Natural Resources Conservation Service

CONSERVATION PRACTICE STANDARD

STREAM CROSSING

CODE 578

(no)

DEFINITION

A stabilized area or structure constructed across a stream to provide controlled access for people, livestock, equipment, or vehicles.

PURPOSE

This practice is used to accomplish one or more of the following purposes:

- Provide access to another land unit
- Improve water quality by reducing sediment, nutrient, and organic loading to a stream
- Reduce streambank and streambed erosion

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all land uses where an intermittent or perennial watercourse exists and a ford, bridge, or culvert type crossing is needed.

CRITERIA

General Criteria Applicable to All Purposes

Apply this standard in accordance with all local, State, Tribal, and Federal regulations, including flood plain regulations and flowage easements.

Identify significant cultural resources or threatened or endangered species that could be affected by the implementation of the practice.

Location

Locate stream crossings in areas where the streambed is stable or where it can be stabilized [see Virginia NRCS Conservation Practice Standard *Channel Bed Stabilization (Code 584)*]. Do not place crossings where channel grade or alignment changes abruptly, excessive seepage or instability is evident, overfalls exist (evidence of incision and bed instability), where large tributaries enter the stream, in newly located or constructed channels, or within 300 feet of known spawning areas of listed species. Avoid wetland areas.

Discourage livestock loafing in the stream by locating crossings, where possible, out of shady riparian areas or by including gates in the design.

Install stream crossings perpendicular to the direction of stream flow where possible. Fully consider the natural lateral migration pattern of the stream in the design. Avoid skews on all but the smallest streams.

Keep vegetative disturbance in surface waters to a minimum.

Access Roads
Where the stream crossing is installed as part of a roadway, size the crossing according to Virginia NRCS Conservation Practice Standard *Access Road (Code 560)*.

Width
Provide an adequate travel-way width for the intended use. A multi-use stream crossing shall have a travel-way no less than 12 feet wide. Make "livestock- only" crossings no less than 8 feet wide and no more than 30 feet wide, as measured from the upstream end to the downstream end of the stream crossing, not including the side slopes.

Side slopes
Make all side slope cuts and fills stable for the channel materials involved. Make the side slopes of cuts or fills in soil materials no steeper than 2 horizontal to 1 vertical (2:1). Make rock cuts or fills no steeper than 1.5 horizontal to 1 vertical (1.5:1).

Stream Approaches
Blend approaches to the stream crossing with existing site conditions, where possible. Use streambank soil bioengineering practices as appropriate and feasible. Make the approaches stable, with gradual ascent and descent grades which are not steeper than 6 horizontal to 1 vertical (6:1),

and of suitable material to withstand repeated and long term use. Make the minimum width of the approaches equal to the width of the crossing surface. When the stream crossing is used in conjunction with Virginia NRCS Conservation Standard *Animal Trails and Walkways (Code 575)*, any transition in width from a walkway to the stream crossing shall be accomplished before entering the stream crossing approaches (ramps).

Divert surface runoff around the approaches to prevent erosion. Direct roadside ditches into a diversion or away from the crossing surface.

Configure the crossing approaches (gradient and curves) to properly accommodate the length and turning radii of vehicles using the crossing.

Rock
All rock must be able to withstand exposure to air, water, freezing, and thawing. Use rock of sufficient size and density to resist mobilization by design flood flows.

Use appropriate rock sizes to accommodate the intended traffic without damage to the livestock, people, or vehicles using the crossing.

Fencing
Restrict livestock access to the crossing through the use of fence and gates, as needed.

Install cross-stream fencing at fords, with breakaway wire, swinging floodgates, hanging electrified chain, or other devices to allow the passage of floodwater and large woody material during high flows.

Design and construct all fencing in accordance with Virginia NRCS Conservation Practice Standard *Fence (Code 382)*.

Vegetation
Plant all areas to be vegetated as soon as practical after construction. If completion does not coincide with appropriate planting dates for permanent cover, use a cover of temporary vegetation to protect the site until permanent cover can be established. Native or functioning-as-native plant species are preferred. Use Virginia NRCS Conservation Practice Standard *Critical Area Planting (Code 342)* where vegetation is unlikely to become established by natural regeneration, or where acceleration of the recovery of vegetation is desired.

In areas where the vegetation may not survive, use Virginia NRCS Conservation Practice Standard *Heavy Use Area Protection (Code 561)* for a stabilization measure.

Permits

Treatments shall be in accordance with all applicable local, state and federal laws and regulations. Any deviation from the criteria contained in this standard will require an application for permits (Joint Permit Application) from the Norfolk District US Army Corps of Engineers (USACE) for work in the waters of United States and corresponding permits from the Virginia Marine Resources Commission, the Virginia Department of Environmental Quality, and/or Local Wetlands Board. If stream crossings are installed according to this standard and the conditions below, an exemption to the Clean Water Act and Virginia Water Protection Permit Regulations (on file at the State Office) allows construction. Treatments may require other permits under local ordinance.

Conditions

- The watershed is less than five square miles.
- All excavated material must be placed in upland sites and not in any streams/floodplains or wetlands.
- Borrow material shall be taken from upland sources whenever feasible and shall be free from toxic pollutants in toxic amounts;
- Minimize the encroachment of trucks, tractors, bulldozers or heavy equipment within state waters that lie outside of the lateral boundaries of the fill itself;
- There are no special environmental concerns identified in the Environmental Evaluation (CPA-52), including:
    - Threatened and endangered species;
    - Designation as a component to the National Wild and Scenic River System or as a trout stream;
    - Nesting and breeding areas for migratory waterfowl;
    - Wetlands; or
    - Spawning areas.

Bridge Crossings

Design bridges in a manner that is consistent with sound engineering principles and adequate for the use, type of road, or class of vehicle. Design bridges with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics. Design bridges to fully span the stream, passing at least the bankfull flow where the design flow is not dictated by regulation.

Bankfull flow is the discharge that fills a stream channel up to the elevation at which flow begins to spill onto the floodplain.

Adequately protect bridges so that out-of-bank flows safely bypass without damaging the structure or eroding the banks.

Vehicle and pedestrian bridges must be designed in accordance with the current American Association of State Highway and Transportation Officials Load and Resistance Factor Design (LRFD) bridge design specifications (AASHTO, 2010).

Evaluate the need for safety measures such as guardrails and reflectors at bridge crossings.

Acceptable bridge materials include concrete, steel, and wood.

Culvert Crossings

Design culverts in a manner that is consistent with sound engineering principles and adequate for the use, type of road, or class of vehicle. For culverts associated with a road, culvert design flow shall meet the criteria in Virginia NRCS Conservation Practice Standard *Access Road (Code 560)*. The design flow for

culverts not associated with a road will be the 2-year, 24-hour storm peak discharge, or bankfull flow, whichever is less. Design culverts with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics.

Design culverts to minimize habitat fragmentation and to minimize barriers to aquatic organism movement.

Do not use culverts where large flows of sediment or large woody material are expected, or where the channel gradient exceeds 6 percent (100 horizontal to 6 vertical).

Evaluate the need for safety measures such as guardrails at culvert crossings.

Crossings shall be adequately protected so that out-of-bank flows safely bypass without damaging the structure or eroding the streambanks or the crossing fill.

At least one culvert pipe shall be placed with its entire length set six inches below the existing stream bottom. Additional culverts may be used at various elevations to maintain terrace or floodplain hydraulics and water surface elevations.

For drainage areas greater than 50 acres or where the dominant land use is not agriculture or forestry, the culvert size(s) shall be selected based on the calculated discharge at the site but shall not be smaller than 24 inches.

For drainage areas equal to or less than 50 acres with a dominant land use of agriculture or forestry, a minimum pipe size can be used based upon the site location. Virginia Engineering Design Note 578 – Stream Crossings contains a map delineating the physiographic regions of the State.

If the site is located in the Northern or Southern Piedmont regions, a minimum pipe size of 30” is required.

In other regions, a minimum pipe size of 24” is required.

As an alternative, a calculated discharge can be also used to size the culvert for drainage areas less than or equal to 50 acres, but the selected pipe shall be no smaller than 24”.

Place a minimum of one foot of cover over the culvert. Make the barrel length of the culvert adequate to extend the full width of the crossing, including side slopes, plus one foot on each side.

Acceptable culvert materials include concrete, corrugated metal, corrugated plastic, new or used high quality steel, and any other materials that meet the requirements of Virginia NRCS Conservation Practice Standard *Structure for Water Control (Code 587)*.

Ford Crossings

The following criteria apply to all ford crossings:

Make the cross-sectional area of the crossing equal to or greater than the natural channel cross-sectional area. Make a portion of the crossing depressed at or below the average stream bottom elevation when needed to keep base flows or low flows concentrated and allow passage of aquatic organisms.

Match ford shape to the channel cross-section to the extent possible.

Provide cutoff walls at the upstream and downstream edges of ford-type stream crossings when needed to protect against undercutting.

Evaluate the need for water depth signage at ford crossings.

To the extent possible, the top surface of the ford crossing shall follow the contours of the stream bottom but in no case shall the top surface of the ford crossing be higher than 0.5 foot above the original stream bottom at the upstream edge of the ford crossing.

Make the downstream edge of the ford crossing with a low-flow hydraulic drop less than 0.5 foot above the original stream bottom

Concrete Fords
Use concrete ford crossings only where the foundation of the stream crossing is determined to have adequate bearing strength.

Use concrete with a minimum compressive strength of 3,000 psi at 28 days, with a ratio of water to cementitious materials of 0.50 or less. Use coarse aggregate of 0.75 to 1 inch nominal size. If designed for freezing conditions, use concrete with 4 to 8 percent air-entrainment.

Use a minimum thickness of 5 inches of placed concrete. Pour the concrete slab on a minimum 4-inch thick gravel base, unless the foundation is otherwise acceptable.

Construct toe-walls at the upstream and downstream ends of the crossing. Make the toe-walls a minimum of 6 inches thick and 18 inches deep. Extend the toe-walls in the stream approaches to the bankfull flow elevation.

Precast concrete panels may be used in lieu of cast-in-place concrete slabs. To the extent possible, the panels shall follow the contours of the stream bottom in order to avoid potential problems with sediment accumulation. Use concrete units that have adequate reinforcement for transportation and placement.

Dewatering of the site and toe-walls is required during placement of the concrete to maintain the proper water/cement ratio. Flowing water will erode concrete that is not sufficiently hardened. The stream must be diverted or retained from flowing over the concrete for at least 12 hours after placement of the concrete.

During construction, aquatic species must be removed from the construction area according to State protocols.

Rock Fords and the Use of Geosynthetics
Coarse aggregate or crushed rock ford crossings are often used in steep areas subject to flash flooding and where normal flow is shallow or intermittent.

When the site has a soft or unstable subgrade, use geotextiles in the design of rock ford crossings. Dewater and excavate the bed of the channel to the necessary depth and width and cover with geotextile material. Install the geotextile material on the excavated surface of the ford and extend it across the bottom of the stream and at least up to the bankfull flow elevation.

Where stream channels are composed of stable coarse rock material or solid bedrock, no geotextile or armor is required on the stream bottom. Geotextile shall be installed on the excavated surfaces of the ford. Cover the geotextile material with at least 6 inches of crushed rock or coarse aggregate sized to withstand the design flow.

Use minimum 6-inch deep geocells, if geocells are used. Use durable geosynthetic materials and install them according to the manufacturer’s recommendations, including the use of staples, clips, and anchor pins.

Design all rock ford stream crossings to remain stable for the bankfull flow. Compute channel velocities and choose rock size using procedures in NEH630; NEH654 TS14N; EFH Chapter 16 (NEH650), Appendix 16A; or other procedures approved by the State Conservation Engineer.

Where rock is used for ford crossings for livestock, use a hoof contact zone or alternative surfacing method over the rock

CONSIDERATIONS

Avoid or minimize the use of or number of stream crossings, when possible, through evaluation of alternative trail or travel-way locations. Assess landuser operations to consolidate and minimize the number of crossings. Where feasible, use existing roads.

Evaluate proposed crossing sites for variations in stage and discharge, tidal influence, hydraulics, fluvial geomorphic impacts, sediment transport and flow continuity, groundwater conditions, and movement of woody and organic material. Increase crossing width or span to accommodate transport of large woody material in the flow. Design passage features to account for the known range of variation.

For culvert crossings, consider incorporating natural streambed substrates throughout the culvert length for passage of aquatic organisms (see Bunt and Abt, 2001, for sampling procedures). Natural streambeds provide passage and habitat benefits to many life stage requirements for aquatic organisms and may reduce maintenance costs. Also consider using such material to cap armoring material in the streambed of a ford crossing. See Virginia Design Note 578 – *Stream Crossing* for additional information.

Consider all life stages of aquatic organisms in the stream crossing design to accommodate their passage, in accordance with the species' requirements. Design criteria are available in NEH Part 654, Technical Supplement 14N, Fish Passage and Screening Design; U.S Forest Service low-water design guidance (USFS, 2006); and stream simulation guidance (USFS,2008). See also Harrelson, et al. 1994, for stream reference site descriptions.

Where a stream crossing is installed to remove an existing barrier to the passage of aquatic organisms, consider using Virginia NRCS Conservation Practice Standard *Aquatic Organism Passage (Code 396)*.

Consider relevant aquatic organisms in the design and location of crossings to improve or provide passage for as many different aquatic species and age classes as possible.

Consider the habitat requirements of other aquatic or terrestrial species that may be affected by construction of a stream crossing. For example, a crossing may be designed with features that also promote safe crossing by terrestrial vertebrates.

Ford crossings have the least detrimental impact on water quality when their use is infrequent. Ford crossings are adapted for crossing wide, shallow watercourses with firm streambeds. If the stream crossing is to be used frequently, or daily, as in a dairy operation, a culvert crossing or curbed bridge should be used, rather than a ford crossing.

Locate stream crossings to avoid adverse environmental impacts and consider the following:

- Effects on upstream and downstream flow conditions that could result in increases in erosion, deposition, or flooding. Consider habitat upstream and downstream of the crossing to avoid fragmentation of aquatic and riparian habitats.
- Short-term and construction-related effects on water quality.
- Overall effect on erosion and sedimentation that will be caused by the installation of the crossing and any necessary stream diversion.
- Effects of large woody material on the operation and overall design of the crossing.

Consider adding a well-graded rock riprap apron on the downstream edge of concrete crossings to dissipate flow energy.

Ford crossings should not be placed immediately downstream from a pipe or culvert because of potential damage from localized high velocity flows.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for stream crossings in keeping with this standard. The plans and specifications must clearly describe the requirements for applying the practice to achieve its intended purpose.

Record all required information in an engineer field book, on a plan sheet or design computation sheet, or in another appropriate location.

DESIGN DATA

- Completed Environmental Evaluation and subsequent requirements.
- Soils investigation.
- Survey and plot data: profile, cross-sections, topography, as needed.
    - Survey and plot profile along centerline of stream (distance should be sufficient to determine channel slope).
    - Survey and plot the existing cross-section perpendicular to the flow, extending beyond the ends of the planned ramps to ensure adequate representation of the designed cross section. Include typical cross sections as needed.
- Design computations, including purpose of practice and references used.
    - Sketch of area to indicate stream meandering and limits of stream protection, if needed.
    - Determine drainage area, land use, and, if applicable, design flows and design velocities.
    - For ramp crossings, design ramp to best fit the section and meet the design criteria. For culvert crossings, show culvert design calculations.
    - Add construction sequence to include stream channel diversion, dewatering, and sediment control measures, as needed.
    - Document landowner/VDGIF contact concerning the proposed stream crossing. Record date, contact person, and outcome of site visit, if one occurred.
- Plan view of site with existing and planned features, showing dimensions, distances, etc. Include such items as: utilities; fencing; crossing width and length; ramp slopes and side slopes; culvert material, diameter, and length.
- Standard Cover Sheet (VA-SO-100) including crossing location map.
- Materials and quantities needed. Identify borrow material and/or spoil area, as needed. Specify thickness, gradation, quantities and type of rock or stone. Specify type, dimensions, and anchoring requirements of geotextile. Specify thickness, compressive strength, reinforcement, and other special requirements for concrete, if used.
- Vegetation and/or ground cover requirements.
- Identification of needed Erosion & Sediment Control measures.
- Supplemental practices required.
- Virginia Conservation Practice Specifications (700 Series).
- Operation and Maintenance Plan

Note: Regulatory agencies may request spot checks of stream crossings to ensure permit conditions are being followed.

CHECK DATA

- As-built surveys.
    - Cross-section of completed crossing.
    - Profile of stream channel to show crossing and stream are on a uniform grade.
- As-built plans including dimensions, types and quantities of materials installed, and variations from

design. Include justification for variations.

- Locations of appurtenant practices.
- Adequacy of vegetation and/or ground cover.
- Complete as-built section of Cover Sheet.

OPERATION AND MAINTENANCE

Develop an operation and maintenance plan and implement it for the life of the practice.

Include the following items in the operation and maintenance plan, as a minimum:

Inspect the stream crossing, appurtenances, and associated fence after each major storm event and make repairs if needed.

- Remove any accumulation of organic material, woody material, or excess sediment.
- Replace surfacing stone used for livestock crossing as needed.

REFERENCES

AASHTO, 2010. American Association of State Highway and Transportation Officials Load and Resistance Factor Design (LRFD) Bridge Design Specifications, Customary U.S. Units, 5th Edition, with 2010 edits; ISBN Number: 1-56051-451-0

Bunte, Kristin; Abt, Steven R. 2001. Sampling surface and subsurface particle-size distributions in wadable gravel-and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring. Gen. Tech. Rep. RMRS-GTR-74. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 428 p (http://www.fs.fed.us/rm/pubs/rmrs_gtr74.html)

Harrelson, Cheryl C; Rawlins, C. L.; Potyondy, John P, 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

(http://www.stream.fs.fed.us/publications/PDFs/RM245E.PDF)

MassDOT, 2010. Design of Bridges and Culverts for Wildlife Passage at Freshwater Streams. Massachusetts Department of Transportation, Highway Division. (http://www.mhd.state.ma.us/downloads/projDev/Design_Bridges_Culverts_Wildlife_Passage_122710.pdf)

USDA-NRCS. Virginia Electronic Field Office Technical Guide (eFOTG), Section IV. [On-line]. Available at: http://www.nrcs.usda.gov/technical/eFOTG

USDA-NRCS. Virginia 700 Series Construction Specifications. [On-line]. Available at: http://www.nrcs.usda.gov/technical/eFOTG

USDA-NRCS. Engineering Design Note 578 – Stream Crossing. [On-line]. Available at: http://www.nrcs.usda.gov/technical/eFOTG

Virginia Standard Drawings