintenance plan for the operator.

As a minimum, include the following items in the operation and maintenance plan:

- Periodic inspections of all structures, channel surfaces, safety components and significant appurtenances
- prompt inspection after unusual flow events or other disasters such as fires or earthquakes.
- Prompt repair or replacement of damaged components.
- Prompt removal of sediment when it reaches predetermined elevations.
- Periodic removal of undesirable trees, brush, invasive species, and burrowing rodents from the channel and adjacent area.
- Maintenance of vegetative protection and immediate seeding or replanting of damaged areas, as needed.

REFERENCES

USDA NRCS. 1977. Engineering Technical Release Number 25 (Title 210). Design of Open Channels. Washington, D.C. https://directives.sc.egov.usda.gov/

USDA NRCS. 2001. National Engineering Handbook (Title 210), Part 653, Stream Corridor Restoration: Principles, Processes, and Practices. Washington, D.C. https://directives.sc.egov.usda.gov/

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