

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

OPEN CHANNEL

(Feet)

CODE 582

DEFINITION

Constructing, improving, re-creating, or restoring a channel in which water flows with a free surface.

PURPOSES

This standard may be applied as part of a resource management system to support one or more of the following:

1. Re-establish or improve a channel to accommodate design flows, provide for riparian vegetation establishment and growth on the floodplain, reduce bed and bank erosion, improve floodplain function and stability and modify sediment transport
2. Provide improved water quality and habitat for aquatic species and improved riparian habitat for upland species

CONDITIONS WHERE PRACTICE APPLIES

This standard applies to construction of new channels or modifications of existing channels.

It applies where stability requirements can be met, where the impact of the proposed construction on resource concerns is evaluated, and the techniques and measures necessary to overcome the undesirable effects are made part of any planned work.

This standard applies to Surface Drainage, Main or Lateral (608), having a drainage area in excess of one square mile.

This standard does not apply to Diversion (362), Grassed Waterway (412), Irrigation Field Ditch (388), Surface Drainage, Field Ditch (607), or Irrigation Canals or Laterals (320).

This standard does not apply to localized reaches of streams that should be treated by using Practice Standard (580) Streambank and Shoreline Protection or (584) Stream Channel

Stabilization.

CRITERIA

A channel can have a fixed boundary or a movable boundary. Changes in bed elevation or bank location are not expected to occur in fixed boundary channels. Movable boundary channel bed and banks consist of materials transported by the channel and changes in the bank location and bed elevation are expected to occur. Fixed or movable channel designs may be applicable to all purposes.

General Criteria Applicable to Fixed and Movable Boundary Channels

Measures shall be installed according to a site-specific plan and in accordance with all applicable local, State, and Federal laws and regulations.

Measures to be applied shall be compatible with improvements planned or being carried out by others.

End sections shall be integrated with existing measures. Grade stabilization shall be provided when there are excessive, undesirable differences in bed elevations or transitions where excessive scour may occur.

Sufficient depth shall be maintained to provide adequate outlets for subsurface drains, tributary ditches, or other channels.

Effect of channel work on existing structures including, but not limited to, culverts, bridges, buried cables, pipelines, irrigation flumes, and inlet structures for surface and subsurface drainage on the channel and laterals, shall be evaluated to determine impacts of the proposed installation.

Measures shall be compatible with the bank or shoreline materials, water chemistry, channel hydraulics, and slope characteristics both above and below the water line.

Designs will provide for protection from upslope runoff.

Internal drainage for bank seepage shall be provided when needed. Geotextile or filter bedding shall be used on structural measures where there is potential for migration of material from behind the structure.

Measures shall be designed for anticipated ice action, debris impact and fluctuating water levels.

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

All disturbed areas around measures shall be protected from erosion. Disturbed areas shall be protected as soon as practical after construction. Vegetation shall be selected that is best suited for the expected soil/moisture regime.

Measures applied shall seek to avoid adverse impacts to threatened and endangered (T & E), and candidate species and their habitats whenever possible. Refer to GM 190 ECS-410 for actions affecting listed species.

Measures applied shall seek to avoid adverse affects to National Register listed archaeological, historic, structural, and traditional cultural properties, whenever possible. Where known archaeological, historic, structural or traditional cultural properties exist, consideration shall be given to using measures that avoid compaction and other extensive disturbance during installation. Refer to GM 420 Part 401 and Cultural Resources Handbook Part 601, Subpart C.

Capacity - 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 grade line for design flow for channels shall be determined. Roughness coefficients 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 in cooperation with the owners or sponsors.

Required capacity shall be established by appropriate methods such as volume-duration removal rates, peak flow, design flow or a combination, as determined by the topography, landscape setting, channel type, purpose of the channel, desired level of protection, and economic feasibility.

Cross Section - Required channel cross section and grade shall be determined by plan objectives, design capacity, materials in which the channel is to be constructed, vegetative establishment plan, and requirements for operation and maintenance.

Urban and other high-value developments through which the channel is to be constructed must be considered in the design of the channel section. If a channel is deepened, grade control must be evaluated to prevent channel incision from extending upstream beyond the project site. Dewatering of shallow aquifers shall be addressed to insure that riparian areas or wetlands are not negatively impacted and to avoid negative impacts to fish.

Channel Stability - Channels must be stable under conditions existing immediately after construction (as-built condition) and able to pass the design flow under conditions existing during effective design life (aged condition). Channel stability shall be determined for discharges under the following conditions:

1. As-built condition - Allowable as-built velocity based on NRCS National Engineering Technical Release 25 (TR-25), Design of Open Channels or other applicable guidelines (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.

Where an erosion control fabric is used on the channel bank, allowable as-built velocity may be increased by a percentage determined according to recommendations provided by the manufacture of the selected erosion control fabric.

When evaluating the as-built condition the lesser of the design discharge or the 10-year frequency flow will be used.

2. Aged condition - Channel-forming flow or design discharge, whichever is larger, except that it is not necessary to check stability for discharge greater than the 100-year frequency. Channel forming flow, for this purpose, is considered a minimum 1.5 year discharge.

The sediment transport characteristics shall be evaluated on a long-term basis as well as for different levels of flow to evaluate risk, to check floodplain interaction and to project future channel adjustments.

Appurtenant Structures - Channel design shall include all structures required for proper functioning of the channel and its laterals, as well as travel-ways for operations 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.

If culverts or bridges are removed, vertical stability of the channel must be analyzed for grade control. Capacity of some culverts and bridges may need to be increased above the design discharge to allow for debris movement, bedload transport or ice.

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

1. Not raise the level of, or block access to, the floodplain, thereby decreasing the accessibility during flood flows
2. Not negatively impact wetland/riparian areas
3. Not confine or direct flows so as to cause instability when the discharge overtops the channel banks

4. Provide for the free flow of water between channel and floodplain unless the valley routing and water surface profiles are based on continuous dikes being installed
5. Not hinder the development of travel-ways for maintenance on fixed boundary channels
6. Leave the riparian area or right-of-way in the best condition feasible, consistent with the project purposes and adjacent land uses
7. Direct water accumulating on or behind spoil areas to protected outlets
8. Maintain or improve the visual quality of the site to the extent feasible

Additional Criteria for Fixed Boundary Channels

TR-25 shall be used in providing direction for surveys, planning, and site investigations for channel work. Design criteria in TR-25 shall be followed using the procedure best adapted to site conditions. Appropriate efforts will be made to classify and characterize the volume and timing of sediment movement in both the present and future conditions.

Additional Criteria for Movable Boundary Channels

Channel changes must maintain or improve habitat for aquatic species. Changes in the riparian corridor must maintain or improve both aquatic and upland wildlife species. Removal of stumps, fallen trees, debris, and bars within the channel shall be done if they are causing, or may cause, detrimental impacts to the stream system. Habitat forming elements that provide cover, food, pools and water turbulence shall be retained or replaced to the extent possible.

Channel construction, improvement, or restoration shall be according to an approved plan prepared for the site by an interdisciplinary team. The channel segment shall be classified according to a system deemed appropriate by the State.

The plan must fit all the various elements of the channel design into a system that allows geomorphic, hydraulic and hydrologic functions to occur. The geomorphic, hydraulic and hydrologic functions shall be designed to result in rates of erosion and deposition that do not require annual maintenance, repair or replacement.

The plan must include channel design elements and the channel location that maintain or improve the overall landscape character and any prominent views.

The plan must include maintaining or establishing appropriate riparian corridor vegetation in order to maintain the designed channel dimension, pattern and form, and rate of lateral migration.

Capacity - The required capacity is the channel-forming flow with higher flows utilizing the floodplain. The required capacity can exceed the channel-forming flow if the boundary materials for that type of channel can withstand the increased depth and tractive stress of the flows that remain within the bank.

Geomorphic, hydraulic, and hydrologic analyses are required to determine the water surface profile and hydraulic grade line.

The sediment transport characteristics of a project reach shall be evaluated on a long term as well as event basis.

Cross Section – Since variability of cross sectional shape is a key energy management feature on many stream systems, particularly pool/riffle, plane bed and step/pool type morphologies, cross section shall vary as appropriate to the stream type.

Channel Stability - A geomorphic analysis for stability shall include, but not be limited to the following: channel gradient, sinuosity, width to depth ratio, meander belt width, radius of curvature, bank material, height and slope, pool/riffle or step/pool spacing ratios, riparian vegetation appropriate for ecological site, access to a floodplain, sediment transport, bed material, and channel and floodplain roughness.

CONSIDERATIONS

General

Consider effects on components of the water budget, especially on volumes and rates of runoff and infiltration.

Consider effects on shallow aquifers.

Consider effects of erosion and the movement of sediment and soluble and sediment-attached substances in runoff during and immediately after construction.

Consider incorporating large woody debris removed from the channel bed, banks or riparian area into the overall design.

Consider effects of the use of chemicals during vegetation control.

Consider effects of changes in channel vegetation on downstream water temperature.

Assess potential for temporary and long-term effects on the visual quality of downstream waters.

Consider stockpiling topsoil and re-spread to improve planting success unless the seed bank contains an excessive amount of noxious weeds.

When designing protective measures, consider the changes that may occur in the watershed hydrology and sedimentation over the design life of the measure.

Consider the type of human use and the social and safety aspects when designing the protective measure. Use construction materials, grading practices, vegetation, and other site development elements that enhance aesthetics and maintain or compliment existing landscape uses such as pedestrian paths, climate controls, buffers, etc.

Consider using vegetative species that are native to local ecosystems. Do not use invasive, noxious, or exotic species that could become nuisances. Consider species that have multiple values such as those suited for biomass, wildlife food, wildlife cover, and aesthetics. Avoid species that may be alternate hosts to disease or undesirable pests. Species diversity should be considered to avoid loss of function due to species-specific pests.

Vegetative measures should be considered on slopes above the elevation where structural measures are required. Use natural fiber fabric when needed for short-term stabilization rather than grass seeding if possible.

Livestock exclusion should be considered during establishment of vegetative measures and appropriate grazing practices applied after establishment to maintain plant community integrity. Wildlife may also need to be controlled during establishment of vegetative measures. Temporary and local population control methods should be used with caution and within State and local regulations.

Measures that promote beneficial sediment deposition and the filtering of sediment, sediment-attached, and dissolved substances should be considered adjacent to, or within the riparian corridor.

Consider maintaining or improving the habitat value for fish and wildlife, which includes lowering or moderating water temperature, and improving water quality and connectivity to adjacent habitats.

Consider fish passage both upstream and downstream for all species present.

Consider maximizing adjacent wetland functions and values with the project design.

Protective measures should be self-sustaining or require minimum maintenance.

Consider the critical low flow i.e. 7-day annual low flow, in the stability analysis if maintaining aquatic habitat is a concern. Sediment transport rates at low flows may not impact channel stability, but sediment deposits could cover critical habitat.

Open channels can create a safety hazard. Measures should be designed to minimize safety hazards to boaters, swimmers, or people using the shoreline or streambank. Appropriate safety features and devices should be installed to protect people and animals from accidents such as falling or drowning.

Maintenance Access - A travel-way should be provided on either side of large fixed boundary channels where necessary for use of maintenance equipment to reach center of the channel. Travel-ways must be adequate for movement and operation of maintenance equipment. 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.

On streams where fish are a concern, construction of any work within the water portion of the stream should be limited to periods of the year when fish migration is not occurring and there are no eggs in the substrate. In-stream work should be performed in accordance with all permit requirements.

PLANS AND SPECIFICATIONS

Plans and specifications for constructing open channels shall be in keeping with this standard.

OPERATION AND MAINTENANCE

An Operation and Maintenance plan must be prepared for use by the landowner or operator responsible for operation and maintenance of an open channel system. The plan should provide specific instructions for operating and maintaining the channels to insure they function properly. It should also provide specific instructions pertaining to the intensity of management activities in the stream channel and riparian area. Where applicable, Operation and Maintenance plans will describe the anticipated time frame for changes and adjustments in the planform and profile, and the appropriate operation and maintenance response to these adjustments. Permits and/or consultation may be required for operation and maintenance. Minimum requirements to be addressed in the Operation and Maintenance plan are:

1. Prompt repair or replacement of damaged components if necessary
2. Remove foreign materials and vegetation that are interfering with proper operation only when necessary
3. Maintain vigorous vegetative growth in riparian areas and for erosion control
4. Maintain travel-ways for operation and maintenance access