STREAM CROSSING

(No.)
Code 578

Natural Resources Conservation Service
Conservation Practice Standard

I. Definition

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

II. Purpose

This practice may be applied as part of a conservation management system to support one or more of the following purposes:

- 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.

III. 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.

IV. Federal, Tribal, State, and Local Laws

Users of this standard should be aware of potentially applicable federal, tribal, state, and local laws, rules, regulations, including floodplain regulations, or permit requirements governing stream crossings. This standard does not contain the text of federal, tribal, state, or local laws.

V. Criteria

The following criteria apply to all purposes.

A. Location

Locate stream crossings in areas where the streambed is stable or where it can be stabilized. See Wisconsin NRCS Field Office Technical Guide, Section IV (WI FOTG), Conservation Practice Standard 584, Channel Bed Stabilization. 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, or within 300 feet of known spawning areas of listed species. Avoid wetland areas.

Identify significant cultural resources or threatened or endangered species that could be affected by the location 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.

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.

Where a stream crossing is installed to remove an existing barrier to the passage of aquatic organisms, use WI FOTG Standard 396, Aquatic Organism Passage.

B. Access Roads

Where the stream crossing is installed as part of a roadway, size the crossing according to WI FOTG Standard 560, Access Road.

C. 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) for livestock and 7 horizontal to 1

[1]Words in the standard that are shown in italics are described in X. Definitions. The words are italicized the first time they are used in the text.

vertical (7:1) for equipment, 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.

D. 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, as measured from the upstream end to the downstream end of the stream crossing, not including the side slopes.

E. 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).

F. 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.

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

G. Fencing

Exclude livestock access to the crossing through the use of fences 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 FOTG Standard 382, Fence.

H. Vegetation

Plant all areas to be vegetated as soon as practical after construction. Use WI FOTG Standard 342, Critical Area Planting, where vegetation is unlikely to become established by natural regeneration, or acceleration of the recovery of vegetation is desired.

I. 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. 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).

Design bridges to fully span the stream, passing at least the *full bank flow* where the design flow is not dictated by regulation. Adequately protect bridges so that out-of-bank flows safely bypass without damaging or eroding the banks.

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

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.

J. 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.

Table 1 shall be used for capacity when no other requirements exist. Design culverts with sufficient capacity to convey the design flow and transported material without appreciably altering the stream flow characteristics. Do not use culverts where large flows of sediment or large woody material are expected, or where the channel gradient exceeds 6 percent.

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

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 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.

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, new or used high quality steel, and any other suitable materials.

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.

K. Ford Crossings

1. 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 recessed 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.

2. 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 as needed to prevent under-cutting 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 full bank 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.

3. Rock Fords and the Use of Geosynthetics

When the site has a soft or unstable subgrade, use geotextiles 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 (when needed). 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 full bank 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 crossings	18 inches or 8 inches underlain with geotextile
Firm foundations for Equipment crossings and ALL cattle crossings	8 inches

Design all rock ford stream crossing base materials to remain stable for the full bank flow or 10-year, 24-hour duration storm flow, whichever is less. Compute channel velocities and choose rock size using procedures in NEH 630; NEH 654 TS14N; and EFH Chapter 16 (NEH 650), Appendix 16A, 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

D_{50} (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.

VI. Considerations

Considerations include additional design recommendations that are not required criteria, but may be used to enhance or avoid problems with the design and function of this practice.

A. 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.

B. 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.

C. 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.

D. 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). Each state also has specific design criteria for culverts and stream crossings (e.g., MassDOT, 2010). See also Harrelson, et al. 1994, for stream reference site descriptions.

E. 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.

F. 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 considered, rather than a ford crossing.

G. Locate stream crossings to avoid adverse environmental impacts and considering the following.

- Effects on up-stream and down-stream 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.

H. Where stream crossings are used, evaluate the need for safety measures such as guardrails at culvert or bridge crossings, or water depth signage at ford crossings.

I. Access road surface treatment for weak-bearing capacity soils should be underlain by a geotextile to minimize required maintenance.

VII. 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 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.
- Design flow calculations.
- 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.

VIII. 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.

IX. References

USDA, NRCS Wisconsin Field Office Technical Guide (FOTG), Section IV, Practice Standards and Specifications.

Wisconsin's Forestry Best Management Practices for Water Quality, Wisconsin Department of Natural Resources, Bureau of Forestry.

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).

X. Definitions

Crushed stone (V.K.3.) - 100% passing the ¾-inch sieve and 10% maximum passing the #200 sieve.

Full bank flow (V.I.) – the discharge that fills a stream channel up to the elevation at which flow begins to spill onto the floodplain.

Graded rock (V.K.3.) - 100% passing the base course thickness dimension and a maximum of 10% passing the ¾-inch sieve. All sizes between the limits shown on the drawings are to be represented.