After the Fire

Storm Proofed Roads

Roads are storm-proofed when runoff and sediment delivery to streams is strictly minimized. This is accomplished by dispersing road surface drainage, protecting stream crossings from failure or diversion, and preventing failure of unstable cutbanks or fillslopes from delivering sediment to a stream.

For typical drawings and more information related to road storm proofing visit: NapaWatersheds.org/Roads

CHECKLIST

Stream Crossings

- ✓ Ensure that culvert inlet, outlet, and bottom are open and in sound condition.
- ✓ Ensure that any plastic culverts have not melted due to exposure to heat.
- ✓ Ensure that culverted stream crossings have no diversion potential (functional critical dips in place).
- ✓ Ensure that culverted stream crossing inlets have low plug potential (single-post trash rack). You should expect streams to flow with more debris than has been previously observed.
- ✓ Ensure that bridges have stable, non-eroding abutments. Check the decking as well as the underside of wooden brigs for any significant damage.

Cutbanks and Fillslopes

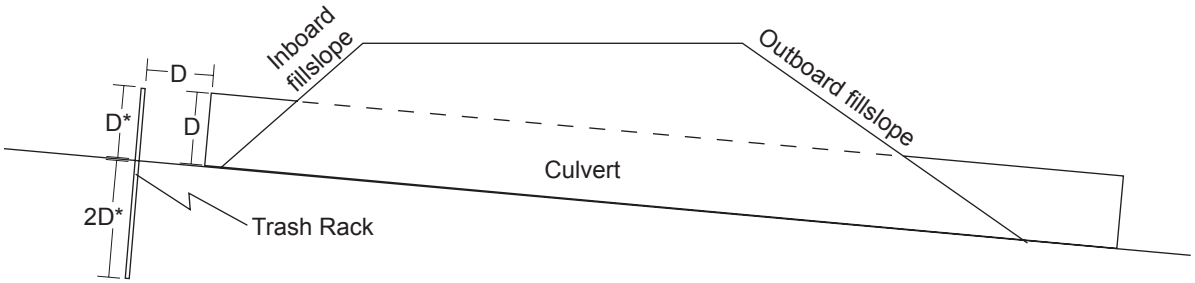
- ✓ Monitor cutbanks and fillslopes for slumping, rock falls, or other landsliding. These areas may become more unstable due to lack of vegetation.
- ✓ Excavated soil should be placed in locations where it will not enter a stream.
- ✓ Excavated soils should be placed where it will not cause further slope failures or landslides.
- ✓ Unstable soils may be too saturated to excavate during the rainy season so treatments may have to wait until dryer time of year.
- ✓ Monitor access and carry a chainsaw - fire-damaged trees may fall on road surface throughout winter.

Road Surface Drainage

- ✓ All road surfaces can be storm proofed by implementing a variety of surface drainage techniques including construction of rolling dips and /or waterbars, and berm removal.
- ✓ Ditches and cutbanks can be storm proofed by frequently draining them with rolling dips or waterbars &/or ditch relief culverts. Ensure that these features do not discharge to streams or onto active (or potentially active) landslide areas.
- ✓ Monitor outflow from rolling dips, waterbars, and ditch relief culverts during the rainy season.
- ✓ Watch for gully development along the outside edge of the road throughout the rainy season. If gullies do develop then dewater them to best extent possible.

Typical Design of a Single-post Culvert Inlet Trash Rack

Cross section view



D - Culvert diameter

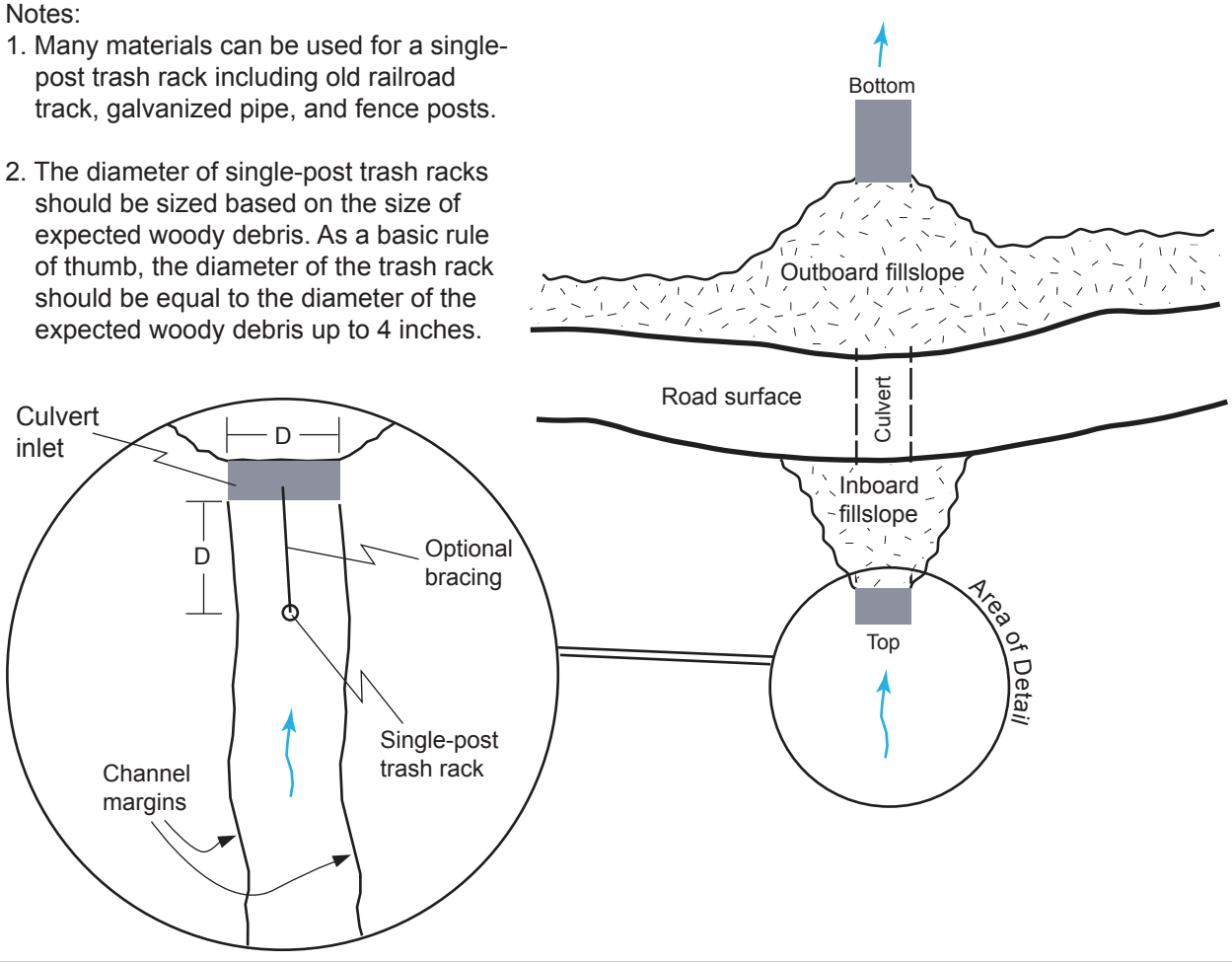
D* - If the culvert is designed for the 100-year peak storm flow, the trash rack height above the streambed should equal D.
If the culvert is undersized, then the trash rack needs to be extended vertically above the streambed to match or exceed the expected headwall height.

Plan view

Notes:

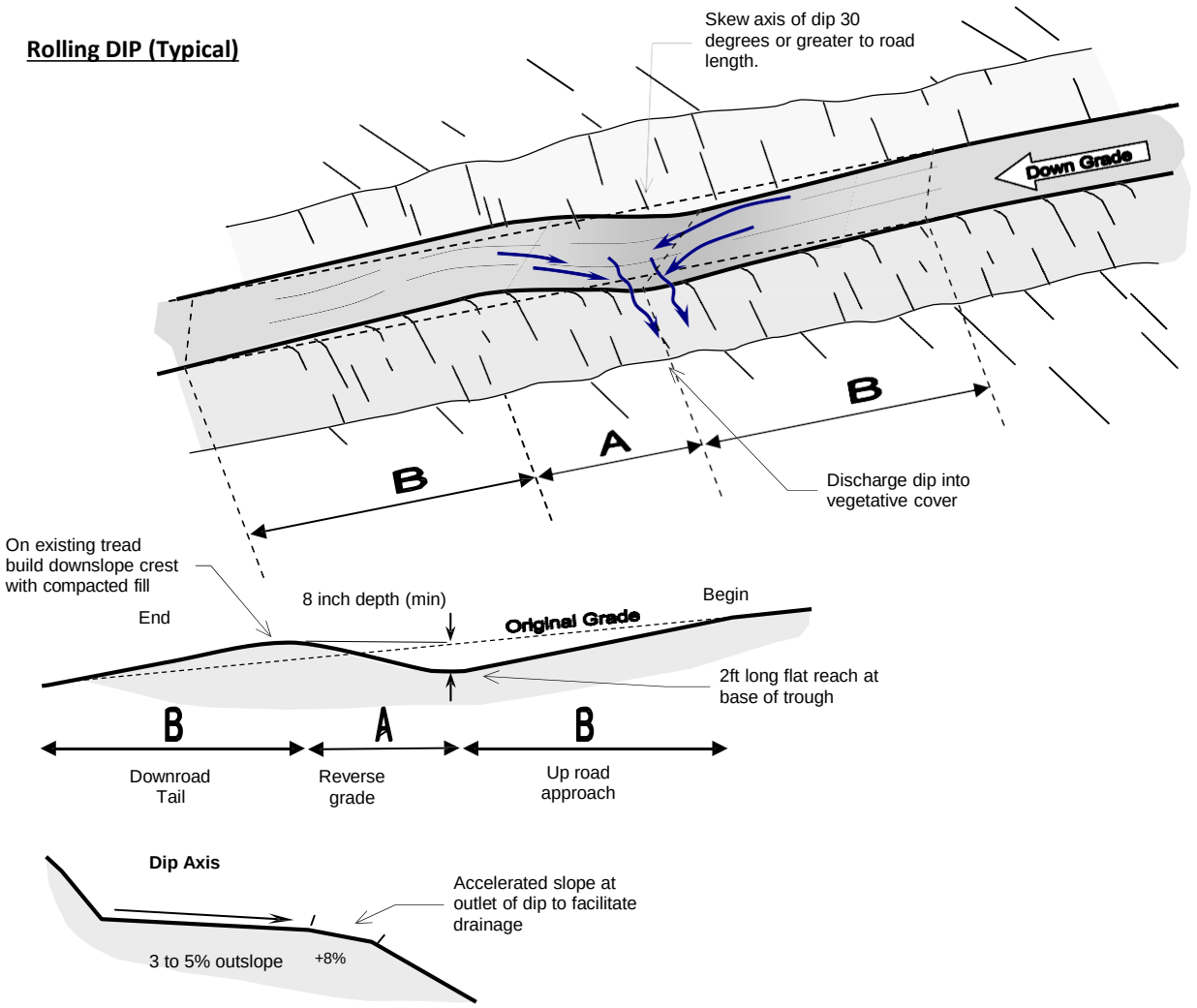
1. Many materials can be used for a single-post trash rack including old railroad track, galvanized pipe, and fence posts.

2. The diameter of single-post trash racks should be sized based on the size of expected woody debris. As a basic rule of thumb, the diameter of the trash rack should be equal to the diameter of the expected woody debris up to 4 inches.



Pacific Watershed Associates Inc.
Geologic and Geomorphic Studies • Watershed Restoration • Wildland Hydrology • Erosion Control • Environmental Services
PO Box 4433, Arcata, CA 95518 / Ph: 707-839-5130 / FAX: 707-839-8168 / www.pacificwatershed.com

Rolling DIP (Typical)



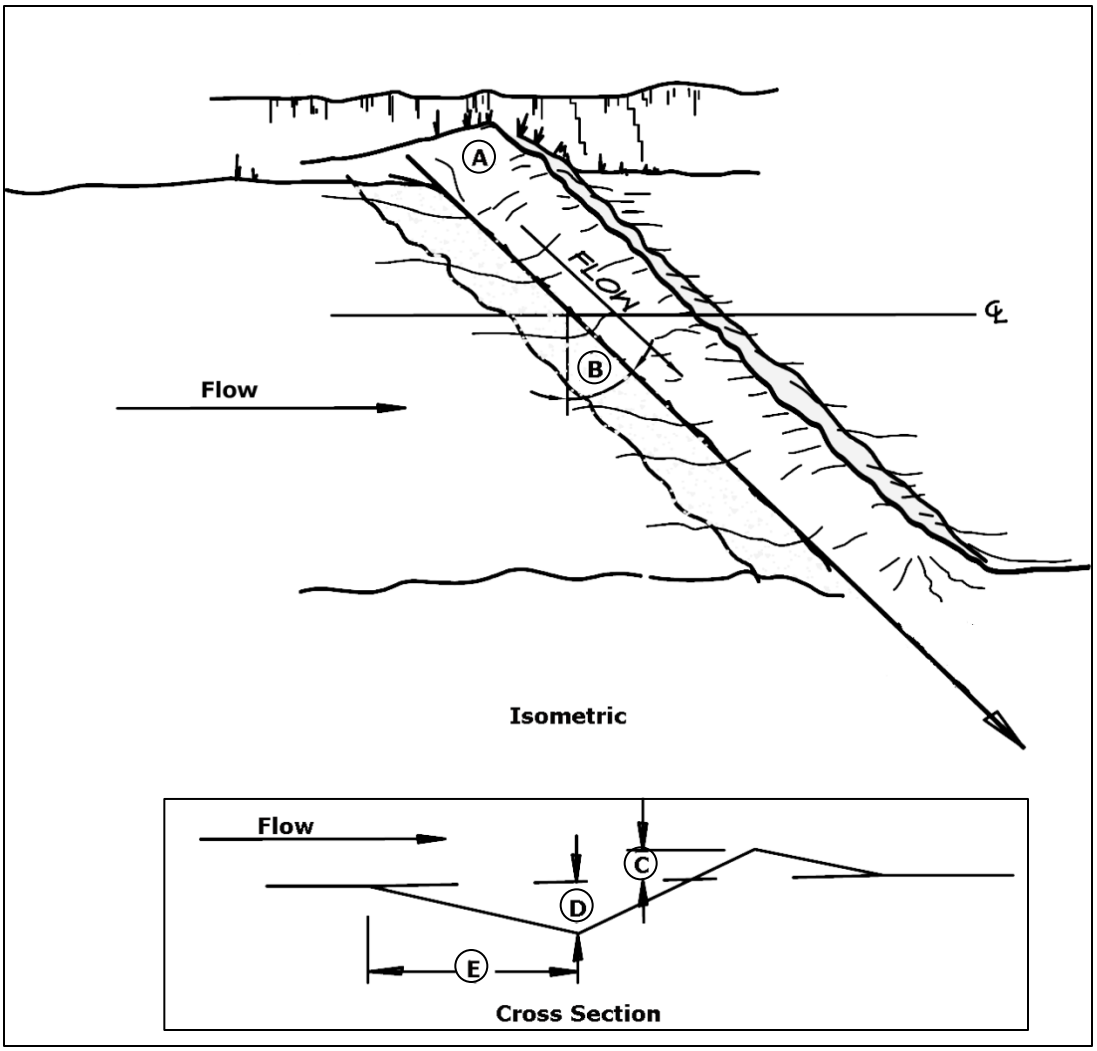
ROAD GRADE (%)	TROUGH	A: REVERSE GRADE	B: UP ROAD APPROACH DOWN ROAD TAIL	
	Minimum depth below downslope crest	Minimum distance and grade from trough axis to downroad crest (ft)	Distance from up-road start of rolling dip to trough axis (ft)	Grade (%)
<5%	8 inches	15 feet at 5%	50	10%
10%			50	15%
15%			30	20%
>15%		7 feet at 10%	30	25%

Rolling dip instructions:

- A rolling dip is a long, permanent dip constructed into native soils. The dip can be constructed to drain the inboard ditch or just the road surface.
- On existing roads the cut of the dip should start 30-50 feet upslope of the trough, with an outslope of 2-4%.
- Dip axis should be skewed down road at 30 degree off of centerline of road length – this will facilitate in efficiently draining the road without buildup of sediments in trough and makes the dip more drivable (i.e. the "roll" of the dip)
- The trough of the dip should be outsloped 3-5% with a flat reach of 2 feet.
- The reverse grade of the dip shall generally be sloped 5% for a minimum of 15 feet to form a minimum 8 inch deep dip. Road surface, where fill material will be placed, should be ripped first to ensure fill material interlocks with existing tread.
- The crest of the reverse grade should be a 2 foot long flat reach and the fill material should continue for a minimum of 30-50 feet before tapering to original grade.
- On roads steeper than 15% a steeper/shorter reverse-grade dip may be required.
- Dips shall be placed as specified in the plans. If not specified, then dips shall be placed at maximum 150-200 foot spacings.

Typical Drawing #11b

Typical Road Surface Drainage by Waterbars



Waterbar installation:

1. Waterbar construction for seasonal use roads. Specifications are average and may be adjusted to conditions.
2. Ⓐ tie-in cut and berm to cutbank.
3. Ⓑ angle waterbar 30^0-40^0 downgrade with road centerline.
4. Ⓒ berm height should be 4”-6” above the roadbed.
5. Ⓓ cut depth should be 4”-6” into roadbed.
6. Ⓔ approach should be 3’-4’ length.

Waterbar spacing: 1,000/slope gradient
Example: @20% slope waterbar spacing =1,000/20=***50 feet***

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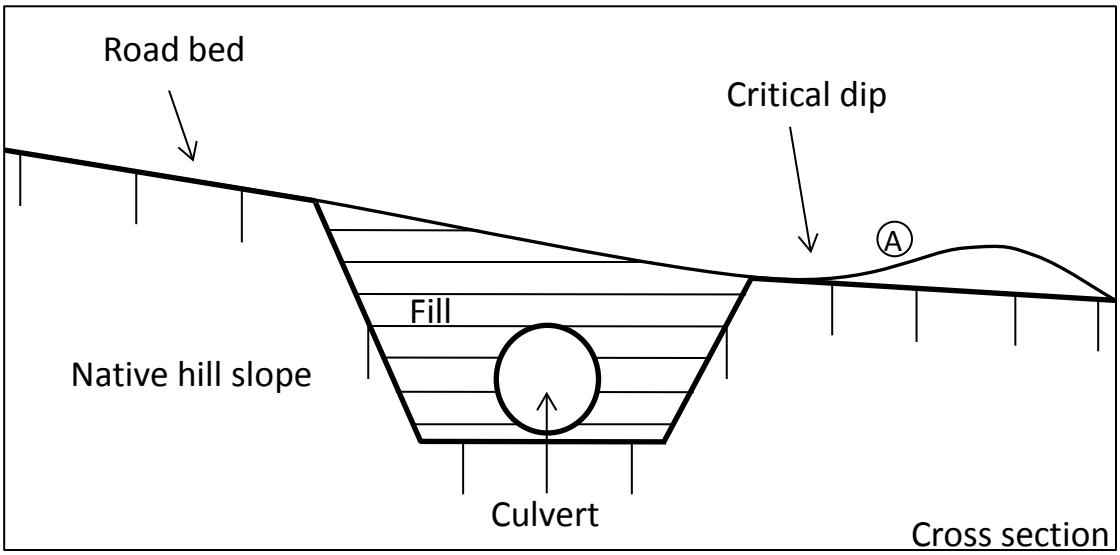
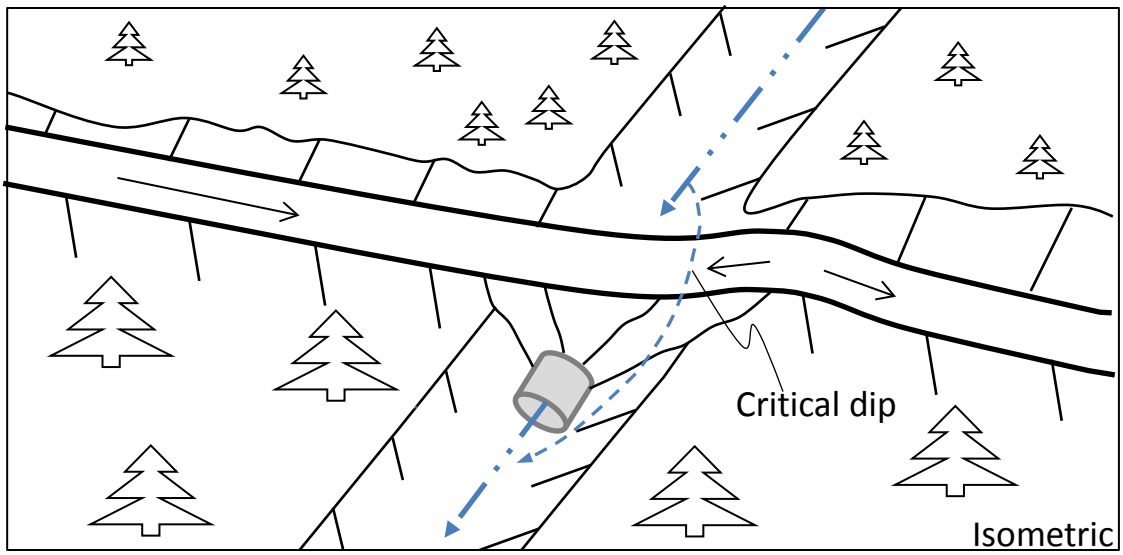
Typical Drawing #21

Typical Critical Dip Design for Stream Crossings with Diversion Potential





Critical Dip Construction:

1. Critical dip will be constructed on the lower side of crossing.
2. Critical dip will extend from the cutbank to the outside edge of the road surface. Be sure to fill inboard ditch, if present.
3. Critical dip will have a reverse grade Ⓐ from cutbank to outside edge of road to ensure flow will not divert outside of crossing.
4. The rise in the reverse grade will be carried for about 10 to 20 feet and then return to original slope.
5. The transition from axis of bottom, through rising grade, to falling grade, will be in the road distance of at least 15 to 30 feet.
6. Critical dips are usually built perpendicular to the road surface to ensure that flow is directed back into the stream channel.

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Typical Drawing # 1c