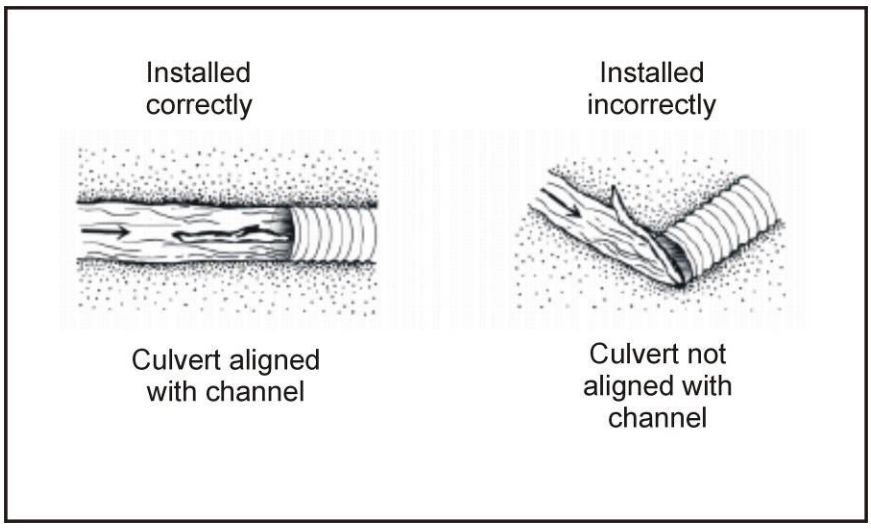


**Figure 12**. A schematic showing the proper and improper alignment for a culvert (Furniss et al., 1997).

**Figure 13.** An illustration of inlet armoring. The crossing is on a large channel and therefore requires large rock for armoring (from Keller and Sherar, 2003).

- ***If water is discharged onto the fillslope, is the fillslope adequately armored to prevent erosion?*** Fill erosion is common below shotgunned culverts (Figure 14). Rock armor on the fillslope should be of sufficient size to not be transported during the 100-year flood.

- ***Do conditions at the culvert inlet promote sediment deposition?*** For example, has the channel been widened above culvert inlet? A widened channel above a culvert inlet is referred to as a “catch basin” (Figure 15).

**Figure 14.** Picture showing inadequate armoring of fillslope below a shotgunned culvert (from Keller and Sherar, 2003). Fillslope armoring is a necessary mitigation when culverts cannot be set to grade.

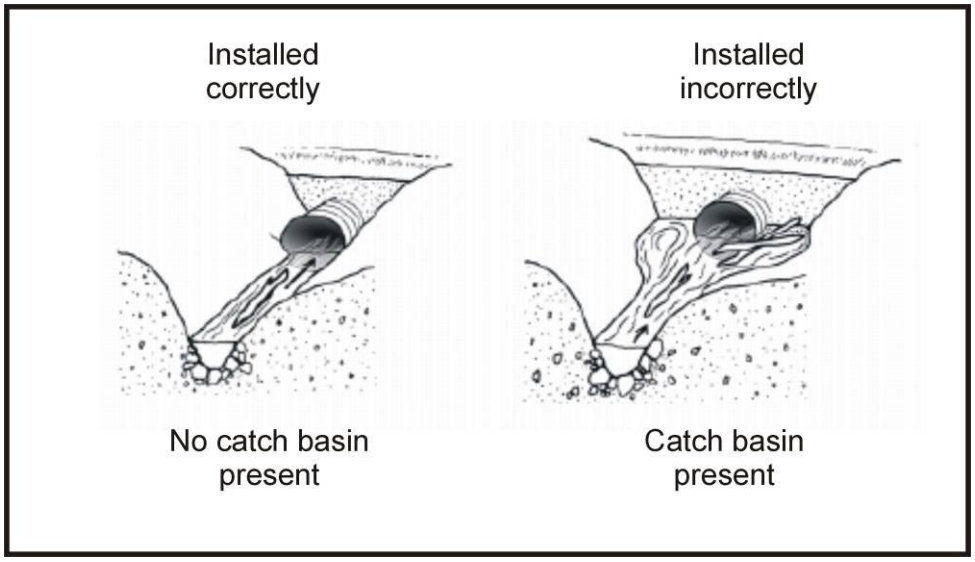


**Figure 15**. Illustration of proper and improper inlet geometry (Furniss et al., 1997)

- ***If necessary, is a critical dip present to prevent the likelihood of stream diversion?*** A properly installed critical dip, or other overflow structure, should be on the downhill side of all crossings (Figure 16). Make sure that the critical dip is built to the specifications listed in the THP, and that the outlet side of the critical dip is armored with rock sufficiently large enough not to be transported during the 100-year flood.

- ***Is road runoff disconnected before it reaches the watercourse crossing?*** For example, are waterbreaks (i.e., rolling dips or waterbars) placed on the approaches to the crossing so that runoff and sediment does not reach the watercourse (Figure 16)? It is virtually impossible to disconnect all of the road drainage from the watercourse. However, the length of road draining to the stream should be kept to a minimum.

- ***If road surfacing (i.e., rock aggregate) is to be used near or at the watercourse crossing, is it done to the specification listed in the THP?*** At the minimum, rocking should be done at the diameter, depth, and extent listed in the THP.

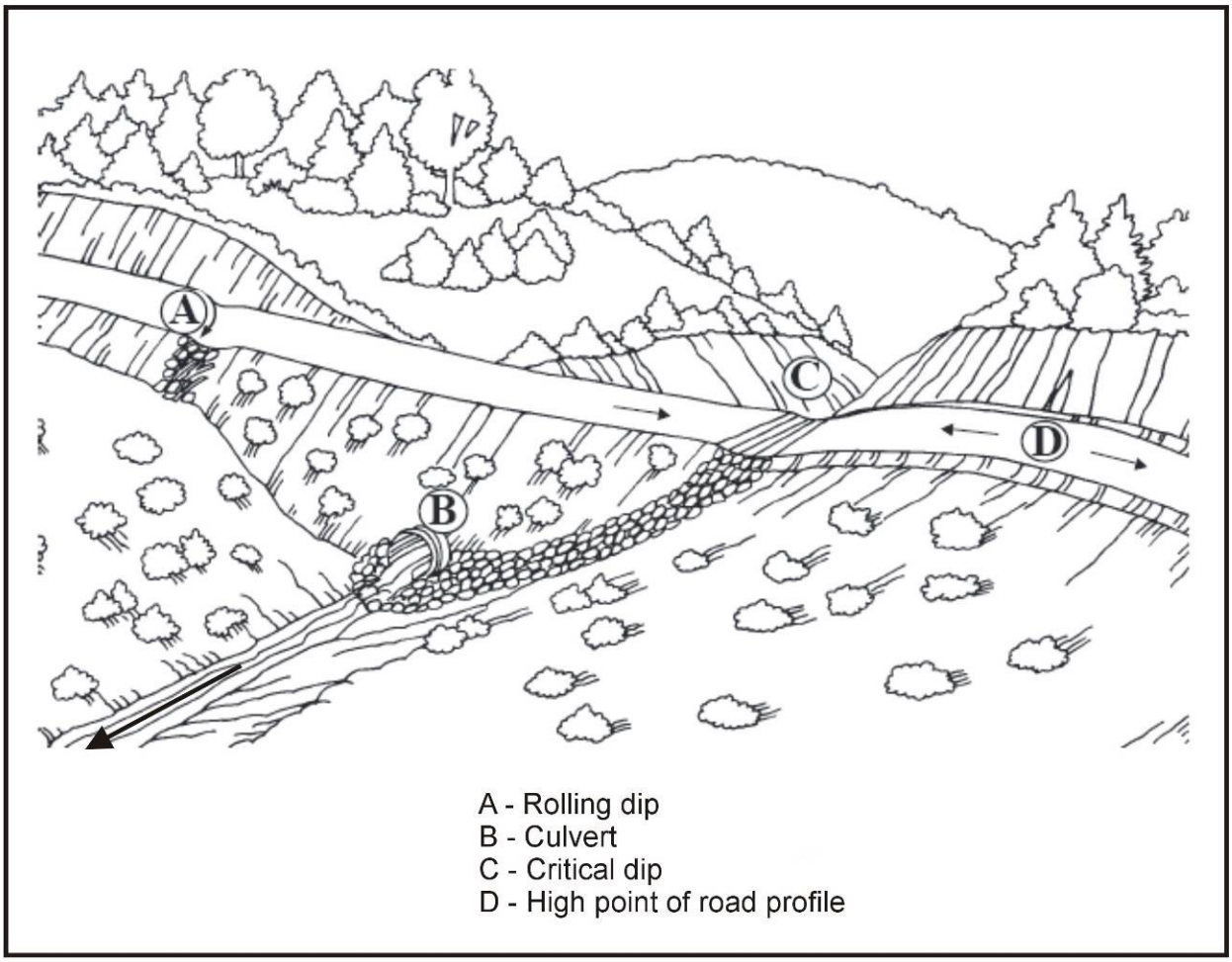


**Figure 16.** Illustration of a critical dip with rocked outfall (Point C). Arrows represent the flow of runoff. The rolling dip uphill of the crossing (Point A) helps to prevent sediment delivery at the crossing. Point D illustrates how a properly designed road can help prevent road runoff and sediment from the delivering to the watercourse (adapted from Keller and Sherar, 2003).

- **If the crossing is temporary, has the fill been excavated to form a channel that is as close as feasible to the natural watercourse grade and orientation, and that is wider than the natural channel (Figure 17)?** If all the fill material is not removed, the channel will downcut through the fill material and possibly result in significant sediment discharge. Widening the channel prevents the banks of the channel from sloughing into the channel.

- ***Has excavated material or bare soil adjacent to the crossing been stabilized as per item 18 of the THP to prevent surface erosion?*** The abandoned crossing must be stabilized to prevent sediment from entering the channel (Figure 17).

### 4.2.3. Watercourse and Lake Protection Zones and Equipment Limitation Zones

Watercourse and lake protection zones (WLPZs) and equipment limitation zones (ELZs) protect water temperature and/or filter sediment before it reaches a watercourse.

- ***Are the widths of the WLPZs and ELZs consistent with those specified in the THP?*** WLPZ and ELZ widths are based on the stream classification (i.e., Class I through IV), slope gradient (Table 1), yarding practices, and whether the watershed is listed as "threatened or impaired" (i.e., T&I).

- ***Is the canopy left in the WLPZ consistent with those specified in the Forest Practice Rules (Table 1)?***

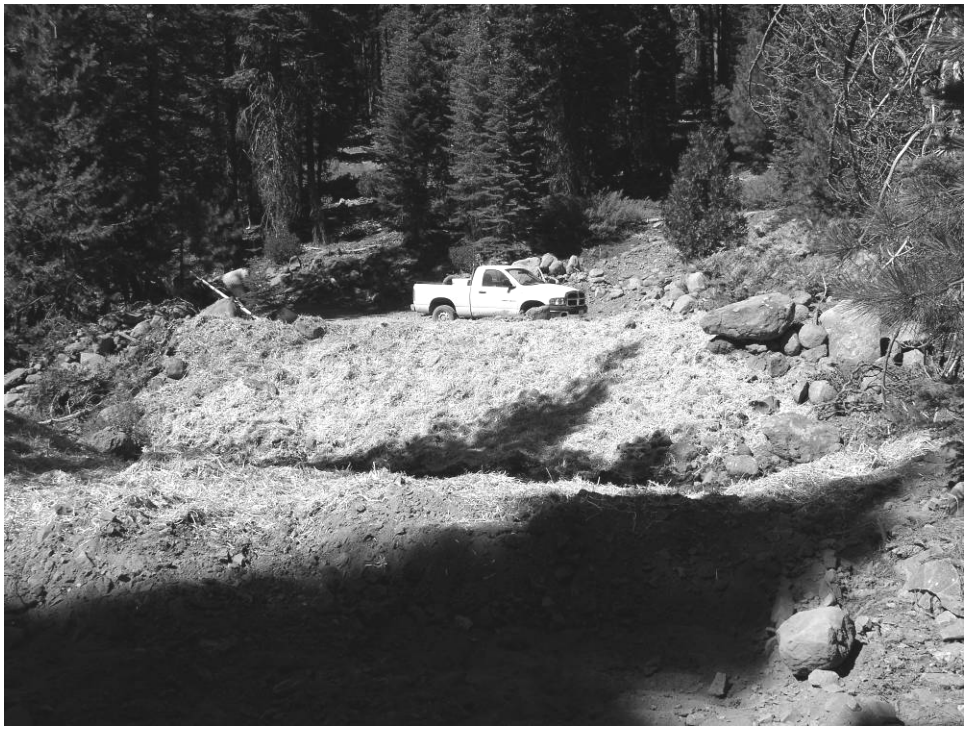

**Figure 17.** An abandoned and stabilized watercourse crossing. The culvert has been removed, and the fill has been pulled back and stabilized. The banks have been stabilized with straw mulch.

### 4.2.4. Roads and Landings

Roads and landings pose a potential threat to water quality if they are close to a watercourse or are on steep slopes above a watercourse. Impacts include chronic inputs of fine sediment and an increased potential for landsliding.

- ***If more than 100 feet of road is constructed on slopes greater than 65%, make sure that excess fill or sidecast is not placed below the road.*** Excess fill or sidecast on steep slopes can cause landsliding.

| Watercourse Classification | Slope Gradient | Buffer Width | Overstory Canopy Requirement | Understory Canopy Requirement |
|---|---|---|---|---|
| Class I | <30<br>30-50<br>>50 | 75<br>100<br>150 for tractor / 100 for cable | ≥50% | ≥50% |
| Class II | <30<br>30-50<br>>50 | 50<br>75<br>100 for tractor / 75 for cable | ≥25% | ≥25% |
| Class III | <30<br>>30 | >25<br>>50 | none | ≥50% |
| Class IV | see THP | see THP | see THP | see THP |

**Table 2.** Watercourse and lake protection zone (WLPZ) and equipment limitation zone (ELZ) widths and protection measures by watercourse classification. WLPZ and ELZ widths and protection measures might be different if the watershed is listed as "threatened and impaired" (see section 916.9 of the California Forest Practice Rules).

- ***Make sure that waterbreaks on road are at the correct spacing and are properly constructed.*** Waterbreak spacing for roads is based on the steepness of the road and the estimated erosion hazard rating (Table 2; Figure 18). Site-specific recommendations on waterbreak spacing may also be listed in Section II, Item 25 of the THP. Waterbreaks should be at least 12 inches in height.

**Table 3**. Waterbreak spacing by erosion hazard rating and road/skid trail gradient

| Erosion Hazard Rating | Road or Skid Trail Gradient (%) | | | |
|---|---|---|---|---|
| | <10 | 11-25 | 26-50 | >50 |
| Extreme | 100 ft | 75 ft | 50 ft | 50 ft |
| High | 150 ft | 100 ft | 75 ft | 50 ft |
| Moderate | 200 ft | 150 ft | 100 ft | 75 ft |
| Low | 300 ft | 200 ft | 150 ft | 100 ft |

- ***If road construction results in excess material (i.e., fill or sidecast), is the excess material deposited and stabilized so that it poses a minimal risk to***

***water quality.*** If it poses a risk to water quality, excess material from road construction and grading should be stabilized. This may include mulching the excess material with straw or slash, sloping back the excess material to a stable angle, or hauling the excess material to a location that is stable, well drained, and isolated from wet areas or watercourses.

- ***If drainage structures and drainage facilities on logging roads discharge runoff onto erodible fill or soils, make sure that energy dissipators are placed below the road drainage outlets so that sediment transport is minimized.*** The placement of energy dissipators is most important when roads are within 300 feet of a watercourse and if long stretches of road are being drained onto the hillslope.


**Figure 18.** A picture of a rolling dip on an outsloped haul road. Arrows represent the flow of runoff (from Keller and Sherar, 2003).