

Chapter 9

Fords and Low-Water Crossings

"Keep the ford profile low, armor the driving surface, and protect against scour."

LOW WATER CROSSINGS, fords, or drifts, as they are commonly called, can offer a desirable alternative to culverts and bridges for stream crossings on low-volume roads where road use and stream flow conditions are appropriate. Like other hydraulic structures for stream crossings, they require specific site considerations and specific hydrologic, hydraulic, and biotic analyses.

Ideally, they should be constructed at a relatively narrow, shallow stream location and should be in an area of bedrock or coarse soil for good foundation conditions. A ford can be narrow or broad, but should not be used in deeply incised drainages that require a high fill or excessively steep road approaches.

Low-water crossings may have a simple rock reinforced (armored) driving surface or an improved surface such as gabions or a concrete slab, as seen in *Figure 9.1a* and *Photo 9.1*. Vented fords combine the

use of culvert pipes or box culverts to pass low flows and a reinforced driving surface over the culverts to support traffic and keep traffic out of the water most of the time, as seen in *Figures 9.1b* and *c*. The reinforced driving surface over the pipes also resists erosion during overtopping at high water flows (*Photo 9.2*). The entire wetted perimeter of the structure



Photo 9.1 Use armored low-water crossings, fords, or drifts as often as possible to cross low flows in broad, shallow natural drainages, thus avoiding the use of pipes. Note that part of this reinforced driving surface needs repair.



Photo 9.2 A vented ford, using multiple culvert pipes to handle low flows through the pipes, yet allow major flows and debris to overtop the entire structure.

should be protected to a level above the anticipated high water elevation.

Key factors to consider for the design and location of a ford include the following: low and high water levels; foundation conditions; scour potential; allowable traffic delays; channel cross-section shape and confinement; protection of the downstream edge of the structure against local scour; stream channel and bank stability; locally available construction materials; and grade control for fish passage.

ADVANTAGES OF LOW-WATER CROSSINGS

- | | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • The major advantage is that a ford is usually not susceptible to plugging by debris or vegetation the way a culvert pipe may plug. • Fords are typically less expensive structures than large culverts or bridges. They may be initially more expensive than culverts, but they require less fill in the channel, and they can ac- | <p>commodate larger flows.</p> <ul style="list-style-type: none"> • Vented fords can be used to pass low flows and keep vehicles out of the water, avoiding water quality degradation. • The structure can be designed as a broad-crested weir that can pass a large flow volume over the top of the ford. It is | <p>not very sensitive to specific flow volumes since a small increase in flow depth greatly increases capacity. They can be more “forgiving” and accommodate more uncertainties in the design flow and thus are ideal for drainages with unknown or variable flow characteristics.</p> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

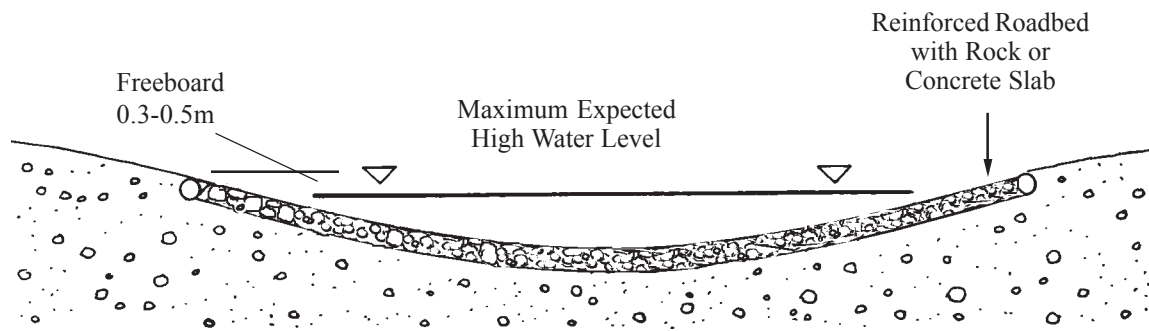
DISADVANTAGES OF LOW-WATER CROSSINGS

- | | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Ford-type structures imply some periodic or occasional traffic delays during periods of high flow. • The shape is not easily suitable to deeply incised drainages that would require high fills. | <ul style="list-style-type: none"> • Since the shape of the structure involves a dip and periodic delays, they are typically not desirable for high use or high-speed roads. • Vented fords may back up the bedload in a stream channel, causing culvert plugging, requiring maintenance, and | <p>causing other channel adjustments.</p> <ul style="list-style-type: none"> • Fish passage may be difficult to incorporate into the design. • Crossing the structure can be dangerous during periods of high flow (<i>Figure 9.2</i>). |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

For fish or aquatic species passage, a natural or rough stream channel bottom should be maintained through the ford, and water velocities should not be accelerated. Ideal structures are either

vented fords with box culverts and a natural stream bottom (see *Photo 9.5*) or simple on-grade fords with a reinforced, rough driving surface (*Figure 9.1a*).

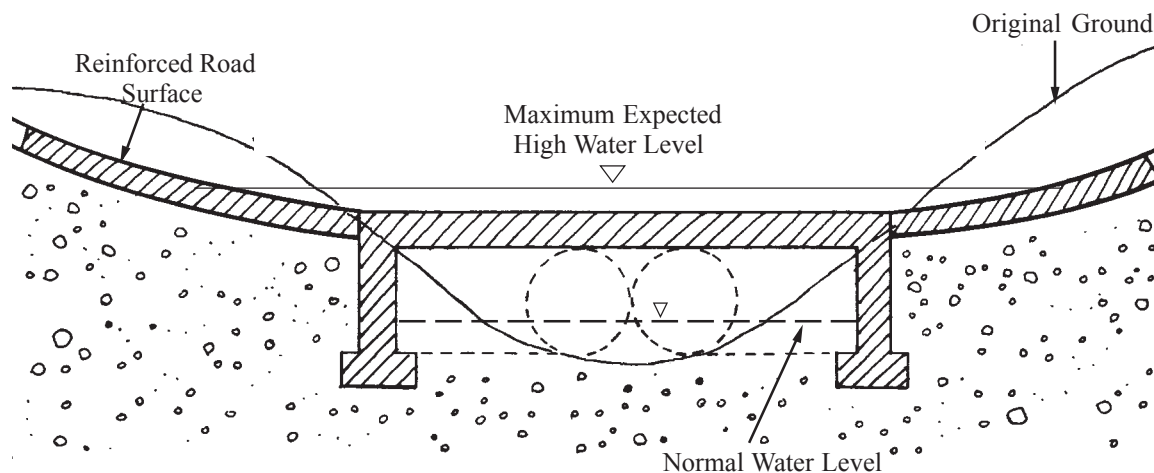
Figure 9.1 Basic low-water crossing (fords or drifts) options. Note: Armor the road surface (with rock, concrete reinforcement, etc.) to an elevation **above** the high water level!



a. Simple Low-Water Crossing with Reinforced Roadbed of Rock or Concrete

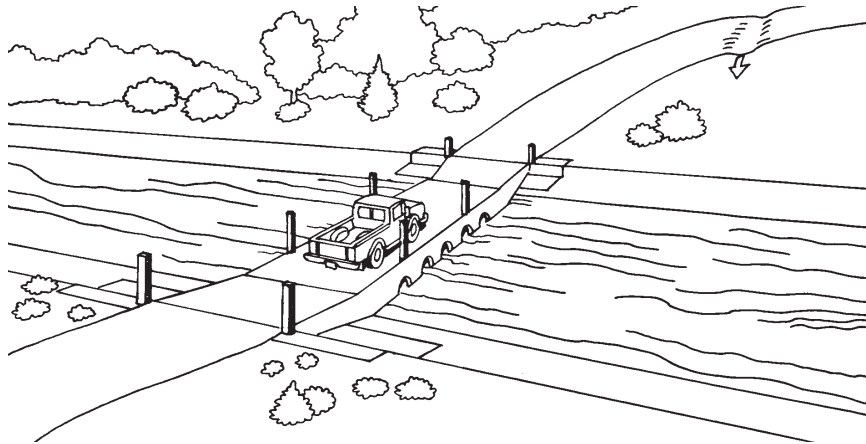


b. Improved (Vented) Ford with Culvert Pipes in a Broad Channel

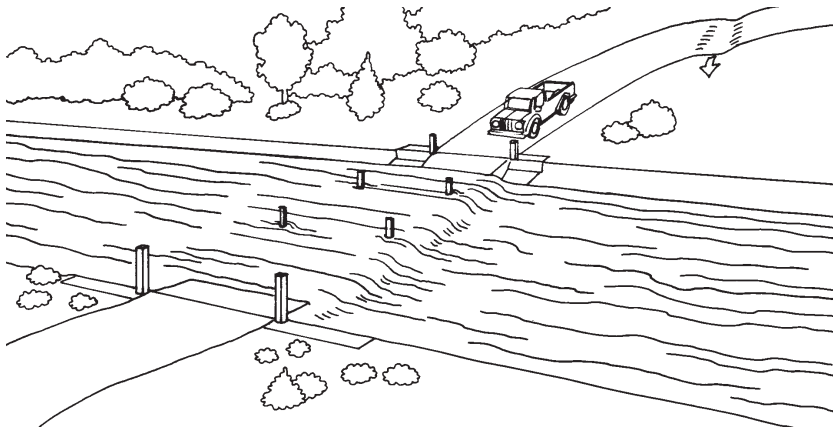


c. Vented Ford with Pipes or Box Culverts in an Incised Channel

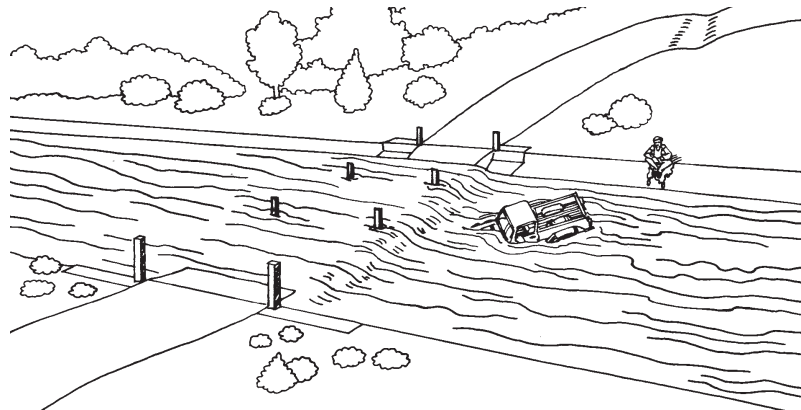
Figure 9.2 Danger of crossing a ford at high water. Fords require occasional traffic delays during periods of high water. (Adapted from Martin Ochoa, 2000 and PIARC Road Maintenance Handbook, 1994)



a. Low-water crossing at low water.



b. Low-water crossing at high water – WAIT!



c. Crossing during high water can be dangerous!

RECOMMENDED PRACTICES

- Use an adequately long slab or structure to protect the “wetted perimeter” of the natural flow channel. Add protection above the expected level of the high flow (*Photo 9.3*). Allow for some freeboard, typically 0.3 to 0.5 meters in elevation, between the top of the reinforced driving surface (slab) and the expected high water level (see *Figure 9.1*). The flow capacity of a ford, and thus the high water level, can be estimated using a “Broad-Crested Weir” formula.
- Protect the entire structure with cutoff walls, riprap, gabions, concrete slabs, or other scour protection. The downstream edge of a ford is a particularly critical location for scour and needs energy dissipators or riprap protection because of the typical drop in water level off the structure and the accelerated flows across the slab.
- For simple rock fords, use large graded rock in the roadbed through the creek, large enough to resist the flow of water. Use criteria as shown in *Figure 6.1*. Fill the voids with clean, small rock or gravel to provide a smooth driving surface. This small rock will have to be periodically maintained and replaced.
- Use fords for crossing seasonally dry streambeds or streams with low flows during most periods of road use. Use improved (vented) fords with pipes or concrete box culverts to pass low water flows (*Photo 9.4*). Accommodate fish passage where needed using box culverts with a natural stream channel bottom (*Figure 9.1c* and *Photo 9.5*).
- Locate fords where stream banks are low and where the channel is well confined. For moderately incised drainages, use improved fords with pipe or box culverts (*Figure 9.1c*).
- Place foundations into scour resistant material (bedrock or coarse rock) or below the expected depth of scour. Prevent foundation or channel scour with the use of locally placed heavy riprap, gabion baskets, concrete reinforcement or dense vegetation.
- Use well placed, sturdy depth markers at fords to advise traffic of dangerous water depths (*Figure 9.2*).

PRACTICES TO AVOID

- Constructing sharp vertical curves on fords that can trap long trucks or trailers.
- Placing approach fill material in the drainage channel.
- Crossing fords during high water flows.
- Placing low-water crossings on scour susceptible, fine grained soil deposits, or using designs without scour protection.
- Constructing fords that block upstream and downstream passage of fish.

Photo 9.3 With low-water crossings, the downstream edge of the structure typically must be protected against scour and the entire wetted perimeter (to a level above the high water level) should be reinforced.



Photo 9.4 Use vented fords with pipes or openings to keep traffic out of the water most of the time, minimize traffic delays, and allow for fish passage. Note the downstream scour protection with gabions and rock.



Photo 9.5 Some fords can be designed as “low-water bridge” structures. They must be designed to be occasionally overtopped and have an erosion resistance deck and approaches. This structure is ideal for fish passage.

