



Course 201. Drainage Design & Drain Dips

STUDENT SKILL OUTCOMES:

- A basic understanding of hillside hydrology, drainage principles, and how trails should work.
- How to identify the best location and construct new drain dips on existing eroded trails.
- Developing “trail eyes” and an eagerness to hike on a rainy day to learn to “think like water.”

KEY TERMS:

Drain Dip: (aka **dip, drainage dip, earthen water bar,** and **rolling grade dip;** a close cousin but different from a **grade dip, Coweeta dip, knick, swale** and **bleeder**) A broad, gradual excavated trail feature to shed water off the trail at regular intervals to prevent tread erosion by interrupting the normal grade of a section of trail. Soil excavated is mounded and compacted down the trail from the dip. Ideally 15-30' long and 8-12" deep. To withstand horse use, drain dips should only be built in very durable soil with trail grades below 10-12%, ideally in the late fall when the soil is moist and just before winter, allowing snow to compact the dip before use in the spring.

Grade Reversal: regular ups and downs designed into a trail alignment is the best way to shed water from a new trail. Such ups and downs can be added to an existing trail with great labor by constructing water bars and drain dips (aka **rolling grade dip**).

Hillside hydrology: generally describes how water from rain, melting snow, and seeps travels down natural slopes. Here we are especially concerned with how such water interacts with trails. Troy Parker uses the additional term, “tread watersheds”, to describe the subsections of a hillside that shed water to a particular piece of trail between two drainage structures.

(Rock or Log) Waterbar: (aka **(rock or log) reinforced drain dip**). As constructed by the PCTA, this trail drainage structure includes a drain dip reinforced by a peeled log or row of large rocks. The reinforcing log or rocks are buried securely at about a 45 degree angle across the tread and 36" down the trail from the bottom of the dip—thus water leaves the trail well before it reaches the log or rocks. Waterbars

are generally required on trail grades in excess of 15%, rather than drain dips. See also, “Old School Waterbar.”

KEY CONCEPTS:

- 1) Safety Documents and Concerns: Personal Protective Equipment (PPE), Job Hazard Analysis (JHA)/ Tailgate Safety Session (TSS), Emergency Action Plan (EAP)
- 2) Trail Crew Leave No Trace: Have a positive impact on the land through trail work and be sensitive to off trail and camping impacts.
- 3) Proper/ Improper Tool Care and Use:
 - Fire shovel, McLeod, adze hoe, Pulaski, Rheinhard
- 4) Hillside Hydrology/ How Trails Work:
 - Effects of water in diverse soil types
 - Out-slope and sheet flow
 - Trail grade and cupped tread
 - Grade reversals and drainage structures
- 5) Develop “Trail Eyes”:
 - Suggest hiking in rain to better understand water on trails
 - Notice every drainage, even disappearing ones
- 6) Locating New Drain Dip Sites:
 - Locate areas of erosion, fix any existing dips, reevaluate
 - Berm and slough removal vs. new drainage structure
 - Trail conditions for a new drain dip
 - Grade less than 10%, moist durable soil, avoid top or bottom of hill
 - Spacing between drainages determined by grade, soil, volume of water
 - Trail conditions that call for reinforcement of the dip with rock or log (Waterbars are covered in Course 203)
- 7) Constructing New Drain Dips:
 - Build a broad gradual apron
 - 20 – 30' in length
 - 15% or greater out-slope to help self clean
 - Excavate a 24" wide outfall ditch
 - Extend below tread as far as you need to keep water off trail
 - Pack soil VERY well
 - Test drainage with tennis ball
- 8) Report Work Promptly

Figure 1. Trail Structure Terms (IMAGE COURTESY OF THE SCA)

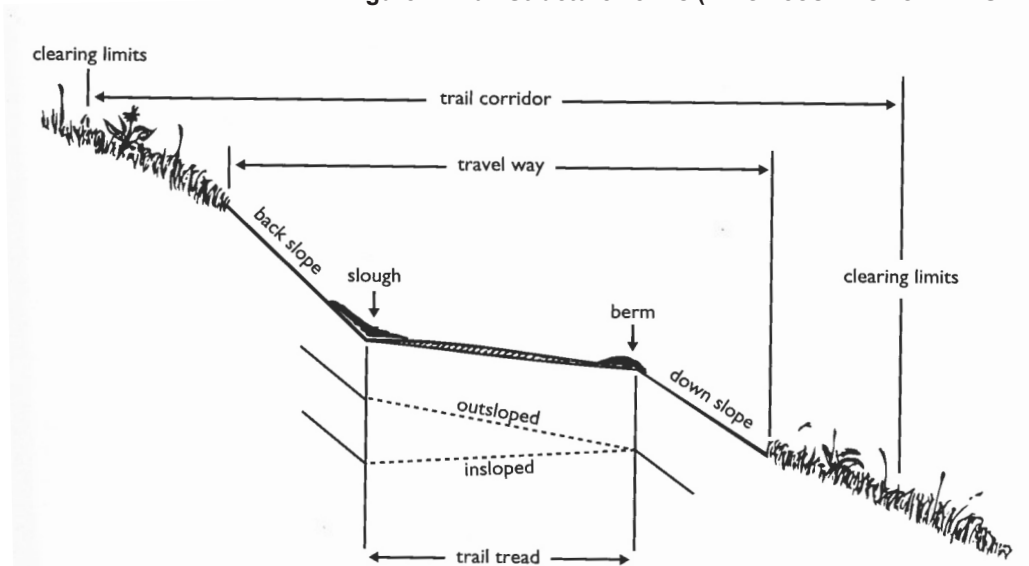


Figure 2. Check Dam (IMAGE COURTESY OF USFS)

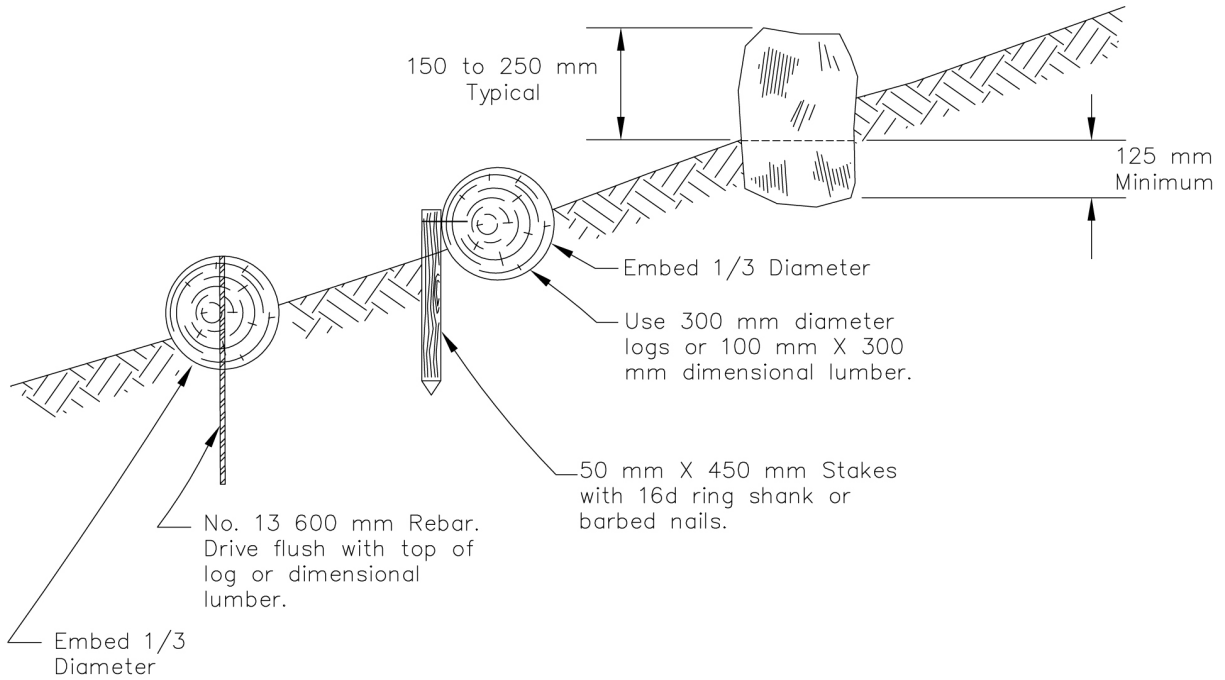


Figure 3. Frequency of Grade Reversals or Cross Drains

Source: Forest Service Trails Handbook 2309.18, Chapter 3,
Trail Preconstruction & Construction

Material Type	Grade (percent)						
	2	4	6	8	10	12	15
Loam	350'	150'	100'	75'	50'	*	*
Clay-Sand	500'	350'	200'	150'	100'	50'	*
Clay or Clay-Gravel	-	500'	300'	200'	150'	100'	75'
Gravel (rounded rock)	-	-	750'	500'	350'	250'	150'
Shale or Angular Rock	-	-	800'	600'	400'	300'	250'
Sand	Varies with local amounts of fine clay and silt. Drainage diversions generally are not required in "pure" sand because of the fast rate of water absorption. For sand with appreciable amounts of fine binder material, use "clay-sand" distances as shown above.						

* Grades not recommended in this material.
- Generally no diversion required for soil stability.

Figure 4. Rolling Drain Dip. In this case the dip is armored with rock (optional), making it a Modern Waterbar

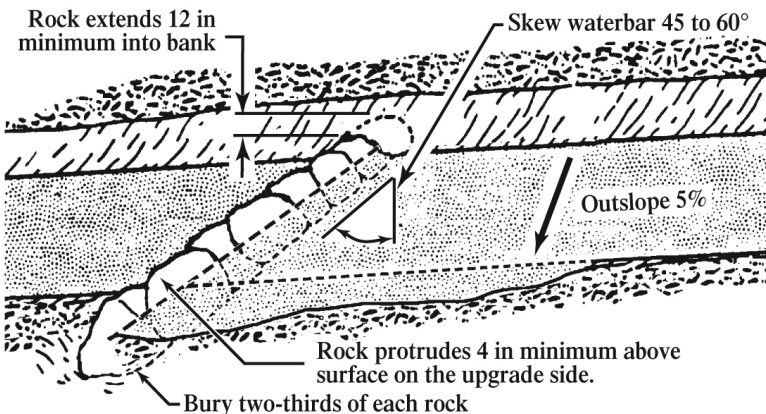
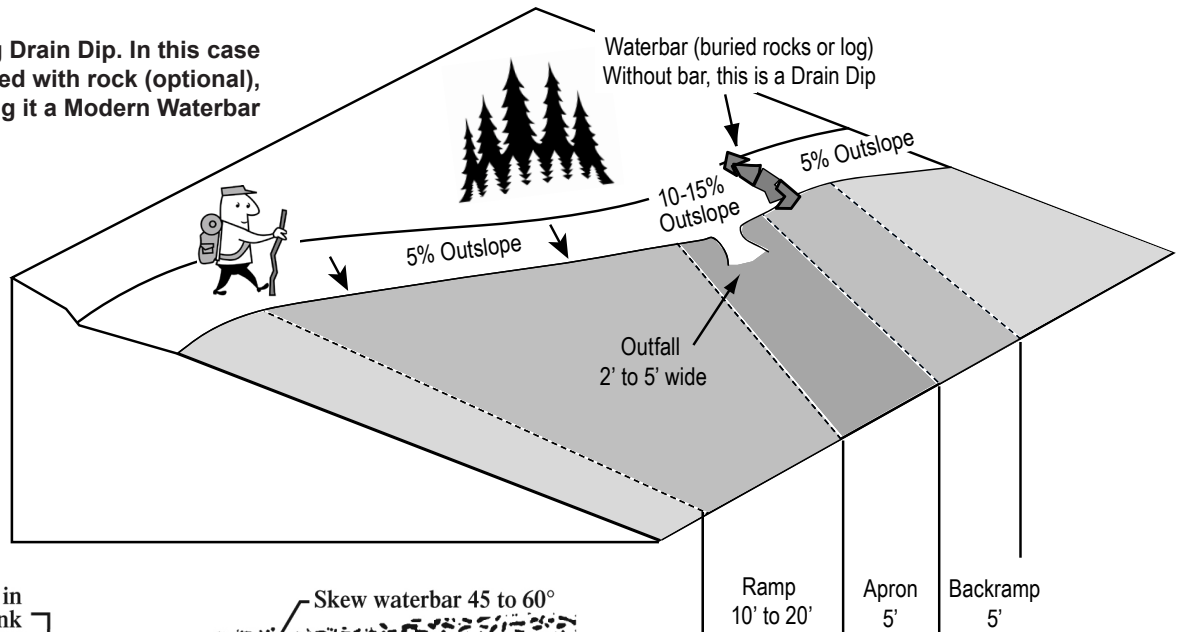


Figure 5. "Old School" rock water bar. (IMAGE COURTESY OF THE USFS)