NORTH CAROLINA
DEPARTMENT OF AGRICULTURE & CONSUMER SERVICES

Fundamentals of Stream Crossings

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Stream Crossings for Normal On-Going Silvicultural Operations are Exempt from Permitting

So long as…certain conditions are met:

- You meet the definition of "**Normal**"
  - Normal is determined by the **on-going** nature of the operation that **must not be a change in use**.
  - If the primary use is hunting, habitat management, recreational access, etc., the crossing is likely **not exempt**
- Must Comply with 15 federally defined BMPs
- Must meet FPG standards (prevent/control/restrain accelerated erosion and visible sediment)
- Cannot significantly alter hydrology
- Cannot introduce toxins

US Army Corps of Engineers®

FPGs

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Stream Crossings Should be Avoided

Stream crossings are **nearly direct pathways** for sediment delivery to streams

Highest risk potential and most frequent violation

Stream crossings can **cost a lot $$$**

Cost can vary tremendously , but one major crossing can easily cost more than 1 mile of road construction

Approachways (the road area leading to the crossing) are **often the primary source of sediment**

If Unavoidable, Minimize the Number of Stream Crossings and Locate them Carefully!

There is **no excuse** for constructing a stream crossing in a poor location when alternative location exist

Use office tools…they are ***FREE***

- Topographic maps
- Aerial photos (Google Earth)
- Soil Survey Maps
- **NEW FPPT** (more on that later)

Leverage knowledge of local personnel (NCFS, CFs, Neighbors, Contractors, Loggers)

Walk the site BEFORE construction begins

Clearly designate the location (flag or paint it) and **communicate that** to the contractor

What Should I Consider When Choosing Stream Crossings

Purpose

- What type of operations are expected
- Will this be used publicly or privately

Traffic size

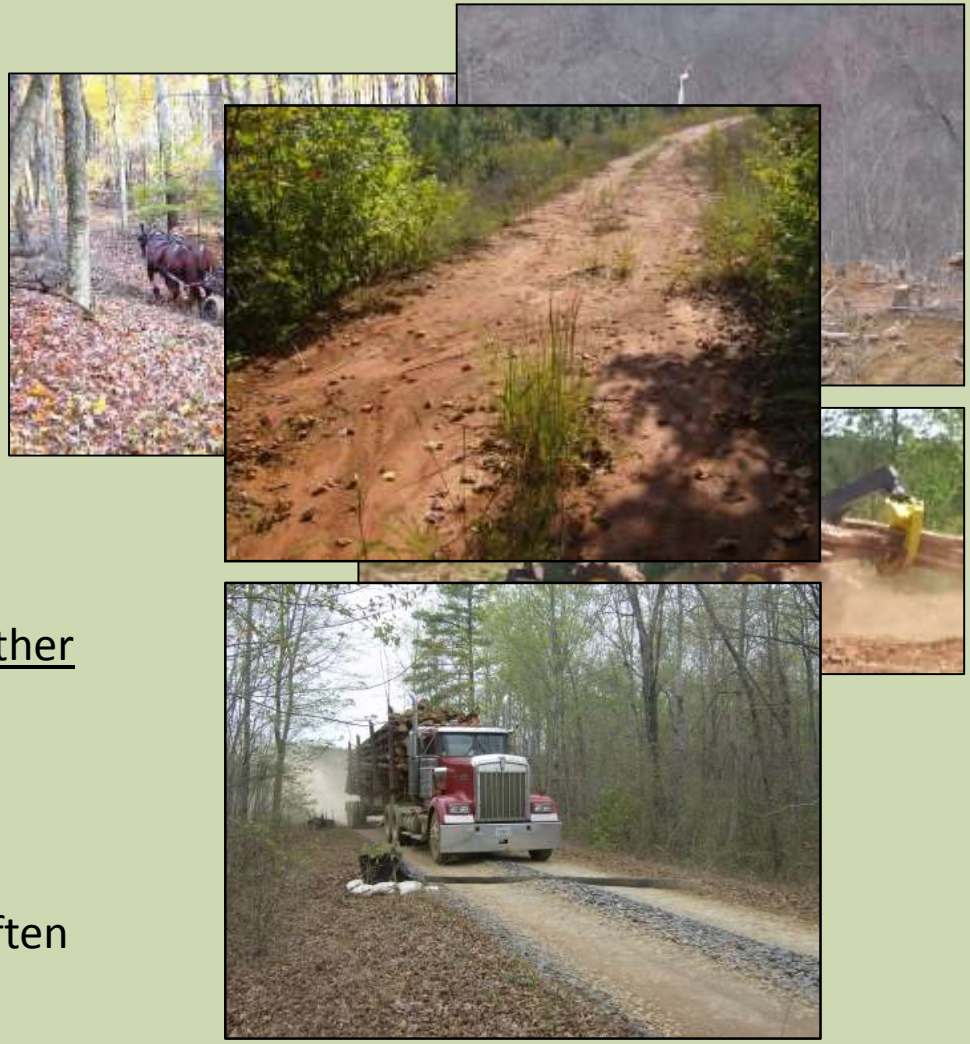
- Number/volume of vehicles
- Weight of vehicles
- Speed of vehicles

Longevity

- Permanent or Temporary
- Time of use: Dry-weather only, all-weather

Costs

- Design
- Construction
- Maintenance
  - Crossings built to lower standards often require more frequent maintenance
- **Don’t forget about your BMP costs!**



What Are Some General BMPs for Stream Crossings

Use existing roads and crossings when feasible

Minimize streambank disturbance

- Bridgemats are great for this

Locate crossings on **straight, flat stream sections** that allow you to **cross at a right angle** (90°)

Construct during low flow conditions

Select a crossing type that fits the site

- A goal is to maintain natural stream characteristics (flow, depth, width)

What Stream Crossings Options Are There?

Natural Bottom Ford

Bridgemats!

Round Culvert

Reinforced Ford

Stringer

Low Water

Squash/Closed Bottom

Pole

Bridgemats!

Arch/Open Bottom

When is a Ford Appropriate?

Fords can be used when the:

- **Straight stream section** has an existing **rocky/hard bottom OR can be reinforced**
- **Approachways are gentle** (less than 4%) **AND runoff/sediment can be controlled**
- **Low streambanks**
- Stream is **too wide for bridges**
- **Beavers are problematic**

Only used for *HAUL TRUCK ACCESS*

What BMPs Exist for Fords?

BMPs for Fords

- **Geotextile products for reinforcement**
- **Use clean hardening material (no asphalt)**
- **Water control structures on approaches**
- **Low trough within the centerline of stream channel to allow low-flows**
- **Stagger tire tracks to minimize rutting**
- **Slow traffic spreads**
- **Frequently inspect: Safe use, Proper flow, WQ**

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When is a Culvert Appropriate?

Culverts can be used for **skidding and haul trucks**

Culverts are appropriate when Bridges or fords are not suitable or cost effective

- Culverts tend to be **easy to store, transport, and install**
- Culverts have **less weight limitations compared to bridges**
- **Fill can be used to idealize the road surface**
- Culverts come in a **variety of shapes and sizes** and can be made from **different materials (concrete, steel, plastic)**

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Select an Appropriately Sized Culvert

Culvert lengths will **vary based on road width, however culvert lengths should exceed road width by at least 2 feet** (more for taller backfills)

Temporary culvert diameters

- Do not use a pipe less than 15-inch diameter
- Reference BMP manual or QR-Field guide
- Based on 1-3 year storms!!

Permanent culvert diameters

- Based on Talbot's Formula for a 2.5" per hour event
- Qualitatively accounts for watershed size, slope, & infiltration
- This formula can be manipulated to adjust for different rainfall intensities and multiple culverts

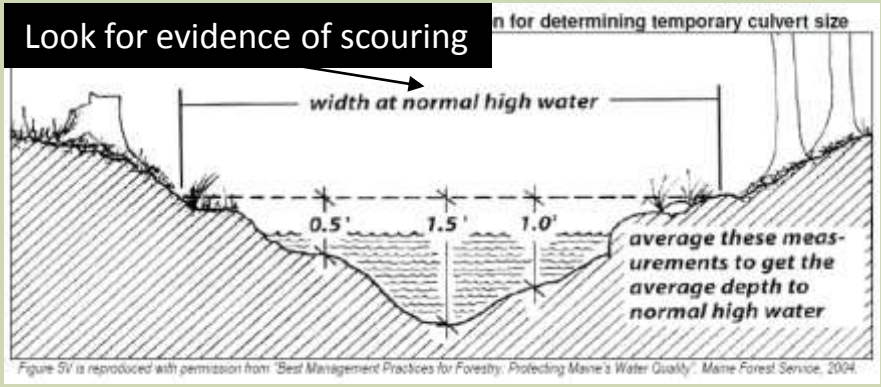


Table 5-3: Suggested Diameter Sizes of Round Culverts for Temporary Installations

Average Channel Width (inches)	Average Channel Depth (inches) 6	12	18	24	30	36	42
12	15	18	18	24	24	30	36
18	15	18	24	24	30	30	36
24	15	24	30	30	36	36	48
30	18	24	30	30	36	48	48
36	18	24	30	36	48	48	48
48	24	30	36	48	48	48	60

Based on Talbot's formula for a 2.5-inches per hour rainfall

Area in square feet required for waterway

No. of acres	Impervious 100% runoff	Steep slopes, heavy soils, moderate cover		Moderate slopes, heavy to light soils, dense cover		Gentle slopes, agricultural soils and cover		Flatland pervious soils
	C = 1.00	C = .80	C = .70	C = .60	C = .50	C = .40	C = .30	C = .20
2	1.0	0.8	0.7	0.6	--	--	--	--
4	1.7	1.4	1.2	1.0	--	--	--	--
6	2.3	1.9	1.6	1.4	1.2	0.9	0.8	--
8	2.9	2.3	2.0	1.7	1.4	1.2	0.9	0.6
10	3.4	2.7	2.4	2.0	1.7	1.4	1.0	0.7
20	5.8	4.6	4.0	3.5	2.9	2.3	1.7	1.2
30	8.0	6.3	5.4	4.8	4.0	3.2	2.4	1.6
40	9.8	7.8	6.8	5.9	4.9	3.9	3.0	2.0
50	11.6	9.3	8.0	7.0	5.8	4.6	3.5	2.3
60	13.4*	10.7	9.2	8.0	6.7	5.3	4.0	2.7
70	15.0	12.0	10.3	9.0	7.5	6.0	4.5	3.0
80	16.6	13.3	11.5	10.0	8.3	6.6	5.0	3.3
90	18.2	14.6	12.5	11.0	9.1	7.2	5.4	3.6
100	19.7	15.8	13.5	11.8	9.8	7.9	5.8	3.9
150	26.9	21.2	18.5	16.0	13.3	10.7	8.0	5.4
200	33.2	26.8	22.9	20.0	16.7	13.3	10.0	6.6
250	39.5	31.8	27.1	23.8	19.7	15.7	11.8	7.9
300	45.7	36.1	31.0	27.1	27.0	18.0	13.5	9.0
350	51.0	40.6	35.0	30.5	25.3	20.2	15.0	10.1
400	56.0	45.0	39.0	33.9	28.0	22.2	16.7	11.2
450	61.7	49.7	42.0	37.0	30.8	24.2	18.0	12.3
500	66.8	52.8	46.0	40.0	33.2	26.5	19.8	13.2
600	77.0	61.8	52.5	46.0	38.2	30.3	22.8	15.3
700	86.0	68.4	59.5	52.0	43.0	34.0	25.8	17.2
800	96.0	76.1	65.8	57.0	47.5	38.0	28.5	19.0
900	104.0	83.0	71.7	62.2	51.9	41.5	31.1	20.8
1000	113.0	90.0	77.7	68.0	56.5	45.0	33.7	22.4

*Due to difficulties in transporting and installing in forested situations, culverts larger than 48 inches in diameter are not recommended. Where watersheds require culverts larger than 48 inches, bridges or multiple culverts are recommended.

What Other BMPs Exist for Culverts?

A lot…when you place fill overtop the channel, things can go wrong quick

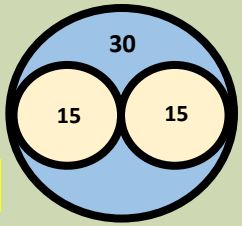
Culvert should be installed **during low flow**, and **placed in center of the stream with a downslope grade** to prevent clogging

10% of culvert should be **below** the streambed

If multiple pipes, understand "area" concept

15" = 1.22 sq ft
30" = 4.91 sq ft

That's four 15" pipes to = one 30"



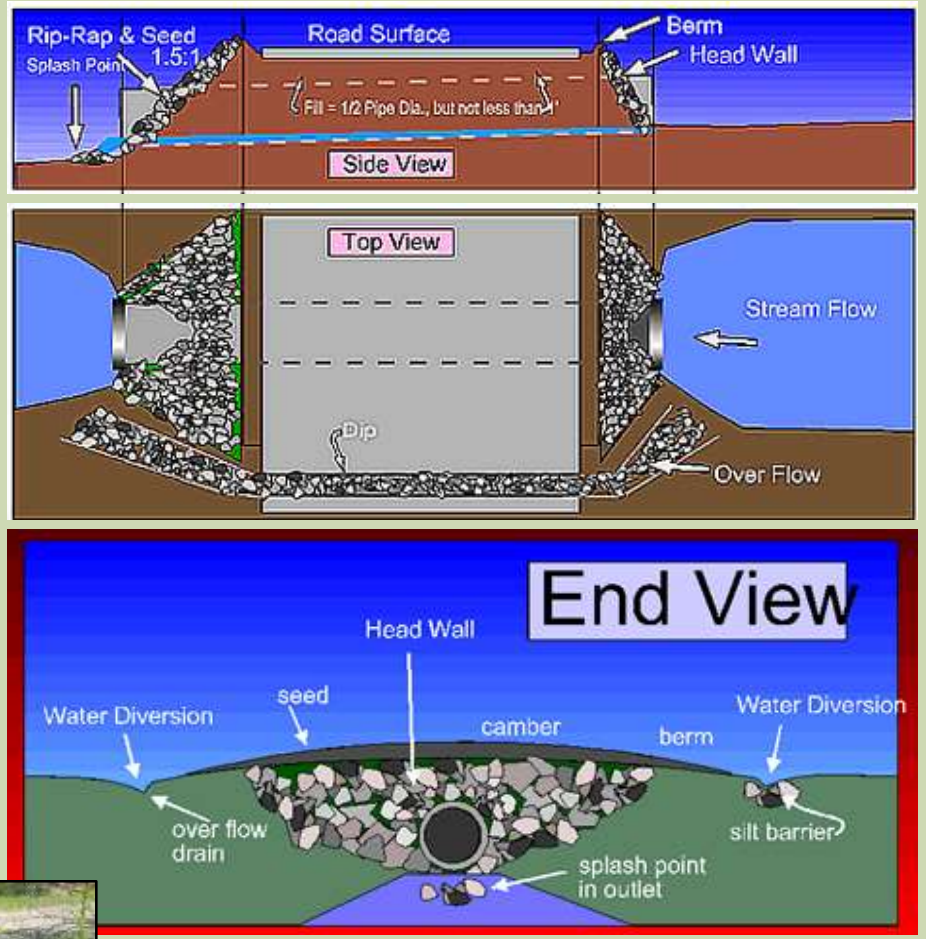
Backfill should be packed down tight and be at least 12-inches thick or ½ of the pipe diameter

Use head- and end-wall stabilization (see examples on the right)

BMPs for Culverts Continued…

Installing culverts

- **Bedding:** make soil contact with minimal course fragments
- **Camber:** have a slight arch so settling will not bow the culvert. Additionally, camber allows floodwater to flow around
- **Length:** pipe should extend 1 to 2 ft past the road edge. If not, head- and end-walls should be used
- **Surfacing:** use rock as needed (traffic should not damage the pipe)



Create low depressions in the approachways as a bypass

When is a Bridge Appropriate?

Bridges can be used for **skidding and haul trucks**

Bridges are appropriate when the site has**:**

- **Straight, narrow channel width**
- **Firm, well formed streambanks**
- **Solid footing on either side**
- **High, level ground on each side**

Low water bridges are appropriate where the **stream is wide, shallow, has a broad floodplain, and flooding is frequent**

Where a major bridge is required or when bridge span exceeds 30 ft, a BRIDGE ENGINEER should be consulted

For temporary crossings, portable Bridgemats are often the best option

Did You Know NCFS Has Bridgemats You Can Borrow?

North Carolina Forest Service

Suppliers of Bridgemats, Portable Bridges, Dragline Mats and Logging Mats

This is not intended to be a complete list of suppliers. This information has been prepared to assist those who may require this equipment for forestry operations. Potential buyers should compare costs and specifications before ordering a mat to ensure that the equipment fits the job needs. Inclusion on this list does not imply recommendation nor any guarantee by the State of North Carolina related to the purchase or use of these products. Not all vendors listed here offer all types of mats. You should contact each vendor to determine what products they have available for your intended use.

Steel Bridgemats (portable logging bridges)

All American Welding		(910) 200-5557	708 Seafarer Drive	Carolina Beach, NC 28428
Atlas Welding	[illegible]	(336) 395-3740	1213 Gant Road	Graham, NC 27253
Bryant's Welding & Repairs	Attn: Greg Bryant	(828) 493-0808	2610 Ralph Bryant Lane	Lenoir, NC 28645
DAMCO, Inc.	damco @ earthlink.com	(252) 633-1404	P.O. Box 3838	New Bern, NC 28563
Hatch Crafters	[illegible]	(336) 859-3237	853 Cid Road	Lexington, NC 27292
KM Machine Company	[illegible]	1/877-420-2368	235 Seaberry Road	Boone, NC 27289
T&W Machine and Welding		(919) 934-6077	1898 Mallard Road	Smithfield, NC 27577
Wharton Welding and Repair Service		(434) 983-3933	273 Allens Lake Road	Dillwyn, VA 23936

Wood, Timber, Engineered Lumber, or Composite Mats (for bridges or roads)

Advantage Lumber Company	advantagelumber @ yahoo.com	1/877-612-3656	926 Anthony Avenue	Opelousas, LA 70570
Albert Forest Products	www.albertforestproducts.com	(828) 862-8188	PO Box 721	Cedar Mountain, NC 28718
Arcola Lumber Company		(252) 257-4923	2316 Highway 43	Warrenton, NC 27589
Anthony Hardwood Composites	[illegible]	(870) 942-4000	PO Box 490	Sheridan, AR 72150-0490
Blue Ridge Pipe and Supply		1/800-738-8327	4267 Goose Creek Rd	Glenwood, NC 28737
Bridgewell Resources LLC	[illegible]	1/800-570-3500	10200 SW Greenburg Rd, Suite 500	Tigard, OR 97281
Carolina Mat Inc.	www.carolinamat.com	(252) 793-4041	103 Hwy149-North	Plymouth, NC 27962
Custom Cut Timber Products		(478) 994-0167	701 W. Main St	Forsyth, GA 31029
Dixie Mat	www.dixiemat.com	1/800-837-2059	236 Herring Road	Sandy Hook, MS 39478
Garnett Wood Products	www.garnettwood.com	1/888-427-6188	P.O. Box 125	Brandsville, MO 65688
Hopewell Hardwood Sales	hopewellhardwoods @ earthlink.net	(804) 458-5178	5333 Hall Farm Rd	Prince George, VA 23875
Long Lumber Company		(334) 886-3526	771 W Bowman Ave	Slocomb, AL 36375
Mabey, Inc	www.mabey.com	866-557-4102	6770 Dorsey Road	Elkridge, MD 21075
Richard West Co., Inc.		(252) 793-4440	174 US Hwy 64 West	Plymouth, NC 27962
Sound Industries	[illegible]	(208) 777-9025	1810 Schneidmiller Ave, Suite 340	Post Falls, ID 83854
South Eastern Timber Corp	[illegible]	(954) 752-9800	PO Box 9289	Coral Springs, FL 33075
Sterling Lumber Company	www.sterlinglumber.com	(708) 388-2223	3415 West 127th St	Blue Island, IL 60406
SVE Portable Roadway Systems, Inc	[illegible]	1/800-762-8267	6128-F Brookshire Blvd	Charlotte, NC 28216
T. E. Johnson Lumber Co		(919) 983-2233	3872 Old School Rd	Four Oaks, NC 27524
Tarheel Mats, Inc		(252) 331-5406	454 Highway 343-North	Camden, NC 27921
The Mat Source	[illegible]	1/877-887-6287		
Tonnac Lumber Co	[illegible]	1/800-925-7063	805 SW Broadway Suite 1300	Portland, OR 97205-3357
Twin Mills Timber & Tie	[illegible]	(618) 552-3062	P.O. Box 34	West Frankfort, IL 62896

This list is periodically updated and is available to download from the "Water Quality >> Bridgemats" section of www.ncforestservice.gov

Updated: January 2017

We have 15 bridgemat set across the state

- 5 sets in the Western region
  - Murphy / Sylva
  - Asheville / Marion
  - Lenoir / Wilksboro
  - Statesville / Monroe
- 6 sets in the Piedmont region
- 4 sets in the Coastal Plain region

Bridgemats may be borrowed, free of cost, to cross streams and ditches

Check out our website for more information

- Installation/use/removal tips
- Bridgemat suppliers/repairs
- Loan project status report
- Videos
- Fact sheets

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What Are the Major Components of Permanent Bridges?

This can get complicated in a hurry…

Consider:

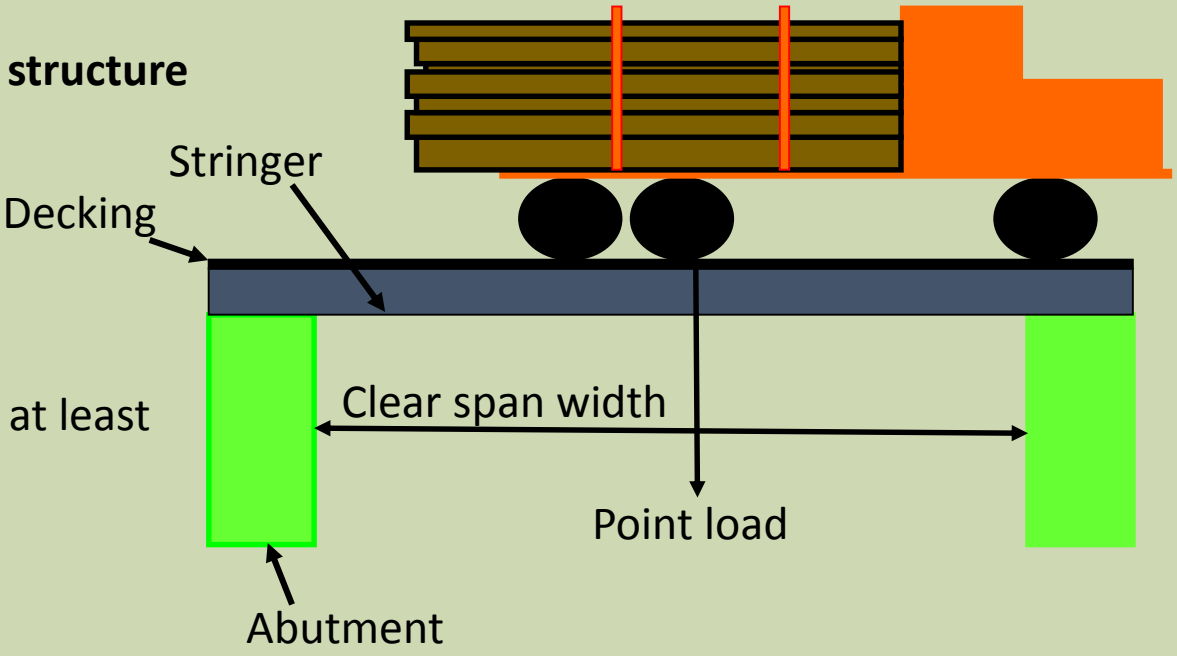
- **Clear span**
- **Structure weight (dead weight)**
- **Traffic weight (live weight)**
- **Location of traffic weight on structure**
- **Materials strength**

Beams/stringers

- Taller is stronger than wider
- Wood strength varies by spp.
- Bottom of stringer should be at least 3 ft above max high water

Decking transfers the load to the stringer

Abutments are key to stabilizing banks, they support the structure



What BMPs Exist for Bridges?

Not near as many as culverts and fords…

Create a solid surface that provide a barrier over the channel and keeps debris out of the stream

Keep equipment out of the channel when installing and removing the structure

Use bumper trees to funnel the load across the bridge (skidder crossings)

Use logs to expand the surface (keep debris from dragging through the stream)

Butt the panels tightly together

What Does All of this Cost?

It depends, but generally

Fords < Culverts < Bridges

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Summary

While forest road stream crossings used primarily for silviculture are exempt from permitting under SPCA, they must abide by FPGs and the 15 federal BMPs

Stream crossings provide direct pathway for sediment if BMPs are not properly implemented and effective

There is help available:

- **Plenty of free planning resources**
- **Assistance for locating or avoiding a crossing altogether**
- **Assistance in planning roadways and estimating costs**
- **Technical expertise**

Get to know your local forest rangers and water quality foresters

Visit
ncforestservice.gov

Join the NPS Mailing List to Receive and Communicate Forest WQ Related Information