Case Study 6. Fitzpatrick Creek Cable Concrete Block Mat Ford

Location

Southwest Oregon. Bureau of Land Management Coos Bay District. Fitzpatrick Creek. BLM road 23-8-11.0.

This ford was constructed in 2000 on a deeply incised perennial stream where passage for salmon, steelhead, and woody debris are major issues. Cable concrete block mats and riprap were used to make a stable driving surface that mimicked natural channel characteristics as closely as possible. The crossing is outsloped at approximately the same grade as the stream (4 percent), and the mat was set just under the final streambed elevation, with the expectation that a low-flow channel would develop to promote juvenile fish passage across the structure. Traffic use at this site is low, and occasional log haul is restricted by agreement with the National Marine Fisheries Service.

Figure A27. Fitzpatrick cable concrete mat ford.

Setting

Oregon and Washington Coast Ranges Section (M242-A). Highly dissected low mountains; moderately deep soils. Riparian vegetation is predominately red alder and big leaf maple with Douglas fir, western red cedar, and hemlock.

Appendix A—Case Study 6

Why Was This Structure Selected?

Key objectives that led to selection of this structure type were to: provide free passage for all aquatic organisms; floodproof the crossing: avoid blocking large woody debris that could cause the structure to fail during floods or require maintenance afterward; and handle only minor summer recreational and occasional log haul traffic.

The extremely low traffic volume reduces concern for public safety and for vehicle impacts on water quality and aquatic organisms. The cost of this structure is much less than the other possible structures, such as a bridge or open-bottom arch.

Crossing Site History

Two earlier culvert installations had washed out at this site. The second one—a 10-foot multiplate pipe installed in 1979—blew out after being plugged with debris during the 1996 floods.

Road Management Objectives

This crossing accesses both BLM and private forest land, but there are no residences or developed recreation sites. It receives little use, most of it during the autumn hunting season. However, the crossing must accommodate intermittent log and equipment haul as well as the low volume of summer and fall recreation traffic. It was anticipated that a private timber sale would occur not long after construction, and future BLM thinning projects were envisioned.

Stream Environment

Hydrology: Fitzpatrick Creek is a perennial stream. Rain on snow can produce large midwinter to spring floods. There is substantial large woody debris and gravel/cobble bed material transport during high flows. Summer low flows are on the order of 1-foot wide and a few inches deep at the site.

Channel Description: The channel is a Rosgen A3, with a 4-percent slope and low sinuosity. It is confined between stable 25-foot-high slopes that are well-vegetated with deep-rooted shrubs and trees (figure A28). Debris jams are not uncommon. The crossing is located immediately upstream of a bend.

Figures A28a and A28b. Channel character (a) looking upstream (b) looking downstream.

Aquatic Organisms: Fitzpatrick Creek is a spawning stream for two endangered species: coho salmon and steelhead, and passage for both spawning adults and juveniles is required. The stream also provides habitat for searun cutthroat trout, resident cutthroat, pacific lamprey, and pacific giant salamander.

Water Quality: Downstream habitats and water quality must be protected. Because the stream is well-confined, road approaches to the crossing are long and steep and if not treated, could be a potential source of sediment. This was dealt with by paving the approaches and the ditches with rock. Vegetation is now growing up through the rock in the ditch.

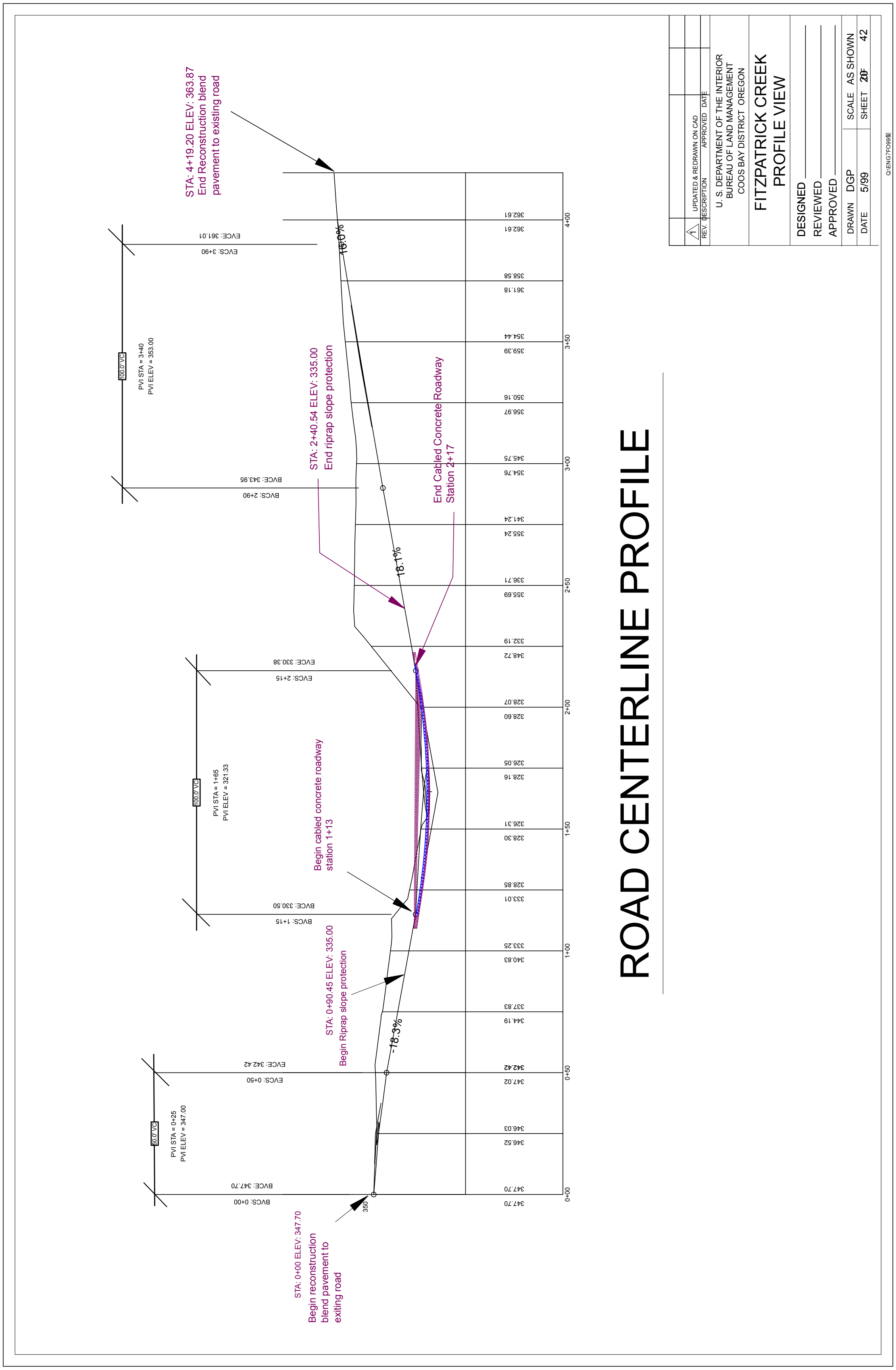

Figure A29a—Road profile through crossing. A full size drawing may be found on the CD included in the back of this publication.

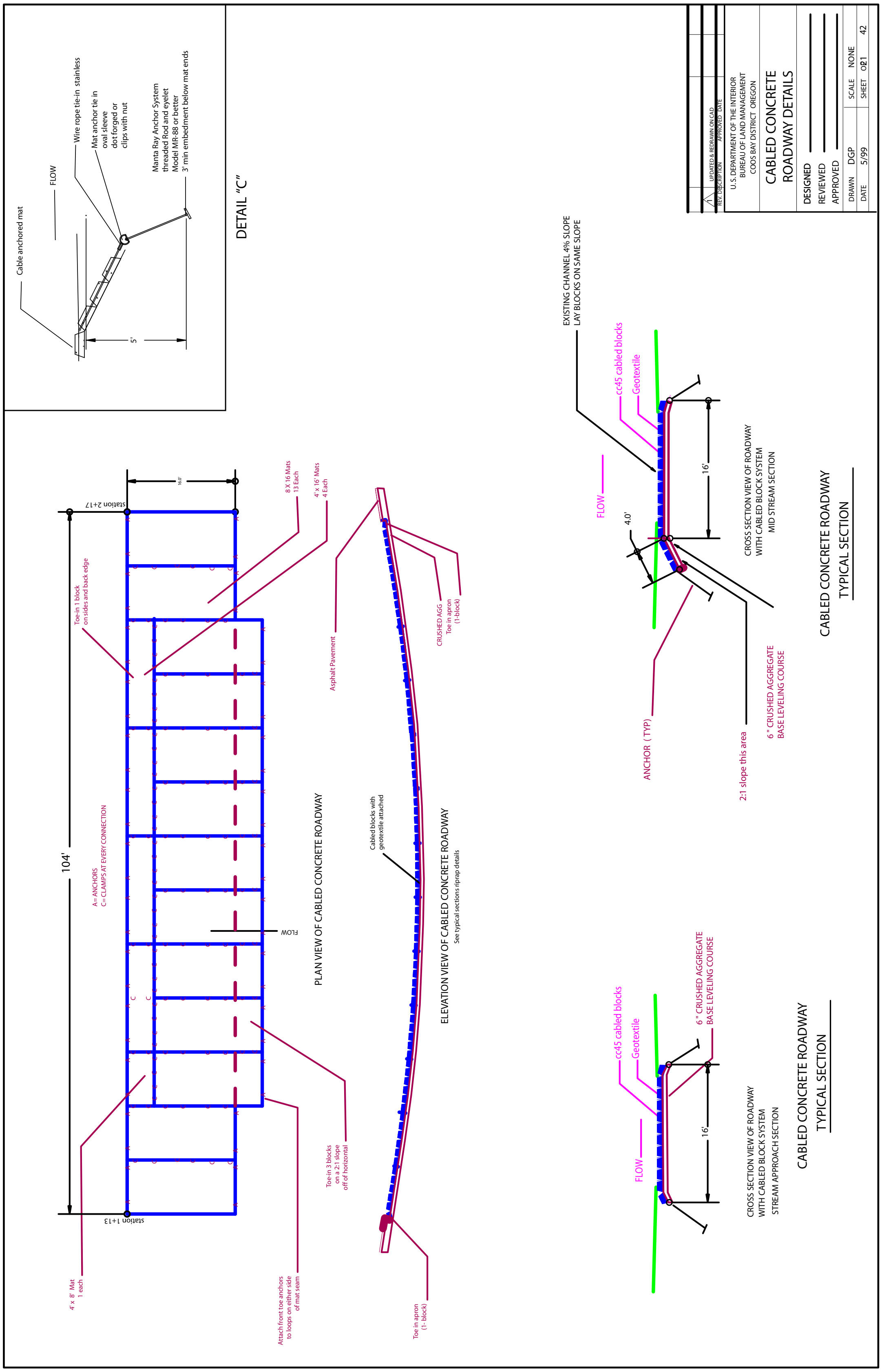

Figure A29b—Roadway cross sections and plan view. A full size drawing may be found on the CD included in the back of this publication.

Structure Details

Structure: The cable concrete mat is 16 feet wide and 104 feet long, extending to approximately the elevation of the 50-year flood (figure A29a). The blocks are sized for the 100-year event, according to manufacturer recommendations. Mats are fabricated with stainless steel cables embedded in the blocks to link them together in both directions. Geotextile fabric is attached to the bottom of blocks to prevent blocks from sinking into soft subbase, and to avoid erosion of fine material from the base. Mats were laid out on a 6-inch base of 1½-inch crushed aggregate to provide both support and a level surface (figure A30).

Figure A30. An excavator installs the mats with geotextile backing.

The mats were backfilled with ¾-inch clean gravel to help bed them and prevent movement, and to make driving easier over the 4- to 5-inch gaps between the blocks. A row of blocks was keyed in on the upstream edge of the structure to prevent scouring (figure A29b). Riprap was placed adjacent to the upstream and downstream edges to a depth just below the top of the blocks to prevent undermining. Earth anchors were driven 4 feet into the ground with a manual pile driver to hold the mat down under stresses expected from up to a 100-year event (Detail “C”, figure A29b).

Bank stabilization and approaches: Riprap was placed to the 100-year flood elevation, or approximately 10 feet above structure height, for a distance of 23 feet up- and downstream. The road approaches of 17 to 18 percent on each side were paved with asphalt, and sloped to drain to a rocked ditch. Ditch water then filters through the riprap blanket.

Cost: The ford cost $60,000 in 2000 and was less expensive than either of the other alternatives, a large open-bottom culvert or a bridge.

Safety: There is no signing at this site.

Flood and Maintenance History

The structure has not yet gone through a large flood and no log haul has occurred. So far, the crossing has needed no maintenance.

Summary and Recommendations

The structure is performing well. As expected, sediment is deposited on the structure during high flows. The channels between the blocks are filled with streambed sediment and allow free fish and amphibian passage even at low flow. Vegetation is growing in the rock-lined ditch along the approaches. Some blocks have tilted slightly, pointing to the need to compact the entire surface before block installation.

There was a slight curve in the road approaching the crossing, and it was not possible to install the mat on a bend. The district used asphalt paving at that location to accommodate the curve. In general, mats are not suitable for installation on curves.

Installation Concerns: Uniform, well-compacted bedding material coarse enough to resist scour is needed as a foundation for the mats. In retrospect, to support future log haul the engineer recommends a thicker layer of larger rock than was used here.

Figure A31. The ford permits low flow passage for aquatic species even though the blocks have settled unevenly.

As originally laid down, the Fitzpatrick Creek mat was uneven. The installers were able to smooth it by running over it with the excavator, but as figure A31 shows, some of the blocks sank unevenly and disrupted the driving surface at the edge of the structure. The Big Horn National Forest sites (see below) are more severe examples of this problem.

Other Comments: Because vehicles drive through water on this crossing, the National Oceanic and Atmospheric Administration's National Marine Fisheries Service and the U.S. Department of the Interior Fish and Wildlife Service required restrictions on timing and conditions when commercial hauling would be allowed over this structure. The district is monitoring the structure to see if there is any channel readjustment and to evaluate structure performance over time.

Don Porior, project designer (now of Porior Engineering), and Brian Thauland of the BLM Coos Bay District provided information and photos for this case study.

Similar Structures at Other Locations

The Bighorn National Forest in Wyoming has used cable concrete mats in several locations with variable success. At one site on the East Fork South Tongue River, soil consolidation after the mat was installed caused the ends of the mat to sink lower in elevation, so that the stream runs around the ends even at low flow (figure A32). Without a firmly compacted base and secure anchoring, the mat has settled unevenly and some of the connecting cables are exposed. Horse and recreational-vehicle trailer hitches tend to catch on the cables. As a result, drivers choose to drive next to the mat rather than on it, and in this wide grassy flood plain there is nothing to restrict that access. Given the high-value fishery in this perennial river, this is an unacceptable situation, and the forest is considering a culvert replacement to disconnect the road from the stream. The tradeoff will be the need to either reroute the road or construct an elevated roadfill across this very wide, active flood plain.

Figure A32. East Fork South Tongue River cable concrete block mat crossing. Note tilted blocks, exposed cables, and short mat length. Traffic is driving around the mat and the river has outflanked it.

On Copper Creek, a much smaller stream with very low summer flow (figure A33), cable concrete mats are considered more successful. Again, the lack of a firmly consolidated base caused the blocks to tilt, making an uneven driving surface, and exposing cables that were then snagged and broken. Even so, the blocks remain in place and functional. At Copper Creek, the mat does extend high enough to contain bankfull flows, and there are no problems with water outflanking the structure (figure A34). The forest considers this a successful crossing in this situation where the road is used mostly by hunters in the fall. It has required no maintenance since construction in 1999.The structure is well-suited to the wide, flat valley site because it does not require a roadfill that would interrupt flows on the flood plain during the extended snowmelt season. This means that overbank flows are more naturally distributed. Flood-plain water storage processes and riparian vegetation are fully maintained, and erosion due to floodwater concentration through a constricted structure such as a culvert is minimized.

One change the forest would make for improvement is to stabilize the exposed streambanks. They are susceptible to erosion by wave action when vehicles drive through deeper water.

Figure A33. Copper Creek tributary, Bighorn National Forest. At this drier site with less traffic, the mat is considered the best crossing option because of its low maintenance requirement and installation cost.

Harold Golden, fishery biologist, and Bryce Bohn, hydrologist, of the Bighorn National Forest, provided information for the Bighorn sites.

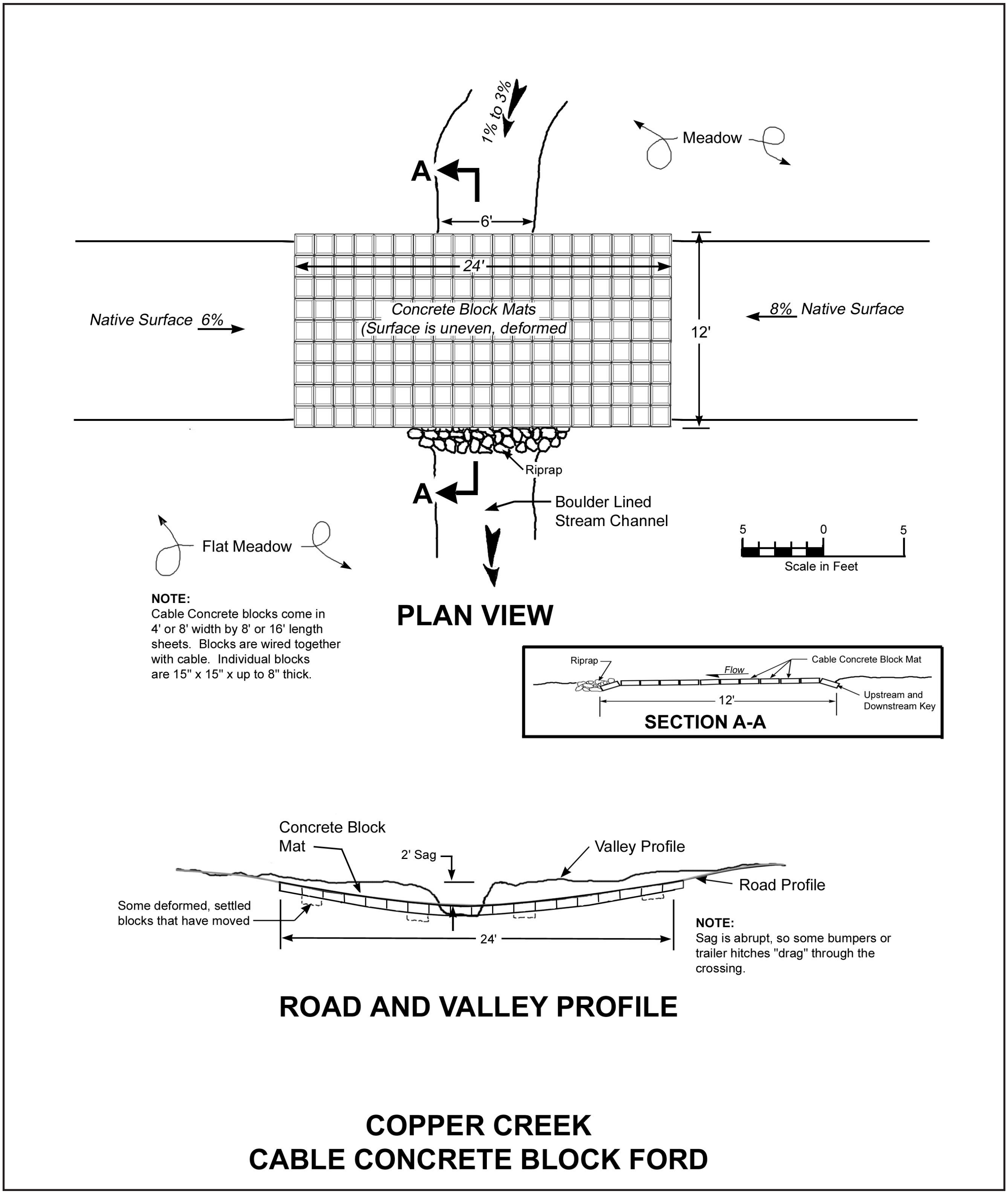

Figure A34. Copper Creek tributary site sketch.