

Case Study 17. Stony River Treated Timber Box Culverts

Location

Northern Minnesota. Superior National Forest, Isabella Ranger District. Stony River, south of Boundary Waters Wilderness Area. 8 miles west of Isabella, adjacent to State Highway 1, approximately ½ mile from McDougal Lakes. Forest Road 933.

Crossing Description

This structure was constructed in 1984 on a perennial fish-bearing stream (figure A112). It is a series of treated timber box culverts embedded into a cobble-boulder streambed. The opening is about 85 to 90 percent of bankfull width on a relatively straight pool-riffle channel. Low flows pass through the structure at similar velocities and depths as in the channel itself, and the structure appears to be passable to fish most or all of the year. The ford was designed to pass the 25-year flow under the bridge deck, and to resist common ice jams. Water has barely overtopped the deck twice, and the structure has required only occasional debris removal and some reinforcement of the joints and connectors.



Figure A112. Stony River box culvert ford.

Setting

Northern Superior Uplands Section (212-L), Laurentian Highlands subsection. Level to rolling glaciated uplands on ground moraine, end moraine, and outwash. Surface materials are well-drained loamy till and gravelly to sandy outwash, with small interspersed areas of peat and

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Why Was This Structure Selected?

swamp. There are many lakes, and except in frozen conditions runoff is moderated by high infiltration and percolation rates. Dominant vegetation in this subsection is mixed pine with aspen-birch, fir, spruce, tamarack, and cedar (Superior National Forest, 1998).

The vented ford structure was selected to accomplish the following objectives.

- Permit fish passage.
- Allow overflow in the event of ice plugging.
- Sustain ice jamming.
- Protect water quality.
- Protect scenic quality. (The structure can be seen from the adjacent State highway and a low profile structure of native materials was desired for aesthetic purposes.)
- Minimize cost. (The forest's estimated cost of construction (\$45,000) was lower than the anticipated cost for a timber bridge long and high enough for the site (\$60,000).)

Crossing Site History

This is the first structure at this site.

Road Management Objectives

Forest Road 933 is a spur originally constructed as a timber haul road and designed for a 55-foot loaded log truck and 12-yard gravel truck. It is a gravel road currently maintained for high-clearance vehicles (maintenance level 2). Current use is for occasional recreation.

Stream Environment

Hydrology: Average precipitation in this area is 26 to 31 inches per year. Flow variability is moderate: flow is snowmelt-dominated and rain-on-snow is uncommon. The crossing's location less than ½-mile downstream of McDougal Lakes, where storage capacity is enhanced by a low dam, also helps to moderate flow variability. For the 71-square-mile drainage area, the estimated annual flood is 234 cubic feet per second and the 100-year flood is 608 cubic feet per second, less than three times the annual flood (R. Pekuri, design notes, 1984). In situations like this where flow variability is low or moderate, low-water crossings are often not considered. However, in this area ice is a significant consideration for all road-stream crossings. Ice cover commonly forms while flow is still relatively high in early winter, occasionally even freezing to the streambed. Spring snowmelt often runs on top of the ice, so that water

elevations are higher than would be anticipated for water only. During spring snowmelt ice blocks break free and drift downstream, which can cause ice-jamming at crossings. Little woody debris moves in the stream.

Channel Description: Stony River is a low sinuosity pool-riffle channel (a B2c or C2 stream type) about 50 feet wide. Boulder riffles provide streambed structure, and pools are quite shallow. Slope near the site is approximately 1.25 percent. Boulders vary from large to small, with a predominance of small to medium sizes. The adjacent riparian area has some tree cover, with dense shrub and sedge vegetation, and the potential for large woody debris recruitment to the channel is low to moderate. Boulders, wood, and vegetation provide good bank stability. The channel is moderately entrenched to unentrenched at the site, with a 5-foot terrace on one bank, and a narrow flood plain on the other (figure A113).



Figure A113. Stony River looking upstream from the ford.

Aquatic Organisms: Fish passage is required at this site. Stony River is within the range of the Creek Heelsplitter (*Lasmigona compressa*), a regional forester's (Eastern Region [R9]) sensitive mussel whose numbers have declined relative to its historical abundance. Host fish are required for the mussel to propagate, but on the Superior National Forest it is not known precisely which species are hosts. On the Chippewa National Forest, host species are listed as the spotfin shiner, slimy sculpin, crappie, and perch (Kitchell, 1999)

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Design and Construction Details

Water Quality: Water quality at this site is good, and management objectives are to maintain it. Because the graveled approaches slope directly to the crossing and some gravel washes into the river, forest personnel recommend paving the approaches.

Structure: The project consists of three double-barrel nail-laminated creosote wood culvert boxes 7½ feet wide and 5 feet tall, embedded in channel substrate. The center box is 8 inches lower than the outer sides of the end boxes to concentrate flow in the center of the channel. The boxes are 5 feet high and were filled to a depth of 1½ feet with streambed material, to provide weight and stability to the structure, as well as to facilitate fish passage. The structure was designed to accommodate the 25-year flow 6 inches under the bridge deck. On both the up- and downstream sides of the structure, timber cutoff walls extend from the bottom of the boxes 3 feet down into the streambed to prevent scour and increase resistance. The upstream faces of the boxes and deck are protected by metal facings against rock, ice, and debris battering. The structure has a solid timber deck and 8-inch timber curbs.

Bank stabilization and approaches: Wingwalls are deadmanned into the road template with buried logs to prevent dislocation by frost heave, which can be extreme in this boreal environment. Approaches are graveled on a slope of 4 percent.

Cost: Actual contract cost was \$63,000 in 1984.

Safety: Curbs are provided on both edges of the low-water bridge. Stony River is lightly used by kayakers, and it has been suggested that warning signs be provided upstream, along with take-out and put-in areas to facilitate kayaks being portaged around the bridge.

Flood and Maintenance History

The flood history of this site is unknown, but there have been very heavy storms in the general vicinity within the structure's lifetime. Since construction, flow has twice been observed to just overtop the structure. Some shifting has occurred and the box connectors have required reinforcement. Debris removal from the upstream face of the structure has been the only other maintenance need.

**Summary and
Recommendations**

This high-VAR ford continues to function well after 20+ years. Boulder streambed material covers 100 percent of the structure bottom, so that streambed continuity and flow velocities similar to the natural channel are maintained through structure. The designer would opt for using concrete if he were building a similar box structure today, because of structural strength and durability. Other recommendations from forest personnel are to pave approaches to protect water quality, and to provide an upstream take-out and portage for kayaks.

Roger Pekuri, forest engineer (and designer of the ford) and Barbara Leuelling, soil scientist, both of the Superior National Forest, provided information for this case study.

References

Superior National Forest. 1998. Characteristics of the Superior National Forest landtype associations. Duluth, MN: Superior NF.

