Case Study 9. Mesman Slotted Concrete Slab Ford

Location

South-central Oregon. Fremont National Forest. Thomas Creek crossing on Forest Road 3724. 15 miles Northwest of Lakeview, Oregon.

Crossing Description

This slotted concrete slab ford was constructed in 1996 on a perennial stream with resident redband trout. Previously at this site, there had been a series of structures that either did not pass fish or were not stable. Fish passage is most important during spring high flows for the spawning migration, and the current structure is low enough that trout successfully swim over it during spring flows. To achieve low flow fish passage, there is a 9-inch box slot with a 4-inch opening at the top (similar to the gap in a cattleguard) crossing the middle of the ford (figure A52).

Since at least the 1980's, objectives for the crossing have included preventing upstream migration of a large headcut moving up through the valley. Today the crossing is part of a restoration project aimed at restoring flood plain and channel connections in the incised reach of stream. The roadway is elevated about 2 feet above stream grade. Class VII riprap faces both the upstream and downstream sides. For specific dimensions, see figure A57.

Figure A52. Looking north at the Mesman ford.

Appendix A—Case Study 9

Setting

Northwestern Basin and Range Section (342-B). This section has near level basins and valleys bordered by long, gently sloping alluvial fans. Pliocene volcanic and shallow intrusive igneous rock occur in the area, and soils are generally aridisols.

Why Was This Structure Selected?

Forest objectives were: to safely pass logging and recreational traffic during the summer; to pass trout during both high and low flows; to avoid flood damage that would harm water quality; and to help restore historical streambed elevations and connections between the stream and its flood plain.

Crossing Site History

The original crossing consisted of a vented ford with three 18-inch culverts, which impeded fish passage. During the fall of 1987, the first channel restoration work was done on the incised section of stream below the crossing. In July 1988, the vented ford was replaced with a large (12 foot by 5 foot) bottomless pipe arch with steel footings. During construction, the footings could not be placed at the design depth, and the structure was not properly embedded. One winter in the early 1990's, an ice jam plugged the culvert and the entire structure was carried downstream. The next structure was a ford constructed of rock that apparently was not large enough. The structure eroded to the extent that, by 1995, it was impassable for passenger cars, and this required some action to improve the crossing again. The current structure was completed in October 1996.

Road Management Objectives

This is a gravel surfaced road maintained for passenger cars (maintenance level 3). It is closed by snow during the winter, typically from mid December to June. During the open season, average daily traffic is less than 10 vehicles. Road use is primarily for logging and recreation. Although the road provides access to a heavily used recreation area and is the primary route from State Highway 140 into this part of the forest, traffic volume is low enough that periodic interruptions (less than once per season, on average) from flooding are acceptable. High water results from snowmelt, and by the time the road opens in spring flood flows have usually passed.

Stream Environment

Hydrology: Thomas Creek is a near-perennial stream with peak flows during spring snowmelt runoff, and low summer flows (less than 1 cubic foot per second). Watershed area above the crossing is approximately 20 square miles. Most years, high flows submerge the structure at least 1-foot deep (figure A53).

Figure A53. Spring flow over the Mesman slotted ford.

Channel Description: Above the crossing, Thomas Creek is a Rosgen C or E gravel-bed stream (figure A54a). Gravels in transport are mostly smaller than ½ inch and the streambed is mobile (not armored). Channel slope is 1 to 2 percent in the vicinity of the crossing. Bankfull width varies from about 20 feet to 35 feet, and the banks above the crossing are about 2 feet high. Naturally, floodwaters flow in multiple channels across the flood plain or they may cover it completely.

A large headcut had moved up through the valley to just downstream of the crossing by the mid-1980's (figure A54b). Channel incision was attributed principally to the old grazing system, which had reduced native bank-stabilizing vegetation. The crossing probably contributed to channel instability by blocking the flood plain and concentrating floodwaters through the single crossing structure. In 1988, the forest initiated an effort to restore the incised channel and reconnect it to its flood plain. The channel was reshaped and slope was controlled with rock check dams.

Restoration objectives were to reestablish the natural overbank flow regime, narrow the channel, restore natural vegetation, and improve trout habitat. Shortly thereafter the open-bottom arch culvert that later failed was installed (figure A55).

In October 1996 as the present ford was being constructed, more boulder-weir grade controls were installed and, along with other sediment-retention measures, the weirs have succeeded in raising the streambed. The ford is now functioning as part of a system of structures aimed at channel and flood plain restoration on Thomas Creek. Because of the flood plain issues here, an important objective at this crossing is to interrupt flood plain overflow as little as possible.

Figures A54a and A54b. Thomas Creek in 1988 as seen from the ford (a) looking upstream of the crossing (b) downstream of the crossing.

Figure A55. Looking upstream at the rehabilitated channel during placement of the culvert in 1988.

Aquatic Organisms: Thomas Creek is an important spawning stream for Goose Lake Redband Trout. They need passage during their spring spawning migration, as well as during summer low flows when they may move to find deep pools with cool water or refuge from predators.

Water Quality: Water quality in the drainage is good. The structure was selected, in part, because of its low risk of failing in a way that would create water quality problems.

Structure Details

Structure: The driving surface of the ford is reinforced concrete. Two parallel W-flanges with tops set flush into the concrete run across the ford perpendicular to the roadway. These create an open slot box (9½ inches wide by 10½ inches high), with a 4-inch opening at the top to allow cleaning with hand tools. The slot passes low flows, fish, and possibly other aquatic species. It was designed for a velocity of less than 2 feet per second and a depth of at least 4 inches during normal summer flows to allow passage of both juvenile and adult fish. The ford and the slot slope downstream at 0.5 percent, which is flatter than the stream, and sand and gravel retained in the slot provide at least a partial natural bottom (figure A56).

Figure A56. View of the slot with gravel bottom, August 2006.

Thomas Creek is susceptible to scour, so 24-inch-deep cutoff walls on the upstream and downstream sides were part of the design (figure A57b).

During construction, the interdisciplinary team decided to raise the ford elevation higher than the contract drawings show, to use the structure as part of the system of grade controls being installed to restore the flood plain. As described above, the goal was to induce streambed aggradation and raise flood elevations to historic levels so that the flood plain recovers its historic vegetation, beaver recolonize the stream, and the stream itself narrows to improve trout habitat.

Bank stabilization and approaches: Class VII riprap provides erosion protection on the upstream and downstream sides of the ford and compensates for the slightly elevated grade. Road grades into the structure are 6 percent. An additional benefit of the during-construction ford elevation change was to reduce the vertical curve on the ford, making it easier for lowboys to use.

The designer incorporated several drainage features in the road as it crosses the flood plain approaching the ford (figure A57a). North of the

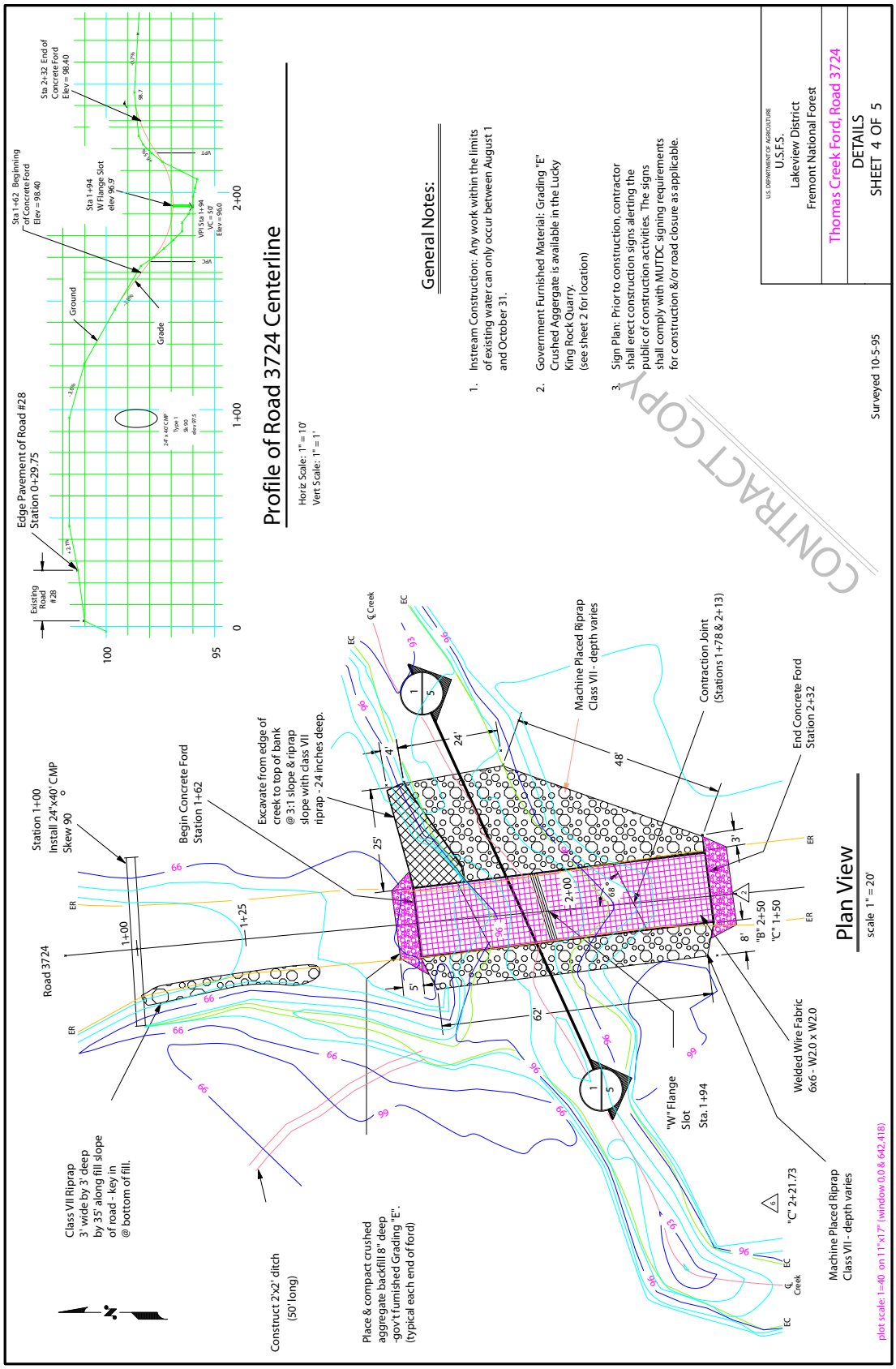
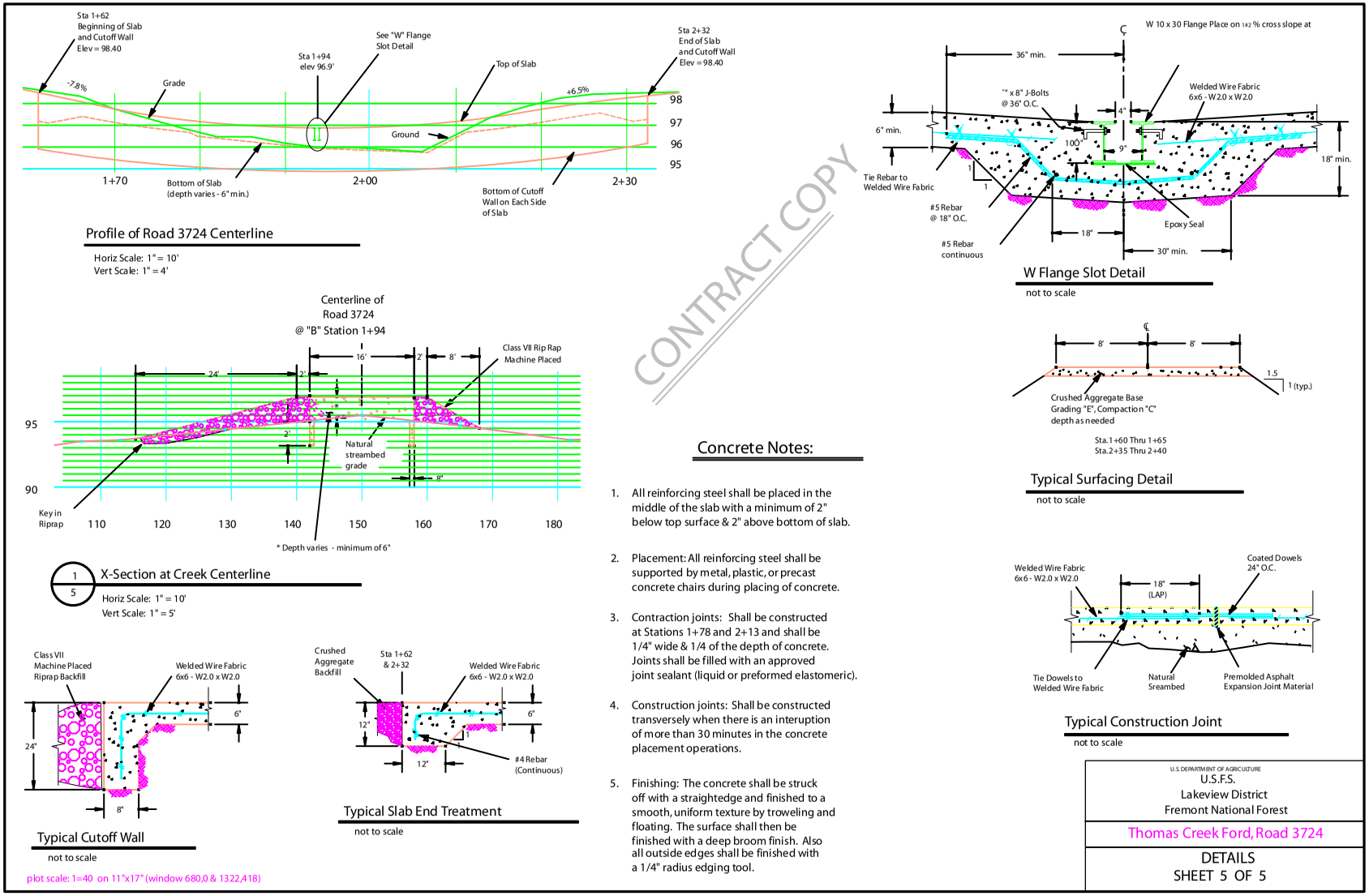


Figure A57a—Thomas Creek ford contract drawings sheet 4: site plan view. (Designed by Jerry Panter, 6/28/1996) A full size drawing may be found on the CD included in the back of this publication.



Concrete Notes:

1. All reinforcing steel shall be placed in the middle of the slab with a minimum of 2" below top surface & 2" above bottom of slab.
2. Placement: All reinforcing steel shall be supported by metal, plastic, or precast concrete chairs during placing of concrete.
3. Contraction joints: Shall be constructed at Stations 1+78 and 2+13 and shall be 1/4" wide & 1/4 of the depth of concrete. Joints shall be filled with an approved joint sealant (liquid or preformed elastomeric).
4. Construction joints: Shall be constructed transversely when there is an interuption of more than 30 minutes in the concrete placement operations.
5. Finishing: The concrete shall be struck off with a straightedge and finished to a smooth, uniform texture by troweling and floating. The surface shall then be finished with a deep broom finish. Also all outside edges shall be finished with a 1/4" radius edging tool.

Figure A57b—Thomas Creek ford contract drawings sheet 5: road profile, slot detail, cross section along creek. (Designed by Jerry Panter, 6/28/1996) A full size drawing may be found on the CD included in the back of this publication.

crossing, a flood plain overflow channel was rerouted toward the ford. There is a flood-plain culvert under the road in that vicinity in case ditch capacity is exceeded. About 150 feet south of the crossing, there is a grade sag in the road surface to permit flood plain flows to overtop the road (figure A58).

Figure A58. Looking south across the submerged ford in January 1999. The road dip beyond the ford is conveying flood plain overflow.

Cost: The original bid for construction in 1996 was $20,900. Final cost was $23,120 due to extra concrete used to raise the center of the structure.

Safety: The crossing is not signed; however safety hazards are minimal. The site is on a relatively straight part of the road with good sight distance. Approach speeds are also low due to the proximity of the crossing to a junction.

Flood and Maintenance History

In 1997, a flood estimated to exceed a 100-year event sent 3,000 cubic feet per second over the ford and submerged the entire flood plain. Other than the loss of a few cubic yards of gravel surfacing from the approaches, no damage occurred (figure A59). In the 10 years the ford has existed, no other maintenance has been required.

Figure A59. Shortly after the 1997 New Year's Day flood. Some gravel washed from the approaches (in foreground) was the only damage from the largest flood on record.

Summary and Recommendations

The forest considers the Thomas Creek slotted ford a very successful application of this type of design. It is working well to achieve channel and flood-plain restoration objectives, and has successfully maintained fish passage by means of the riprap placed up and downstream as well as the low-flow slot. The riprap cascade placed downstream to make up the elevation difference between ford and streambed resembles cascades found a short distance downstream where the meadow ends and slope increases. The cascade is clearly passable to both adult and juvenile trout.

Another reason for the success of this design is that the stream at the crossing site is not entrenched—banks are only 2 feet high—so the approaches are not excessively steep. Also, the stream is wider than normal at the site, due to the previous crossing structures. Spreading the water out wider than the natural channel may partially offset the ford's smoother surface, and help to keep overtopping velocities within the range that spawning trout can negotiate. The road approaches are low and incorporate drainage structures that maintain flood flows across the flood plain, avoiding floodwater concentration at the structure.

A third reason for the ford's success is that although there is an active beaver lodge just upstream of the crossing, the ford does not offer the beaver anything to plug or dam. While the beaver occasionally places twigs in front of the slot opening, they can be cleared out easily. The ford is a much more desirable structure in this kind of stream than a culvert, which most likely would attract the beaver as a dam site.

The only change the forest would make in the design is to extend the concrete further up the approaches to cover the full wetted perimeter of a major flood event.

Photos and information on the Messman ford were provided primarily by Jerry Panter, design engineer. Dave Hogan, fisheries biologist of the Fremont National Forest; Clay Speas, fisheries biologist, Grand Mesa, Uncompahgre, and Gunnison National Forests; Mike Montgomery, district ranger/hydrologist, Malheur National Forest; and Mike Lohrey, regional hydrologist, USDA Forest Service Pacific Northwest Region provided additional historical background.