INTRODUCTION

About this guide

Bridges are the fuses in the circuit of any snowmobile or all-terrain vehicle trail system. In time, these bridges may need repair or may need total replacement. This guide was assembled to help counties, clubs and trail groups through the process of repairing or reconstructing these vital components of a trail system.

Since 1991, the State has funded 848 grants totaling $21,232,107 for bridge projects to either construct, repair or relocate existing structures."

Due to the variable nature of existing conditions (topography, stream flow, soil conditions, snow load, etc.) and the variety in type of bridge structures (designed and prefabricated), **this document should <u>NOT</u> be used as a sole bidding document**, but as a part of a bid package or as a reference document only.

How to use this guide

This guide is arranged in four major sections and is color-coded for easier use.

Printed on white paper
Printed on green paper
Printed on white paper
Printed on green paper

- ☐ General information about bridge review
- ☐ Engineering design requirements
- ☐ Illustration for various design features
- ☐ Appendix containing helpful hints and sources

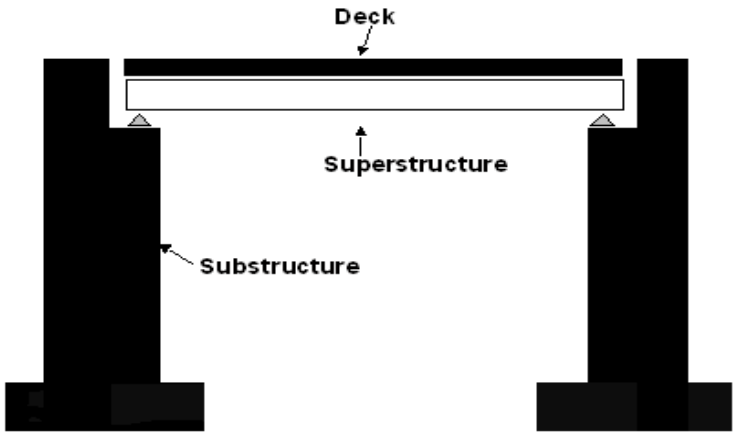
Department rule

The Department of Natural Resources is required by law to review all new and replacement bridge structures and culverts constructed in or over navigable waters to assure compliance with state statutes and codes. Adequate clearances and flood flow design requirements are necessary to prevent obstruction to navigation, and to protect human life and minimize property loss in periods of high water.

Counties interested in constructing new or replacement structures should arrange to review the proposed water crossing with the appropriate regional or basin water management specialist. This review will determine the need for a permit. If a permit is necessary, the permit application will outline the necessary type of information needed for further review by the water management specialist.

Bridges are made up of three major components (see figure page 2)

1. <u>Deck</u> (Wearing surface; transfers loads (live and dead) to other bridge components
2. <u>Superstructure</u> (Includes all components that support the deck system and loads applied to the deck; transfers loads to substructure) Bridges are often named for their specific type of superstructure (timber, steel, truss, prefabricated, arch, etc.)
3. <u>Substructure</u> (Includes all elements that support the superstructure; transfers loads to the foundation/earth).



Major Bridge Components

The following "white" pages contain tables and diagrams that compose specific types of superstructures:

- Wooden clear span bridges up to 20' in length
- Steel clear span bridges using wide flange "I" beams for the superstructure up to 50' in length

Department Engineering Review or Not?

1. If an organization is using a previously approved (by the department) bridge plan with an existing foundation that is approved by the project sponsor AND is less than 50' in length, then no department engineering review is required. It is the project sponsor's responsibility to verify the structural adequacy of the existing substructure.

2. Any bridge structure under 50' in length (not meeting requirement #1 above), requires the submittal of the following information to the regional community services specialist for department review and approval.
   (a) A plan view of the bridge to scale, with adequate dimensioning
   (b) A cross section of the bridge to scale, with adequate dimensioning
   (c) The name and location of the water crossing, road system crossing, etc., on a topographic map
   (d) Bearing details (fixed and movable sides)
   (e) Typical connection details as appropriate

(f) Foundation details (if new or modified in ANY way and IF required by the project sponsor)
(g) Loading calculations used for design of the superstructure and substructure (IF required by the project sponsor)
(h) Soil information, including type and bearing capacity and sample report IF required by the project sponsor
(i) Deck detail (material thickness, orientation of decking)
(j) Railing construction detail

3. Any Bridge structure over 50' in length requires the submittal of the previous information with the addition of requiring that the plans be stamped by a Professional Engineer, with current registration in the State of Wisconsin.

Please Note - Rehabilitation

4. The length of the structure is determined as the length of the span between the two abutments. Approaches are to be included in this length if they are integral to spanning the watercourse and are not 100% supported by the earthen banks.

5. Any retrofit, replacement in kind or modification to an existing bridge structure or component of the structure **does** require structural review by the Department unless such work is deemed by the project sponsor not detrimental to the structural adequacy of the structure.

Water regulatory review requirements

Please be aware that the Department's water regulatory program requires submittal and review of construction plans for all bridges as required by S. 30.123, Stats. Please contact the region or basin water management specialist for details.

Since 1991, the State has funded 848 grants totaling $21,232,107 for bridge projects to either construct, repair or relocate existing structures."

Please Note!

Due to the varying nature of bridge designs, retrofits, soil conditions, varying degrees of degradation and changes in loading situations, etc., it is the project sponsor's responsibility to determine what should be required for submittal as detailed above in regards to soil information, substructure and loading calculations. A site visit by the project sponsor to verify all conditions is highly recommended.

BRIDGE DESIGN

General bridge design considerations

Permanent bridges should be designed to meet the appropriate minimum loading requirements specified below. Anticipated maintenance and grooming needs should be considered when the bridge is being designed. Normally bridges designed for snowmobiling and all-terrain recreation purposes vary from 8 to 12 feet in width depending on the equipment used, the span of the bridge, and whether the bridge is in conjunction with an abandoned railroad grade.

Construction and placement of removable bridges may be approved by the Department. These bridges must be attached securely to one footing with a flexible type connection to prevent loss during flooding conditions.

Please Note!

Existing bridges such as logging, old highway, or farm bridges may be utilized for snowmobiling or all-terrain vehicle purposes. The project sponsor is responsible for approving the structural adequacy of the bridge structure. Bridges should be at least eight feet wide for two-way traffic. These bridges must be signed in accordance with Department trail signing guidelines.

Where possible, bridges should be sited so that existing banks are not substantially altered in the construction of the bridge approach.

Winter ice crossings may be allowed by the Department with due consideration for user safety and the environment. Determination by department district staff will be based on factors such as depth of water, stream bottom materials, approaches to the stream, and nature of the stream freeze/flow cycle.

About railings

Under circumstances where depth of water, fast current, or vertical drop from bridge to water surface dictate, railings will be required on either permanent or removal bridges. Similarly, railings may be necessary for culverts under these conditions.

Where railings are judged necessary, they must be a minimum of 42 inches in height above the deck and designed to prevent the passage of an object with a diameter greater than 6 inches (as per current Department of Commerce code). Railing extensions may be highly desirable depending on the type of approach to the bridge.

On bridges where railings are not judged to be necessary "kicker plates" or other low retaining devices must be fastened to the deck.

Generally, when a permanent bridge is open for off-season pedestrian use, railings should be provided. If the bridge is closed to off-season use, properly signed, and barricaded, railings may not be necessary.

Bridge and culvert crossings should be signed with the standardized reflective black and yellow hazard markers. Used in pairs, the hazard markers delineate an opening through which the trail user must pass. Markers should be placed on each end rail of the bridge or on separate posts if the bridge is not railed. Each hazard marker of the pair is placed with alternate black and yellow 45 degree diagonal stripes facing down and in toward the center of the bridge or culvert.

Engineering Design Requirements

The following are engineering design requirements for bridge structures that are placed on approved snowmobile or all-terrain vehicle trail systems:

- The bridge must be designed to withstand a horizontal wind force of 30 pounds per square foot applied on the net projected vertical surface.

- Bridge footings must be designed to support design deck load and dead loads.

- Footings shall extend a minimum depth of below frost penetration and preferably below stream bed level. Footing design may vary with soil types.

- Bridges 0 to 40 feet long shall be designed to meet the following loading requirement which creates the greatest bending moment:

    a. A minimum uniform live load of 85 pounds per square foot applied to the entire deck surface; or

    b. A uniform live load of 30 pounds per square foot applied to the entire deck surface plus a concentrated load of 5 ton applied to an area of deck 8 feet wide by 10 feet long. The maximum moment will result with this 5-ton load at mid-span.

- Bridges over 40 feet long should be designed to meet the following loading requirement which creates the greatest bending moment:

    a. A minimum uniform live load of 60 pounds per square foot applied to the entire deck surface; or

    b. A uniform live load of 30 pounds per square foot applied to the entire deck surface plus a concentrated load of 5 ton applied to an area of deck 8 feet wide by 10 feet long. The maximum moment will result with this 5-ton load at mid-span.

- The allowable deflection of the bridge spans due to uniform live load shall be L/200 for timber bridges and L/500 for steel bridges.

- All railings shall be designed to withstand a load of at least 200 pounds applied in any direction at any point.

- Bridges constructed above the 100 year flood elevation should be anchored to the footing securely enough to prevent shifting due to the wind loading given above.

- Bridges constructed that extend below the 100 year flood elevation should be anchored to the footing securely enough to prevent shifting due to the wind loading given above plus the loading caused by flood water flowing past the bridge. The force due to the water flowing past the bridge can be figured using the formula.

$$\text{Force (in pounds)} = 3.9\ AV^2$$

Where A = projected vertical bridge area in flow and
V = velocity of water in feet per second

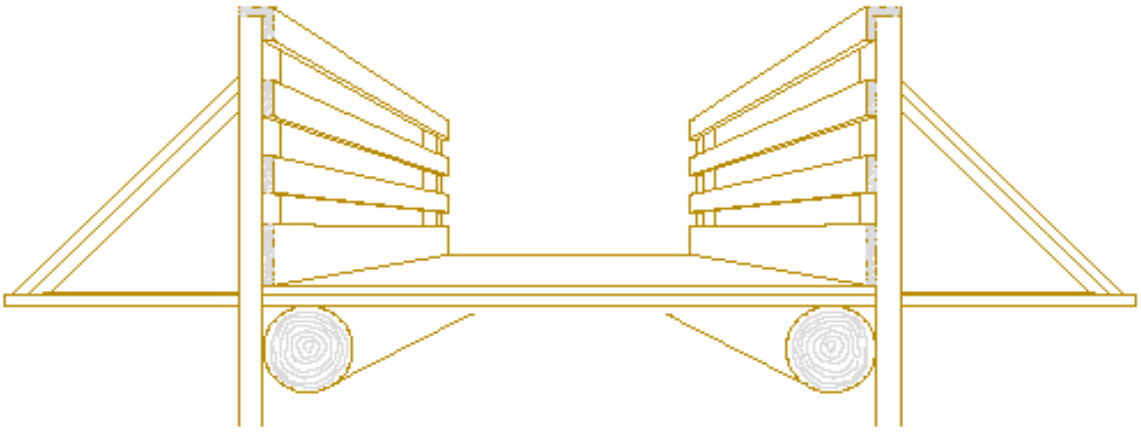
Please Note!

These requirements do not release the project sponsor from the potential for failure of a bridge structure due to the use of improper construction techniques or inadequate or substandard construction materials.

Illustrations The following “white” pages contain tables and diagrams that deal with:

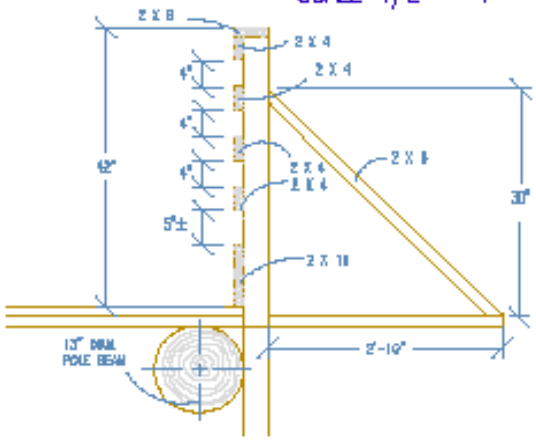
- Wooden clear span bridges up to 20 feet in length
- Steel clear span bridges using wide flange “I” beams for the superstructure up to 50’ in length.

Please Note! It is the project sponsor’s responsibility to verify the structural adequacy of these bridges and their corresponding bridge components (abutments, piers, railings, etc.) and the existing or modified conditions (soil types, stream bank, etc.)



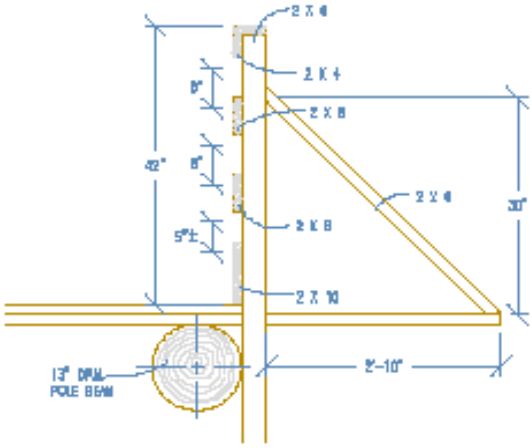
1 SNOWMOBILE BRIDGE PERSPECTIVE

SCALE 1/2" = 1'



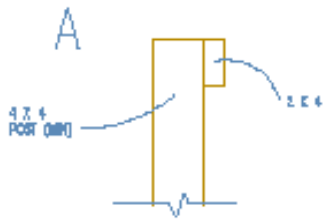
2 RAILING DETAIL w/ 2 X 4 RUNNERS

SCALE 1/2" = 1'



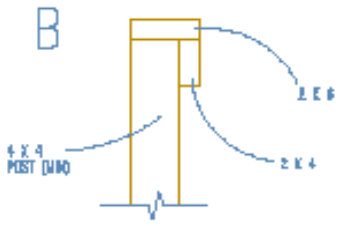
3 RAILING DETAIL w/ 2 X 6 RUNNERS

SCALE 1/2" = 1'



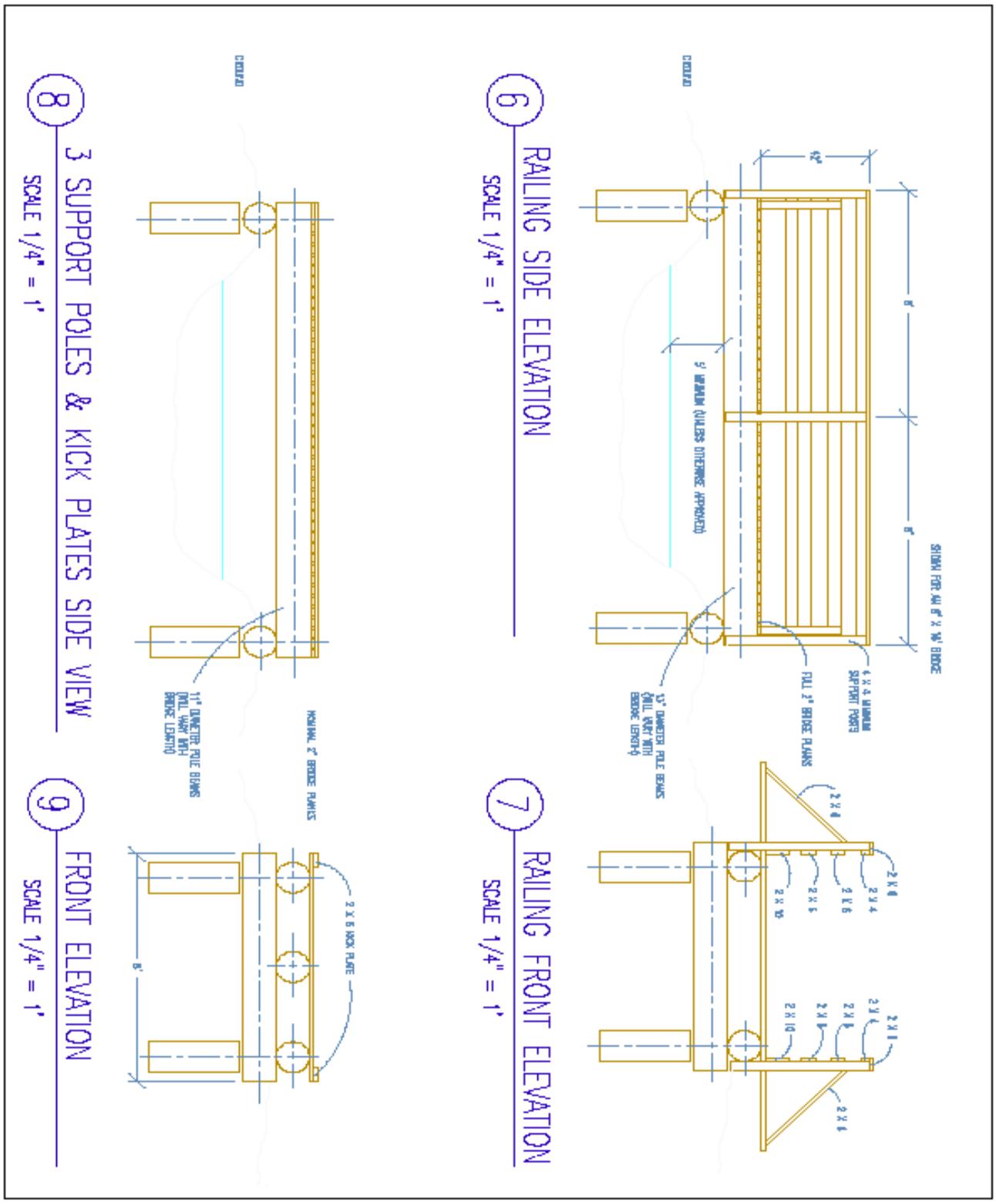
4 TOP RAILING DETAIL SUPPORT 2'-6" O.C.

SCALE 1" = 1'



5 TOP RAILING DETAIL SUPPORT 8'-0" O.C.

SCALE 1" = 1'


6
RAILING SIDE ELEVATION
SCALE 1/4" = 1'
7
RAILING FRONT ELEVATION
SCALE 1/4" = 1'
8
3 SUPPORT POLES & KICK PLATES SIDE VIEW
SCALE 1/4" = 1'
9
FRONT ELEVATION
SCALE 1/4" = 1'
FULL 2" BRIDGE PLANKS
2 X 6 KICK PLATE

Wood Pole Bridges (40’ or less)

Based on the loading requirements specified within this guide

8’ Wide Bridges

**Span	2 pole	3 pole	4 pole	5 pole	6 pole
10’	*10” diameter	8”	8”	7”	7”
12’	11”	9”	9”	8”	7”
14’	11”	10”	9”	9”	8”
16’	13”	11”	10”	9”	9”
18’	14”	12”	11”	10”	9”
20’	15”	13”	11”	10”	10”

10’ Wide Bridges

**Span	3 pole	4 pole	5 pole	6 pole
10’	*9” diameter	8”	8”	7”
12’	10”	9”	9”	8”
14’	11”	10”	9”	9”
16’	12”	11”	10”	9”
18’	13”	12”	11”	10”
20’	14”	12”	11”	11”

12’ Wide Bridges

**Span	3 pole	4 pole	5 pole	6 pole
10’	*10” diameter	9”	8”	8”
12’	11”	10”	9”	9”
14’	12”	11”	10”	9”
16’	13”	12”	11”	10”
18’	14”	12”	11”	11”
20’	15”	13”	12”	11”

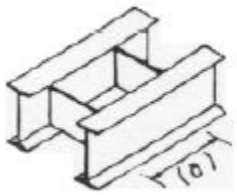
* Diameter dimension: is the smallest measurable dimension along the entire pole length
** Span = ***Longest*** unsupported length, not necessarily total bridge length

Note: 2 layers of decking material used:

- Top coarse as a wear course only (2” nominal thickness)
- Bottom coarse to be support related (2” Full thickness)

Steel "I" Beam Bridges (40' or less)

Based on the loading requirements specified within this guide



Example: 8W10
8: indicates the depth of the beam, this case: 8"
10: indicates the weight in pounds per foot, this case: 10 lbs/foot
(a): indicates maximum spacing (in feet) for lateral support of "I" beams (limit buckling, etc)

8' Wide Bridges

**Span	2 beam	3 beam	4 beam
20'	12W14 (3.5)	10W11.5 (3.8)	8W10 (4.2)
25'	12W19 (4.2)	12W14 (3.5)	10W11.5 (3.8)
30'	12W22 (4.3)	12W16.5 (4.1)	12W14 (3.5)
35'	14W26 (5.3)	12W19 (4.2)	12W16.5 (4.1)
40'	14W30 (7.1)	14W22 (5.3)	12W19 (4.2)

10' Wide Bridges

**Span	2 Beam	3 Beam	4 Beam	5 Beam
20'	12W16.5 (4.1)	12W11.8 (2.7)	10W11.5 (3.8)	8W10 (4.2)
25'	12W22 (4.3)	12W16.5 (4.1)	12W14 (3.5)	10W11.5 (3.8)
30'	14W26 (5.3)	12W19 (4.2)	12W16.5 (4.1)	12W14 (3.5)
35'	14W30 (7.1)	14W22 (5.3)	12W19 (4.2)	12W16.5 (4.1)
40'	18W35 (6.3)	14W26 (5.3)	12W22 (4.3)	12W19 (4.2)

12' Wide Bridges

**Span	2 Beam	3 Beam	4 Beam	5 Beam	6 Beam
20'	12W19 (4.2)	10W19 (4.2)	10W15 (4.2)	6W25 (6.4)	6W20 (6.4)
25'	14W26 (5.3)	14W22 (5.3)	12W19 (4.2)	12W14 (3.5)	8W21 (5.6)
30'	16W31 (5.8)	14W26 (5.3)	14W22 (5.3)	12W22 (4.3)	10W22 (6.1)
35'	18W35 (6.3)	14W34 (7.1)	14W30 (7.1)	12W26 (6.9)	14W22 (5.3)
40'	18W46 (6.4)	14W48 (7.2)	14W38 (7.1)	14W30 (6.0)	14W26 (5.3)

** Span = ***Longest*** unsupported length, not necessarily total bridge length

Appendix The following pages contain a list of prefabricated bridge manufacturers, bridge contractors and cost saving ideas. This information was collected by Earl Orner former member of the Snowmobile Recreation Council. The listing of sources is not to be construed as an endorsement of products or contractors or as an exhaustive listing.

List of Prefabricated Bridge Manufacturers

Anderson Bridges
3900 Morningcrest Rd.
Eau Claire, WI 54703
(715) 874-6918
[Prefabricated steel bridges with wood decks (Installation available).]

Wheeler Lumber, LLC
9330 James Avenue South
Bloomington, MN 55431
(800) 328-3986
(952) 929-2909 (Fax)
Home Page; http://www.wheeler-con.com
E-Mail: info@wheeler-con.com
[Precut wood bridges for on-site assembly]

Continental Bridges, Inc.
Route 5, Box 178
Alexandria, MN 56308
(800) 328-2047
[Prefabricated steel bridges with wood decks.]

Custom Manufacturing
606 Delco Drive
Clinton, WI 53525
(608) 676-2283
[Kits of bridges include pre-drilled steel I-beams and cross members, wood deck planks, pre-drilled wood posts and wood railings (Installation available).]

Sentinel Structures
477 South Teck Avenue
Peshtigo, WI 54157
(715) 582-4544
[Precut wood bridges for on-site assembly - laminated wood beams also available.

United Construction
4830 Brookside Road
Abrams, WI 54101
(920) 826-7744
[Fabricate and install steel and wood bridge structures]

Spooner Machine
1100 Roundhouse Road
Spooner, WI 54801
(888) 552-0835
(715) 635-3220
www.spoonermachine.com

Sales Representative:
Randy McQuade

United Hydro Solutions, LLC
4830 Brookside Road
Abrams, WI 54101
(920) 273-0636
(866) 491-3652

Sales Representative:
Scott Boyea

U.P. Fabricating Co. Inc.
120 US 41 East

Gary Hedberg: Mechanical Engineer

Negaunee, MI 49866
(906) 475-4400
(906) 475-5538
E-mail: ghedberg@upfab.com

Bridge Contractors

Flannery Trucking
606 South Grandview
Crandon, WI 54520
(715) 478-2415
[Constructs abutments and crane service to install bridges]

Horizon Construction
4100 Campbellsport Drive
P.O. 439
Campbellsport, WI 53010
(414) 533-8490
[Constructs abutments, installs prefabricated metal bridges and does site grading]

Krueger and Stienfest
P.O. Box 159
Antigo, WI 54409
(715) 627-7020
[Installs pilings and bridges]

Ruzic Construction
W 4897 Highway 73
Neillsville, WI 54456
(715) 743-4138
[Builds and installs metal, timber and concrete bridges. Pile driving available]

Smith Construction
Route 1
Wabeno, WI 54566
(715) 473-5324
[Wood truss bridge assembly]

Bean's Inc.
Route 1, Box 181
Chaseburg, WI 54621
(608) 452-3169
[Have installed Wheeler bridges]

Fenner Excavating and Trucking
Cty J and 10th Avenue
Friendship, WI 53934

(608) 339-9072
[Have installed Wheeler bridges]

Great Lakes Marine Contracting
N256 Hwy. 49
Weyauwega, WI 54983
(414) 867-3455
[Have installed Wheeler bridges]

Lakeland Landscaping
7828 Parkside Court
Minocqua, WI 54548
(715) 356-4099
[Have installed Wheeler bridges]

Lunda Construction Company
Box 669
Black River Falls, WI 54616
(715) 284-9491
[Have installed Wheeler bridges]

McMullen & Pitz Construction Co.
17 Maritime Drive
P.O. Box 8
Manitowoc, WI 54221
(414) 682-0131
[Have installed Wheeler bridges]

Edward Kraemer & Sons
One Plainview Road, P.O. Box 220
Plain, WI 53577
(608) 546-2311
[[Builds and installs metal, timber and concrete bridges. Pile driving available]

Bridge Material Sources that Offer Special Values

Isaksson Lumber Co., Inc. - (HCR Box 15, Herbster, WI (715) 774-3381) saws pine lumber and has rough sawed and smooth finished pressure treated lumber from stock or to special order.

Fastenal - good source for bridge hardware

National Steel Fabricators - (W 16890 U.S. Highway 8, Rice Lake , WI 54868) can provide bridge engineering service, drawings and steel fabrication.

Sentinel Structures (477 South Tech Avenue, Peshtigo, WI 54157, (715) 582-4544) sells laminated wood beams for bridges up to 100 feet long.

Cost Saving Ideas

- Look thoroughly up stream and down stream for the best crossing location. The original site might not be the best.
- Consider culverts instead of bridges in locations with intermittent, small or medium stream flows. Long term maintenance can be minimized with proper culvert sizing and installation. Blockage of culverts by beaver is a potential problem.
- If possible, get your DNR basin water management specialist to look at the proposed site and agree on how the project should be done before you start detailed planning, before you request a water permit and before you apply for funding. A clear span bridge and no stream or bank disturbance is preferred (their viewpoint is parallel to the stream while yours may be parallel to the trail).
- Build bridges with club labor. Use local contractor assistance, if needed. Use the skills of local club members and keep it simple and safe.
- Try to get the services of the Wisconsin Conservation Corps for construction.
- Buy used steel beams if available.
- Flat bed semi-trailers can be used for light duty bridge support structures.
- Hog panels can be used for bridge railings if properly braced. They are relatively inexpensive, long lasting and easy to replace.
- Use deck planks without trimming ends whenever possible to reduce the amount of sawing.
- Use ship augers for fast drilling of holes.
- Use electric or air impact wrenches for tightening nuts. Size bolt lengths carefully.
- Eliminate or minimize engineering costs by using pre-engineered plans, pre-engineered kits, prefabricated bridges and non-concrete supports.
- Eliminate expensive abutments and their engineering costs by making a bridge longer so it bears on wood timbers placed further back from the water.
- Abutments can be constructed from treated wood instead of concrete.
- Wood bridge supports are easier to remove if the bridge is relocated to another site.
- In some locations, using cheaper, temporary bridges that don’t require abutments and are removed each spring is a better alternative than a permanent structure.
- Bridge pilings, consisting of 8 inch diameter steel pipes can be placed in the ground using high pressure water. An enlarged footing for the piling can also be so formed. The pipes are then filled with concrete for an inexpensive alternative to a poured concrete piling.
- Prefabricated steel bridges can be shipped without the deck installed to lighten the weight for installation.

- Prefabricated steel bridges often can be dragged from a road to the site with a truck or bulldozer. They can be placed in position, without a huge lifting crane, by sliding the bridge into position without lifting it's full weight using steel cable and tractors or large backhoes at each end.

- Prefabricated metal bridges are pre-engineered and are available in long single spans.

- Pre-engineered wood bridge kits, using steel beams are available for on site assembly.

- Pre-cut, all wood, bridge kits are pre-engineered and require on-site assembly.

- Both prefabricated metal and precut wood bridges may be ordered with load ratings increased above the 12,000 pound limit for fundability (This difference must be paid by the county ordering the bridge). The cost to increase a metal bridge from 12,000 to 15,000 pounds is 7-10% and to 18,000 pounds is 14-20%. The cost to increase a wood bridge loading from 12,000 to 19,000 pounds is from less than 1% to 5%.

- Make beams on-site out of treated lumber for bridges up to 32 feet long.

- Purchase laminated beams up to 100 feet long and club-build the rest of the bridge using non-precut materials.

- Use rough sawn, pressure treated lumber which is full dimensioned and therefore much stronger than smooth finished nominal dimensioned lumber. The bending strength of 2 inch rough sawed material is over twice as strong as nominally sized 2 inch planed material.

- Rough sawn hardwood such as white oak is tougher and longer lasting than treated pine.

- Use 3 inch rough sawn decking if the bridge will be crossed by pickup size vehicles.

- Remember that the point load of a tractor utilized for grooming is significantly greater than for a tracked grooming power unit.

- Use replaceable 2 inch thick longitudinal wear planks over the basic deck to protect the deck from groomer cleats and studded snowmobile tracks.

- Metal bridges are easy to relocate should a trail easement be lost.