

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD

STREAM CROSSING

(No.)
Code 578



DEFINITION

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

PURPOSE

- Provide access to another land unit
- Improve water quality by reducing sediment, nutrient, organic, and inorganic loading of the 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

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

Impact to cultural resources, wetlands and Federal and state protected species shall be

evaluated and avoided or minimized to the extent practicable during planning, design and implementation of this conservation practice in accordance with established National and Florida policy, General Manual (GM) Title 420-Part 401; Title 450-Part 401, Title 190-Parts 410.22 and 410.26, National Planning Procedures Handbook (NPPH) Florida Supplements to Parts 600.1 and 600.6, National Cultural Resources Procedures Handbook (NCRPH), National Food Security Act Manual (NFSAM), and the National Environmental Compliance Handbook (NECH).

For this conservation practice standard, bankfull flow is defined as the discharge that fills a stream channel up to the elevation at which flow begins to spill onto the floodplain.

Location. Locate stream crossings in areas where the streambed is stable or where it can be stabilized (see Florida 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 bed instability), where large tributaries enter the stream, or within 300 feet of known spawning areas of listed species. Minimize impacts to wetland areas when at all possible.

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.

Do not install stream crossings in a newly located or constructed channel. Disturb only the area necessary to install the crossing and avoid disturbing the stream channel upstream or downstream of the crossing during installation.

Conservation practice standards are reviewed periodically, and updated if needed. To obtain the current version of this standard, contact the Natural Resources Conservation Service.

Locate crossings, where possible, out of shady riparian areas to discourage cattle loafing time in the stream.

Stream crossings shall provide a way for normal passage of water, fish and other aquatic animals within the channel during all seasons of the year.

Access Roads. Where the stream crossing is installed as part of a roadway, size the crossing according to Florida NRCS conservation practice standard, Access Road, Code 560. Where high rates of erosion of the adjacent roadway that slope towards the crossing threaten to deliver an excessive amount of sediment to the drainage, install measures to minimize erosion of the roadside ditch, road surface, and/or cut slopes.

Width. Provide an adequate travel-way width for the intended use. Make "livestock- only" crossings no less than 6 feet wide and no more than 30 feet wide. A multi-use stream crossing shall have a travel-way no less than 10 feet wide. Width shall be 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 4 horizontal to 1 vertical (4:1), 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.

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. Exclude 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 Florida NRCS conservation practice standard, Fence, Code 382.

Vegetation. Plant all disturbed areas 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 Florida 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 Florida NRCS conservation practice standard, Heavy Use Area Protection, Code 561.

Bridge Crossings

Design bridges in a manner that is consistent with sound engineering principles and adequate for the use, type of road, class of vehicle or load requirements. 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 a regulatory authority.

Adequately protect bridges so that out-of-bank flows safely bypass without damaging the bridge 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). For bridges not designed by NRCS, the design shall be signed

and sealed by a professional engineer registered in Florida.

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 Florida 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 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 recessed 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.

Make the barrel length of the culvert adequate to extend the full width of the crossing, including side slopes, and inlet or outlet extensions.

Acceptable culvert materials include concrete, corrugated metal, corrugated plastic, steel, and any other materials that meet the requirements of Florida NRCS conservation practice standard, Structure for Water Control, Code 587. Design of culverts shall be consistent with sound engineering principles and shall be adequate for the use, type of road, or class of vehicle.

Ford Crossings

The following criteria apply to all open 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.

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 with minimum reinforcement of 6-inch by 6-inch, 6 gauge welded wire fabric. Pour the concrete slab on a minimum 4-inch thick gravel base, unless the foundation is otherwise acceptable.

When heavy equipment loads are anticipated, the concrete slab shall be designed using an appropriate procedure as described in American Concrete Institute, ACI 360, Design of Slabs on Grade.

Construct toe-walls at the upstream and downstream ends of the crossing. The toe-walls shall be of sufficient depth (minimum 18 inches)

and thickness (minimum of 6 inches) to prevent undermining. Extend the toe-walls up the stream approaches to the bankfull flow elevation.

Design a rock rip-rap apron along the downstream edge of the concrete to dissipate velocity and protect the downstream edge of the crossing from degradation. The rip-rap apron shall be of sufficient width (minimum 3 feet) and thickness (minimum 18 inches) to protect the downstream edge of the crossing for the length of the crossing determined to be susceptible to degradation.

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. Precast concrete units shall comply with ACI 533, or as otherwise acceptable for local conditions. Use concrete units that have adequate reinforcement for transportation and placement. The downstream edge of concrete panels shall be protected in the same manner as cast-in-place concrete.

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. Cover the geotextile material with at least 6 inches of crushed rock.

If geocells are used, use minimum 6-inch deep geocells.

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; and 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.

Vented Fords

Design vented fords (hardened culvert crossings) in a manner that is consistent with sound engineering principles and adequate for the use, type of crossing, or class of vehicle. Design the culverts (or vents) to carry the flow for the normal stream base flow with non-erosive outlet velocities without overtopping the ford (or driving surface).

The elevation of the ford travel surface will be designed to provide a dry crossing during normal wet season base flow. Design the ford to be stable from overtopping for the 10 year – 24 hour storm.

Design vented fords with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics.

Design vented fords to minimize habitat fragmentation and to minimize barriers to aquatic organism movement.

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

Vented fords are not to be crossed when the ford is overtopped but for safety purposes, place a marker or sign on each edge of the top of the ford so the edge can be located when flow overtops the ford. The marker shall be placed at least 1 foot higher than the design storm elevation or 10 year – 24 hour storm elevation, whichever is higher. The markers shall be covered with reflective tape and be spaced at intervals no greater than 30 feet. Evaluate the need for other safety measures such as guardrails.

Adequately protect vented fords so that flows over the ford will not cause damages to the structure or erode the streambanks or downstream channel. Both side slopes and top of the elevated ford shall be armored for the entire length that is expected to be overtopped during the design storm event. Acceptable materials for armoring are concrete, rock riprap, articulated concrete block mats, sand cement bag riprap and other materials that would be stable during the design storm event. Cut-off walls shall also be used on the upstream and downstream side of the ford to prevent undermining due to scour. Additional scour protection shall be used on the downstream side of the ford.

The crossing surface shall be protected to the design storm elevation.

The vented ford shall have at least one culvert pipe placed with its entire length recessed six inches below the existing stream bottom. Additional culverts may be used at various elevations to carry the normal base flow.

Make the barrel length of the culvert adequate to extend the full width of the crossing, including side slopes, and inlet or outlet extensions.

Acceptable culvert materials include concrete, corrugated metal, corrugated plastic, steel, and any other materials that meet the requirements of Florida NRCS conservation practice standard, Structure for Water Control, Code 587.

Additional information on the design and use of vented ford crossings can be found in Clarkin et al. 2006.

CONSIDERATIONS

Avoid or minimize the use of or number of stream crossings, when possible, through evaluation of alternative trail or travel-way locations. Assess land user 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.

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 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. However, culverts are not recommended for large drainage areas. When a culvert is utilized, consider using riprap outlet protection since culverts concentrate flow and often create streambed scour.

Because of the potential for damage resulting from the excessive velocities, consider not placing ford crossings immediately downstream of a pipe or culvert.

For vented ford crossings, consider sizing the vent (or culvert) area to be equal to or greater than the bankfull area of the channel to promote better aquatic organism and sediment passage.

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.
- Effects of instream work on rare and listed species; particularly in Gulf strurgeon critical habitat and northwest and north Florida federally listed mussel habitat.

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.

As a minimum, include the following in the plans and specifications:

- Location of stream crossing.
- Stream crossing width and length with profile and typical cross sections.
- Design grades or slopes of stream approaches.
- Thickness, gradation, quantities, and type of rock or stone.
- Type, dimensions, and anchoring requirements of geotextile.
- Thickness, compressive strength, reinforcement and other special requirements for concrete, if used.
- Vegetative requirements that include seed and plant materials to be used, establishment rates, and season of planting.
- Location, type, and extent of fencing required.

- Method of surface water diversion and dewatering during construction.
- Location of utilities and notification requirements.
- Location of safety measures, as needed.

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

American Association of State Highway and Transportation Officials Load and Resistance Factor Design (LRFD) Bridge Design Specification

American Concrete Institute Standards:
Design of Slabs on Grade, 360
Precast Panels, 533

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_qtr74.html

Clarkin, Keller, Warhol, Hixson, 2006. Low-Water Crossings: Geomorphic, Biological, and Engineering Design Considerations. U.S. Department of Agriculture, Forest Service
<http://www.fs.fed.us/t-d/pubs/pdf/LowWaterCrossings/index.shtml>

Florida NRCS Conservation Practice Standards:
Access Road, Code 560
Channel Bed Stabilization, Code 584
Critical Area Planting, Code 342
Fence, Code 382
Structure for Water Control, Code 587

General Manual

Title 420-Part 401

Title 450-Part 401

Title 190-Parts 410.22 and 410.26

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>)

National Cultural Resources Handbook

National Environmental Compliance Handbook

National Food Security Act Manual

National Planning Procedures Handbook

Florida Supplements to Parts 600.1 and 600.6

NEH, Part 630, Hydrology

NEH, Part 650, Engineering Field Handbook, Chapter 16, Streambank and Shoreline Protection

NEH, Part 654, Stream Restoration Design

NRCS Conservation Practice Standard, Aquatic Organism Passage, Code 396