

**Case Study 16. Sibley Creek Vented Ford**

**Location**

Washington. Mt Baker-Snoqualmie National Forest. Mt Baker Ranger District. Cascade River Road (County Road No. 15, Milepost 10.2).

**Crossing Description**

This massive vented ford was constructed in 1997, after rain-on-snow floods washed out the crossing. The stream is very steep and prone to debris torrents, and previous drainage structures have failed repeatedly over the years. The road is closed in winter, but is a major access route to North Cascades National Park, and long-term traffic interruptions (which occur when this crossing washes out) are not desirable. The structure is a large concrete edifice with three box culverts with removable concrete tops (figure A105). The design allows it to pass large rocks and debris over the top, and to withstand the high stream power at this location.



Figure A105. Sibley Creek vented ford.

**Setting**

Western Cascades Section (M242-B). Steep, highly dissected, volcanic terrain. Alpine glaciation. Silver fir and Douglas fir forest.

## Appendix A—Case Study **16**

### Why Was This Structure Selected?

A large, strong structure was needed to withstand debris flows and to pass as much debris and rock as possible. The structure must sustain battering by boulders and large wood during floods.

### Crossing Site History

Previous structures at this site have included multiple culverts, which have been washed out at least 6 times since 1960 (1962, 1976, 1988, 1989, 1990, and 1995) (figure A106). Those events had resulted in significant sediment deposition of roadfill material in coho salmon spawning areas in lower Sibley Creek, as well as temporary loss of public recreation access.



Figure A106. Two-culvert crossing on Sibley Creek blew out in November 1995.

### Road Management Objectives

The Cascade River road is a major public recreation access route to Cascade Pass in the North Cascades National Park and the Glacier Peak Wilderness area. It is a two-lane paved road to MP 5 and gravel-surfaced beyond.

### Stream Environment

**Hydrology:** The stream is perennial and the annual peak generally occurs during snowmelt in late spring and early summer. Landslides and debris torrents caused by rain-on-snow events are common in November and December. Flows estimated using regional equations for this 4.7 square mile watershed were 144, 172, and 198 cubic feet per second for the 25-, 50-, and 100-year flows respectively (Peter Wagner, design file).

**Channel Description:** Sibley Creek is a steep (approximately 25 percent), incised, Aa+ channel with a boulder-cobble substrate, low sinuosity, and no flood-plain development. The site is located near the break-in-slope between the very steep debris torrent-prone glacial valley walls and the milder mid-slope zone.

**Aquatic Organisms:** Sibley Creek is considered to be too steep to support fish at this location. Coho salmon spawning habitat is not far downstream. In this wet environment, amphibians travel overland and should not need passage through the crossing. The road is not considered a barrier to aquatic species.

**Water Quality:** This crossing has affected water quality and fish habitat in the past when roadfill material was washed downstream during floods. This massive, well-armored structure has so far prevented downstream sedimentation.

### Structure Details

**Structure:** This is a cast-in-place reinforced concrete ford with three 7-foot-wide by 5-foot-high box culverts. Together the boxes convey the 100-year flood (water only). The ford itself has a 6-percent grade on the approach slabs and is designed to convey 1½ times the 100-year event over the concrete top, in case debris plugs the inlet (figure A107). The I-beam trash rack slopes at 6:1 to allow large debris to pass over the top in case of a debris torrent (figure A108). The tops of the boxes are covered by level precast concrete slabs that can be lifted to remove smaller debris. The bottoms of the boxes are set at such a steep grade (20 percent) that high velocity water removes cement and fine aggregates until the coarse aggregates are exposed. As they are exposed, the 3-inch aggregates used in the concrete produce roughness and protect the concrete against further degradation.

**Bank stabilization and approaches:** The graveled road approaches slope at between 3 and 6 percent into the ford. Riprap was used above the inlet to stabilize the streambanks, which may erode somewhat because the structure is not aligned perfectly perpendicular to the stream (figure A109). In this location where deposition is expected during major storms, the riprap is a temporary solution until the next major event. Downstream, large rock was placed at the toe of the concrete apron to avoid undermining.

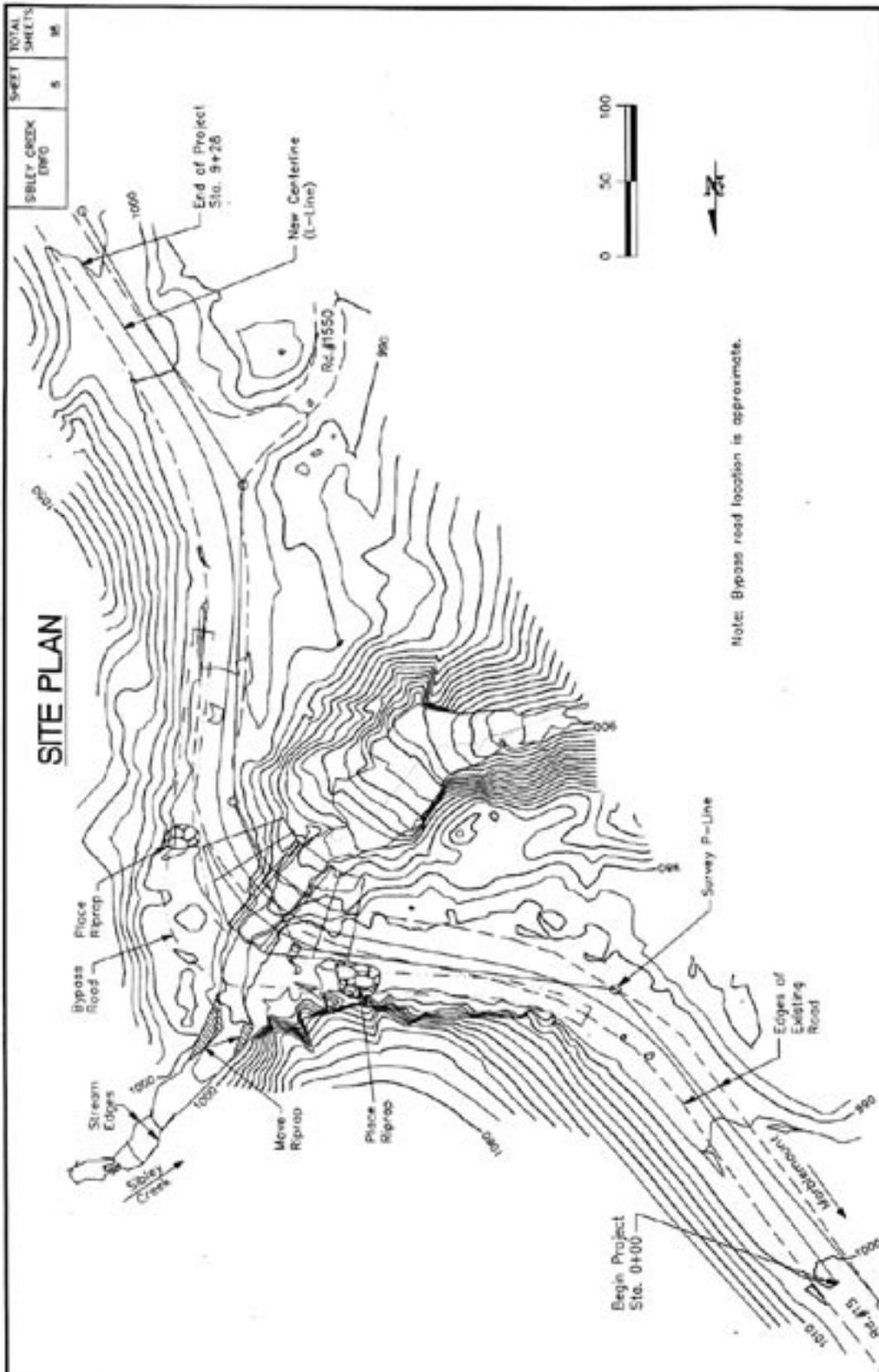


Figure A107a. Site plan map.

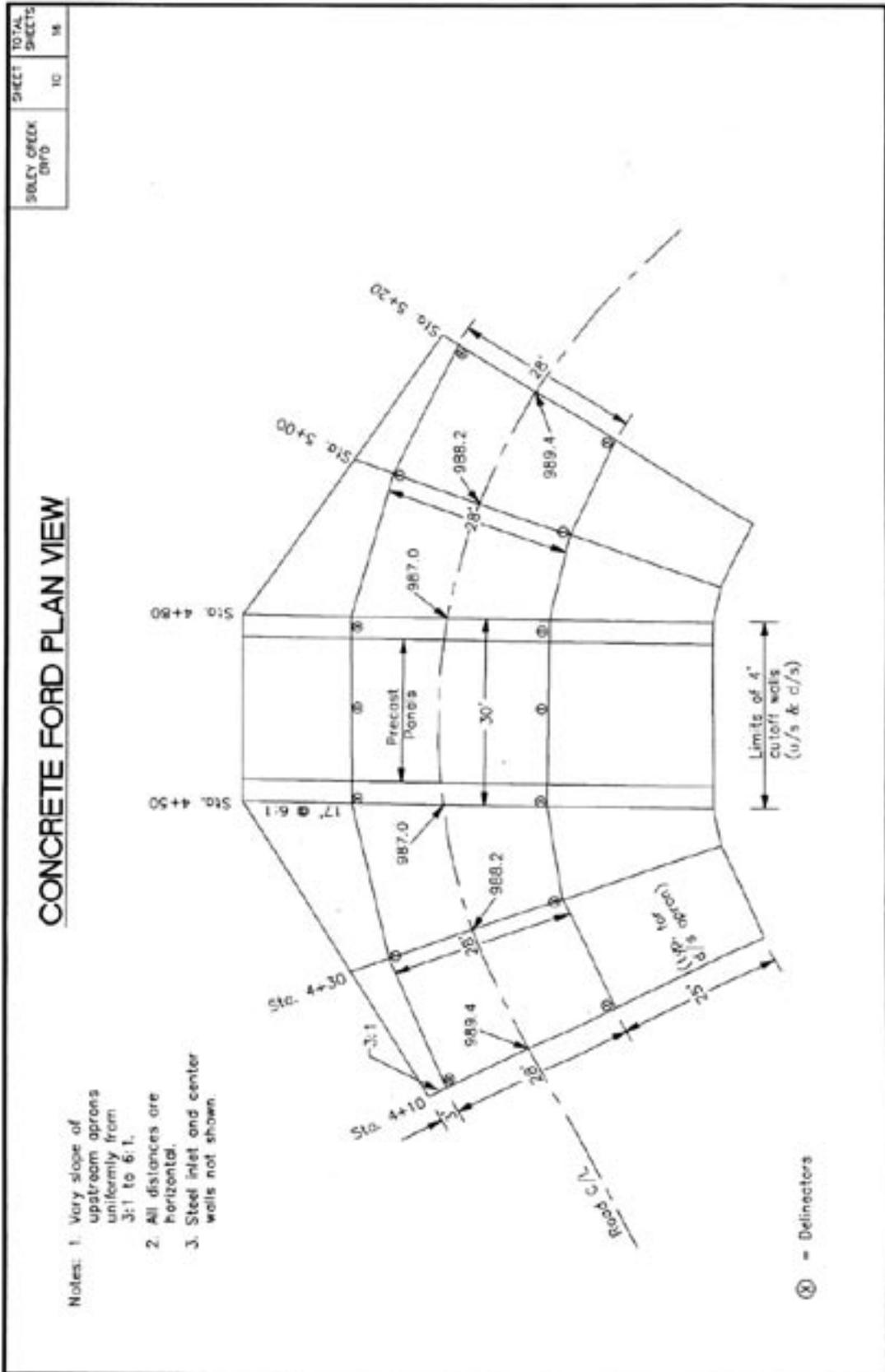


Figure A107b. Ford plan view.



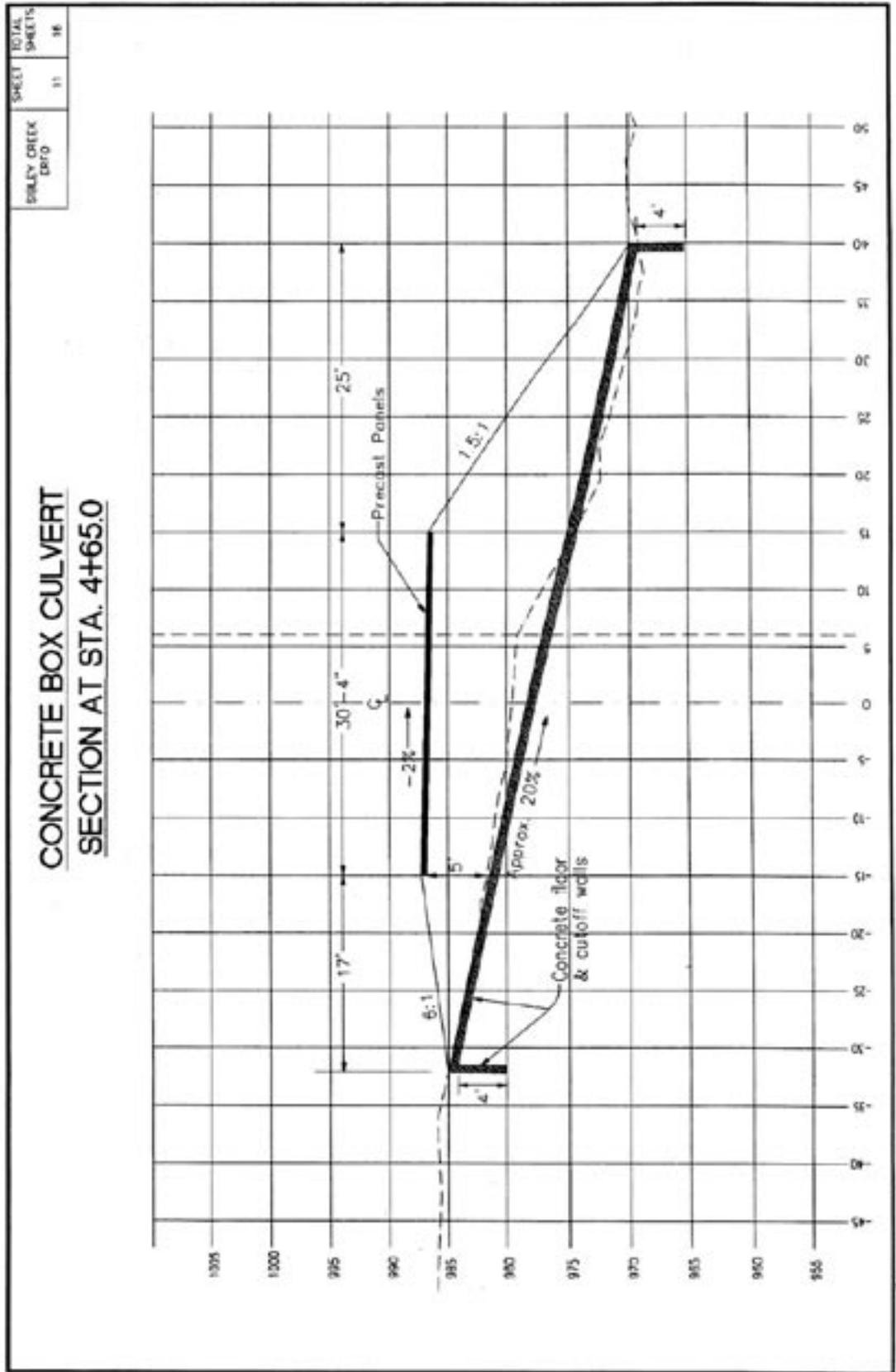


Figure A107d. Detail drawings.

**Appendix A—Case Study 16**



Figure A108. Looking downstream at the ford.



Figure A109. Sibley Creek currently approaches the inlet at a slight angle.

**Cost:** \$ 185,000 in 1997.

**Safety:** Delineator posts define the road edges and type III object markers are at both ends and both sides of the ford to focus traffic toward the road center (figure A110).



Figure A110. Safety markers on ford and approaches.

## **Flood and Maintenance History**

The only major flood event since the structure was built—in October 2003—did not cause any problem at the Sibley Creek crossing. The only maintenance that has been necessary is to clean rocks and wood off the inlet trash rack periodically. There have not been any other maintenance needs or any problems with the structure.

## **Summary and Recommendations**

It is an extreme challenge to maintain a crossing structure on a stream this steep and prone to debris torrents. After many attempts with other structure types, this massive concrete ford appears to fit the site and its geomorphic processes well. It makes every provision for debris, rock, and water passage in spite of expected blockages. Similar concrete structures are in use elsewhere on nonfishbearing streams on the Mt Baker-Snoqualmie, Gifford Pinchot, and Olympic National Forests.

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### Similar Structures In Other Locations

Wayne Hamilton, assistant forest engineer; Peter Wagner, bridge engineer; Jim Doyle, fisheries biologist (retired) and Roger Nichols, geologist provided the information for this case study.

Robert Askin (Askin 1992) describes a rockfill ford on a similar channel in the Catherine Creek watershed on Vancouver Island, British Columbia. The ford was designed for a new (1992) logging road to cross a channel that had a 27-percent slope and a serious risk of debris torrents. Objectives were to keep costs low, pass water and debris, and avoid diverting flood flows down the road. After overexcavating the channel bed below the predicted depth of scour, large riprap was interlocked to construct a foundation, and the structure was built up to grade using coarse fill materials (figure A111). The crossing surface is about 8 feet above the natural channel bed, and it is outsloped at 9 percent to permit debris to move over the surface. Low flows move either through or over the permeable ford.

As of April 2002, the ford had not been subjected to a debris flow. It was functioning well, but the original vertical curve had been compromised by road grading over the years so that a large flow might now be diverted down the road (Askin, personal communication).

Askin's 1992 paper discusses how he estimated the volume of debris that could come down in a debris torrent and be trapped behind or on the structure, and it provides details on costs and materials volumes. It is another excellent example of designing for geomorphic processes at a site.

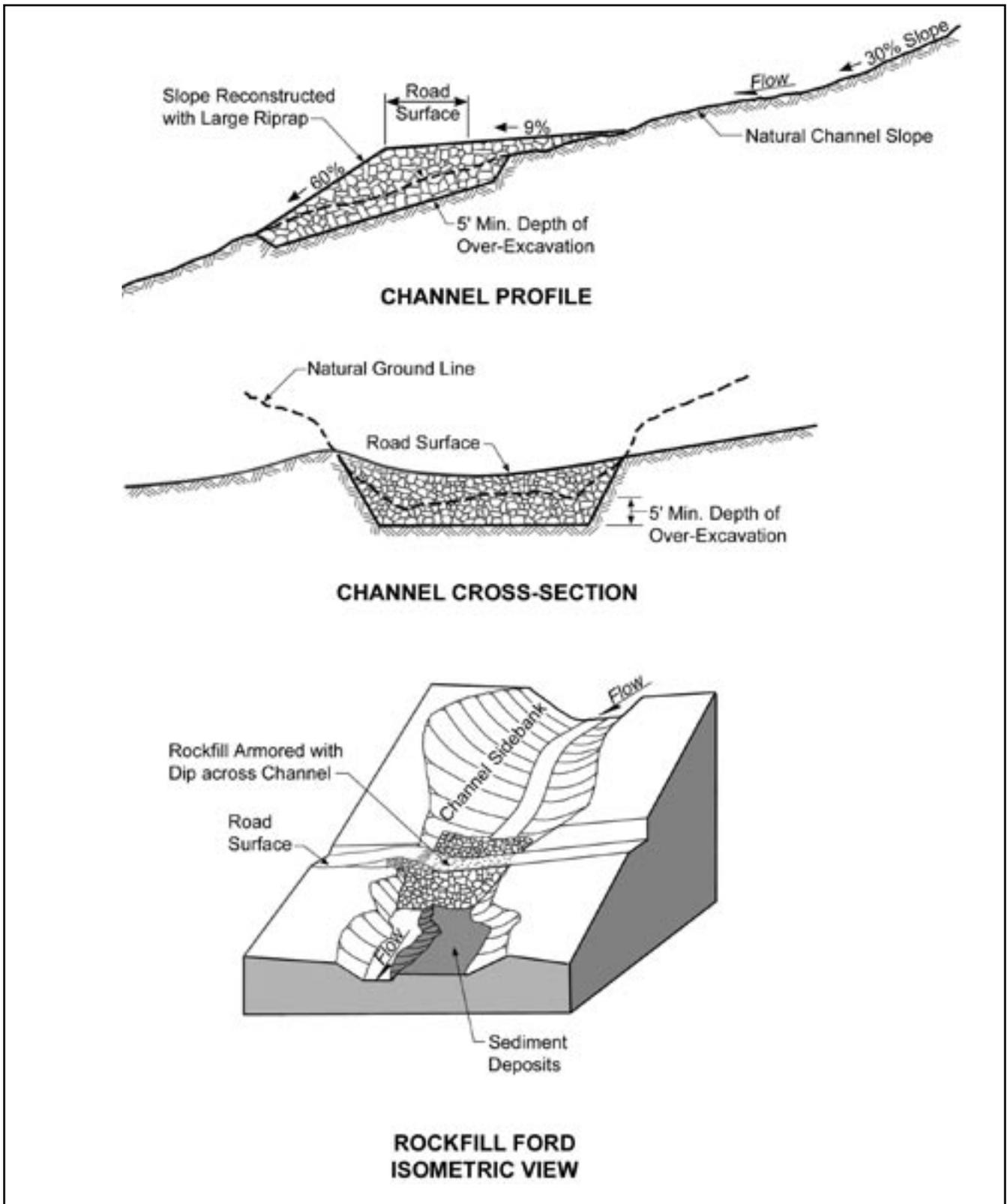


Figure A111. Stream and ford longitudinal profile, Catherine Creek, Vancouver, B.C. Redrawn from Askin 1992.

