

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 applied to:

- Improve water quality by reducing sediment, nutrient, or 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 (stream) exists.
- Controlled access from one side of the stream to the other side is necessary to reduce or eliminate environmental degradation.
- Soils, geology, fluvial geomorphology, and topography are suitable for construction of a stream crossing.

CRITERIA

General Criteria Applicable to All Stream Crossings

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

Identify significant cultural resources or threatened or endangered species that could be affected by the implementation of the practice. During construction, aquatic species must be removed from the construction area according to state protocols.

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.

The landowner/contractor is responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

Do not create a passage barrier where aquatic species are present and using the stream.

Location. Locate the stream crossing in an area where the streambed is stable or where the streambed can be stabilized (see WI NRCS Conservation Practice Standard (WI NRCS CPS) Channel Bed Stabilization (Code 584); and Title 210, National Engineering Handbook (NEH) Part 650, Chapter 16, “Streambank and Shoreline Protection”). Do not place a crossing where the 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, or within 300 feet of known spawning areas of listed species. Avoid wetland areas where possible.

Install the stream crossing perpendicular to the direction of stream flow where possible. Consider potential future lateral migration of the stream in developing the design.

Avoid the use of or minimize the number of stream crossings through evaluation of alternative trail or travel-way locations, and land user operations. Where feasible, use existing roads. Discourage livestock loafing in the stream by locating crossings, where possible, out of shady riparian areas or by including gates in the design.

Where a stream crossing is installed to remove an existing barrier to the passage of aquatic organisms, use WI NRCS CPS Aquatic Organism Passage (Code 396).

Access road crossings. Where the stream crossing is installed as part of an access road, design the crossing in accordance with WI NRCS CPS Access Road (Code 560).

Width. Provide an adequate travel-way width for the intended use. Make a “livestock-only” crossing no less than 6 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 topography. Use streambank soil bioengineering practices and other streambank stabilization measures such as WI NRCS CPS Streambank and Shoreline Protection (Code 580) as appropriate and feasible. Design stable approaches, with gradual ascent and descent grades that are no steeper than 4 horizontal to 1 vertical (4:1). Construct approaches with suitable material to withstand repeated and long-term use. Design the minimum width of the approaches equal to the width of the crossing surface.

Divert surface runoff around the approaches to prevent erosion. Use WI NRCS CPSs Diversion (Code 362), Structure for Water Control (Code 587), Lined Waterway or Outlet (Code 468), or Grade Stabilization Structure (Code 410) as needed.

Rock. Use only rock that is sound, durable, and able to withstand exposure to air, water, and freezing and thawing. Use rock of sufficient size and density to resist mobilization by design flood flows. Use appropriate rock sizes that will accommodate the intended traffic without causing injury to livestock or people, or damage to vehicles using the crossing. For a rock livestock crossing, use a hoof contact zone or alternative surfacing method over the rock.

Materials for rock crossings shall be in accordance with Wisconsin Construction Specification 11, Small Rock Aggregate.

Fencing. Exclude livestock access to the crossing using 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 WI NRCS CPS Fence (Code 382).

Vegetation. As soon as practical after construction, vegetate highly disturbed areas in accordance with WI NRCS CPS Critical Area Planting (Code 342). In areas where the vegetation may not survive, use WI NRCS CPS Heavy Use Area Protection (Code 561).

Criteria Applicable to Bridge Crossings

Design the bridge in a manner that is consistent with sound engineering principles and adequate for its intended use. Refer to 210-NEM, Part 536.

Design the bridge to fully span the stream, passing at least the full bank flow where the design flow is not dictated by regulations. At design flow capacity, the structure must convey stream flow, sediment, and other materials without appreciably altering stream flow characteristics and pass the design flow without causing erosion or overtopping of the structure.

Bridges must meet the requirements for capacity as required by state statutes or local ordinances. Table 1 shall be used when no statutory or ordinance requirements exist.

On public roads, the minimum design storm runoff capacity shall be conveyed without causing erosion or road overtopping.

On non-public use roads, an erosion-resistant low point or overflow area may be constructed across the road to supplement the capacity. Flow depths and velocities must allow safe passage of private and emergency vehicles.

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

Acceptable bridge materials include concrete, steel, and wood.

Table 1

Road Type	Storm Frequency (24-hour duration)
Forest, Farm Field	2-year*
Farm Driveways, Non-Public	10-year
Public	25-year

**Full bank flow may be used if the 2-year storm produces out-of-bank flow.*

For all bridge crossings, perform a geologic subsurface investigation that is in sufficient detail and analysis to support the design. Describe the soil material observed, subgrade conditions, bearing capacity, and depth to bedrock; and any geologic conditions or hazards that needs to be addressed in the design, construction, or operation of the bridge Refer to 210- NEM, Part 531, “Geology.”

Adequately protect the bridge so that flows exceeding the bridge’s flow capacity can safely bypass without damaging the bridge or eroding the streambanks.

Follow requirements in 210-NEM, Part 536 on acceptable bridge materials and necessary safety measures.

Criteria Applicable to Culvert Crossings

Design the culvert in a manner that is consistent with sound engineering principles and adequate for its intended use.

Design the culvert to have sufficient capacity to pass storm flow in Table 1. Adequately protect the culvert crossing so that flows in excess of culvert capacity can safely bypass the structure without damaging it, or eroding the streambanks or crossing fill material. Do not use culverts in locations where large flows of sediment or large woody material are expected, or where the channel gradient exceeds 6 percent (100 horizontal to 6 vertical).

On non-public use roads, an erosion-resistant low point or overflow area may be constructed across the road to supplement the capacity. Flow depths and velocities must allow safe passage of private and emergency vehicles.

At least one culvert pipe must be placed with its entire length set 6 inches below the existing stream bottom. Additional culverts may be used at various elevations to maintain terrace or floodplain hydraulics and water surface elevations. The length of the culvert system must be 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, new or used high quality steel, and any other materials that meet requirements of WI NRCS CPS Pond (Code 378). Evaluate the need for safety measures such as guardrails at the culvert crossing.

Criteria Applicable to Ford Crossings

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. Do not place ford crossings immediately downstream from a pipe or culvert because of potential damage from localized high-velocity flows. Use a culvert crossing or curbed bridge if the stream crossing is to have frequent or daily use, such as in a dairy operation.

Ensure that the cross-sectional area of the crossing is equal to or greater than the natural channel cross-sectional area. To the extent possible, design the top surface of the ford crossing to follow contours of the streambed. Slope the crossing toward the center of stream to provide a thalweg (low-flow) channel. Recess the subgrade of the stream crossing so that the constructed surface of the crossing is at or below the original surface of the streambed.

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

Evaluate the need for water depth signage.

Concrete fords. Use a concrete ford crossing only where the foundation of the stream crossing has adequate bearing strength. Perform a subsurface investigation that is in sufficient detail and analysis to support the design. Describe the soil material observed, subgrade conditions, bearing capacity, and depth to bedrock. Refer to 210- NEM, Part 531, Subpart B, “Engineering Geology.”

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. Construct the concrete slab on a minimum 4-inch-thick gravel base, unless the foundation is otherwise acceptable. Refer to 210- NEM, Part 536 for design criteria.

Dewatering of the site and toe walls is required during placement of the concrete to lessen the potential for segregation and 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 until the concrete makes its final set, and a minimum of 12 hours after placement of the concrete.

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 bank-full 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.

Rock fords and the use of geosynthetic materials. When the site has a soft or unstable subgrade, use geotextiles to improve the foundation bearing capacity in the design of rock ford crossings. Geotextiles shall meet the requirements of Table I or II, Class IV, contained in WI FOTG Construction Specification 13, Geotextiles.

Dewater and excavate the bed of the channel to the necessary depth and width and cover with geotextile material. Install the geotextile material to extend across the bottom of the stream and, at least, up the side slopes to at least the bank-full flow elevation.

Cover the geotextile material or excavated bed with graded rock base as shown in Table 2. 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.

Table 2

Foundation Consistency and Use	Minimum Base Course Thickness
Soft foundations for equipment crossing	18 inches or 8 inches underlain with geotextile
Firm foundations for equipment crossings and ALL cattle crossings	8 inches

Design the rock ford stream crossing base material to remain stable for the full bank design flow or 10 yr-24-hr duration storm flow, whichever is less. Compute channel velocities and choose rock size using procedures and guidelines set forth in the appropriate section in 210-NEH, Part 630, “Hydrology;” 210-NEH, Part 654, Technical Supplement (TS) 14N “Fish Passage and Screening Design;” and 210-NEH 650, Chapter 16, Appendix 16A, “Size Determination for Rock Riprap,” or other procedures approved by the State conservation engineer.

Crushed stone surfaces shall be stable for design velocities computed for the 10-year, 24-hour duration storm or full bank flow, whichever is less, unless provisions for replacement are included in the Operation and Maintenance Plan.

Allowable velocities for various sizes of rock material are shown in Table 3.

Table 3

D₅₀ (inches)	Velocity (fps)
0.5	2.7
1	3.2
2	4.3
3	5
4	5.6
5	6
6	6.5
7	7.2
10	8

Base course options include quarry-run (angular) or field stone (rounded) graded rock (see Table 3).

Surfacing treatment options include either:

- a. 4 inches of crushed stone.
- b. 4 inches of additional base course thickness.

If a 2-inch thick hoof contact zone is used, the thickness of the stone surface layer may be reduced by 2 inches. The material to be used for hoof contact will be decided upon by the landowner and could include sand, ground limestone, rock screenings, or similar materials.

CONSIDERATIONS

For culvert crossings, consider incorporating natural streambed substrates throughout the culvert length for passage of aquatic organisms. See Bunte 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 including a well-graded rock riprap apron on the downstream edge of concrete crossings to dissipate flow energy.

Consider all life stages of aquatic organisms in the stream crossing design to accommodate their passage, in accordance with the species' requirements. WI NRCS CPS aquatic organism passage standards can be found in WI NRCS CPS Aquatic Organism Passage (Code 396). Design criteria are available in 210-NEH, Part 654, TS 14N; Clarkin, Keller, et.al, (2006); and Forest Service stream simulation guidance (USFS, 2008). Also, see Harrelson, et al. (1994), for stream reference site descriptions. 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.

For concrete fords, consider using precast concrete panels in lieu of cast-in-place concrete slabs. To the extent possible, the panels must follow the contours of the streambed in order to avoid potential problems with sediment accumulation. As with the poured-in-place concrete, install a gravel base and toe walls.

Locate stream crossings to avoid adverse environmental impacts and consider:

- Using the “riffle” section of the stream for the proposed crossing, for it is frequently one of the most stable sections of a stream. When riffles are not present, consider using a stable straight reach.
- 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.

PLANS AND SPECIFICATIONS

Prepare plans and specifications for stream crossings in accordance with this standard. Clearly describe the requirements for applying the practice to achieve its intended purpose in the plans and specifications must as a minimum, include the following in plans and specifications:

- Location of stream crossing.
- Stream crossing width and length with profile and typical cross sections.
- 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.
- Applicable structural details of all components, including reinforcing steel, type of materials, thickness, anchorage requirements, lift thickness, covering.
- Load limits for bridges and culverts.
- 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 or a statement making the contractor responsible for selecting such.
- Location of utilities and notification requirements.
- Additional site-specific considerations.

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 at least annually and after each major storm event. 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. 2016. LRFD Bridge Design Specifications, Customary U.S. Units, 7th Edition, with 2015 and 2016 Interim Revisions: 2014 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: 978-1-56051-592-0, 2160, pages1-56051-451-0. https://bookstore.transportation.org/item_details.aspx?id=2211.

Bunte, Kristin; Steven R. Abt. 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. (<https://www.wapps.fs.usda.gov/rmrs/publications/sampling-surface-and-subsurface-particle-size-distributions-wadable-gravel-and-cobble>).

Clarkin, K., G. Keller, T. Warhol, and S. Hixon. Oct. 2006. Low-water crossings: Geomorphic, biological, and engineering design considerations. U.S Forest Service National Technology and Development Program Publication 0625 1808-SDTDC, 8 chapters plus appendices. San Dimas, CA. http://www.fs.fed.us/t-d/php/library_card.php?p_num=0625%201808P.

Harrelson, Cheryl C; C.L. Rawlins; John P. Potyondy. 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.treesearch.fs.fed.us/pubs/20753>.

USDA-NRCS. Dec. 1996. Streambank and Shoreline Protection: National Engineering Handbook (NEH); Part 650, Engineering Field Manual, Chapter 16, 88 p. plus appendices. <https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17553.wba>.

USDA-NRCS. May 2008. National Engineering Handbook (NEH), Part 654, Stream Restoration Design. Washington, DC. <https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21433>.

USDA-NRCS. July 2010. National Engineering Manual (NEM), Part 536, Structural Engineering, 5 p. Washington, DC. <https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=27528>.

USDA-NRCS. May 2012. NEH, Part 630, Hydrology. Washington, DC. <https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=21422>.

USDA-NRCS. June 2013. NEM, Part 531, Subpart A, Geologic Investigations. 7 p. Washington, DC. <https://directives.sc.egov.usda.gov/viewerFS.aspx?hid=33952>.

USDA-USFS. Stream-Simulation Working Group. 2008. Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road-Stream Crossings: Technology and Development Center Publication 0877 1801P. 11 chapters plus appendices. San Dimas, CA. http://www.fs.fed.us/t-d/php/library_card.php?p_num=0877%201801P.