

This document is reproduced with permission from
California State Parks and Rec



TRAIL SHORTS

A Cursory Look at Trail Maintenance

INTRODUCTION

This document focuses on wilderness trails only and is intended to be used as a reference by trail maintenance crews. If you have questions about the contents, please do not hesitate to contact Clay Phillips at the Southern Service Center of California State Parks at (619) 220-5303.

Trail construction and maintenance is an inexact science with many variables. Much depends on the location of the trail, the soil, the climate, and the types of uses. However, there are certain general guidelines which, if adhered to, will prevent most trail deterioration and minimize maintenance costs.

Trail Problems

Trail users may not be able to articulate what a "perfect" trail looks like, but almost everyone can list the characteristics of a "bad" trail:

1. **Deep Trenching** - The trail is sunken such that hikers feel like they're walking in the bottom half of a pipe and equestrians drag their spurs.
2. **Widening** - The trail has widened from a single or double track to an unsightly wilderness "freeway" of multiple parallel tracks, all trenched to a different degree.
3. **Short Cuts** - Knowing that the shortest distance between two points is a straight line, users create a web of trails, most of which are steep and erosive.
4. **Tripping Hazards** - Regular use and erosion ultimately expose tree roots and rocks.
5. **Steepness** - If a trail is too steep over a long distance one of two things will happen: either people won't use it, or users will not enjoy their excursion.
6. **Impact to Natural / Cultural Resources** - Erosive trails and multiple trails compound the impact that trails have on rare plants and on archaeological sites.

Causes

All of these problems can be tied to one or more of the following three causes:

1. **Water** is the foremost cause of trail problems. The movement of water causes erosion and deep trenches. It also exposes tripping hazards.
2. **Poor Initial Trail Design** can rarely be overcome, even by regular maintenance.
3. **Inadequate or Inappropriate Maintenance** wastes valuable crew time and can sometimes increase trail problems.

DESIGNING FOR TRAIL MAINTENANCE

Ultimately, the most influential component of trail maintenance is the original trail design / alignment. A well-designed trail will be easier to maintain, will deteriorate more slowly and will be more pleasant to use. On the other hand, a poorly-designed trail is difficult to maintain, deteriorates quickly and, once you lose it, there's not much that can be done to restore it. In addition, a poorly designed trail will always be less pleasant to hike or ride.

Elements of a Well-Designed Trail

There are many factors which go into a well designed trail; here we will only look at the elements required from a maintenance perspective.

1. Gradient

Generally, the linear gradient of a trail should be less than 10%. The term "gradient" refers to the ratio of the rise over the run. In other words, an elevation gain of 2 feet in 20 horizontal feet represents a 10% gradient.

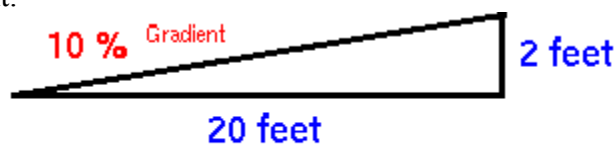


Figure 1

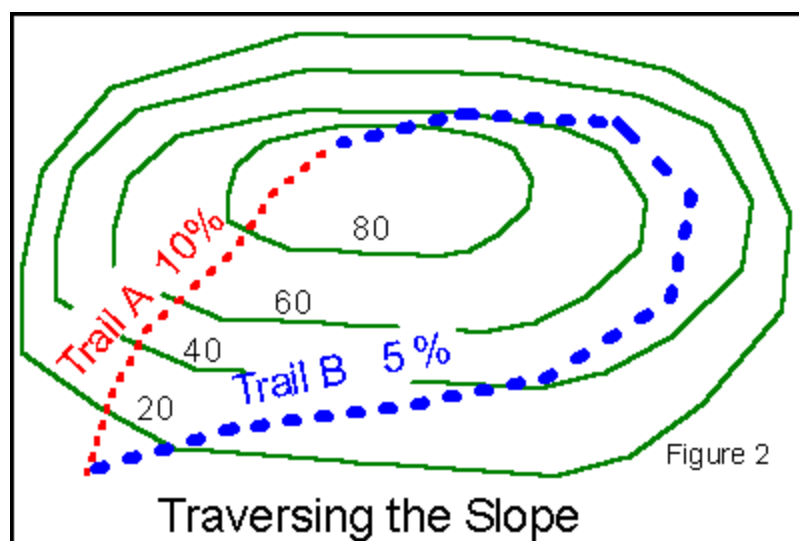
Ten percent is a good standard, but circumstance may warrant a greater or lesser gradient.

In highly erosive, sandy soils, a 5% slope may be excessive. Granitic soils are more forgiving and can allow long sections of trail to be constructed at 13 to 15%. It is best to look at existing trail conditions and measure gradients to determine what maximum gradient works best in each unique condition. However, it should be noted that trails less than 10% are far more comfortable to hike and ride. The soils may allow for a trail that exceeds 10%, but the users might not!

2. Relationship to Existing Contours

In map jargon, a contour is a line of points that are at the same elevation. If you walk precisely parallel to a contour, you are walking at a level (0%) grade. If you walk perpendicular to a contour, you are walking either straight uphill or straight downhill. A well-designed trail is laid out to traverse a hillside, closer to parallel than perpendicular to the contours.

The figure below shows two proposed trail routes to the top of the hill. Although Trail A stays within a gradient of 10%, it is the poorer route because it travels perpendicular to the contours. When a trail runs perpendicular to the contours, water runs down the middle of the trail, causing trenching, even at a 10% gradient. The only way to get water off the trail is for the route to **traverse** the natural slope (Trail B), because then there is always a lower side of the trail. When there is a lower side of the trail, it becomes a simple matter to redirect water across and off the trail, rather than allowing it to cut a channel down the trail's centerline.



3. Outslope

A well-designed trail should be constructed to have a 3% to 4% cross-slope to get the water off the trail as soon as possible. This explains why it is difficult to construct an effective trail in a flat meadow. You can not merely cut out sod and call it a finished trail. It will always be easiest to construct an outsloped trail if the original trail alignment traverses the natural slope as in Trail B, above.

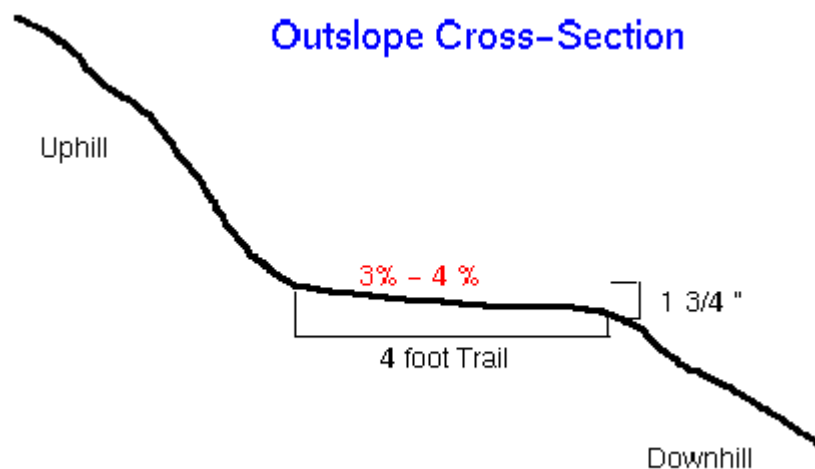


Figure 3

4. Avoid Switchbacks

A "switchback" is any place where the alignment of a trail traverses a slope in one direction and then abruptly "switches back" toward the opposite direction. Switchbacks are often used to run a trail up a steep slope in a constrained location. Although switchbacks are often the only solution to the problems of rock outcrops and steep slopes, they should be avoided where possible. Unless they are perfectly designed and constructed, switchbacks present an irresistible temptation to shortcut the trail and cause erosion over a web of indiscriminantly created volunteer routes.

KEY ELEMENTS OF TRAIL MAINTENANCE

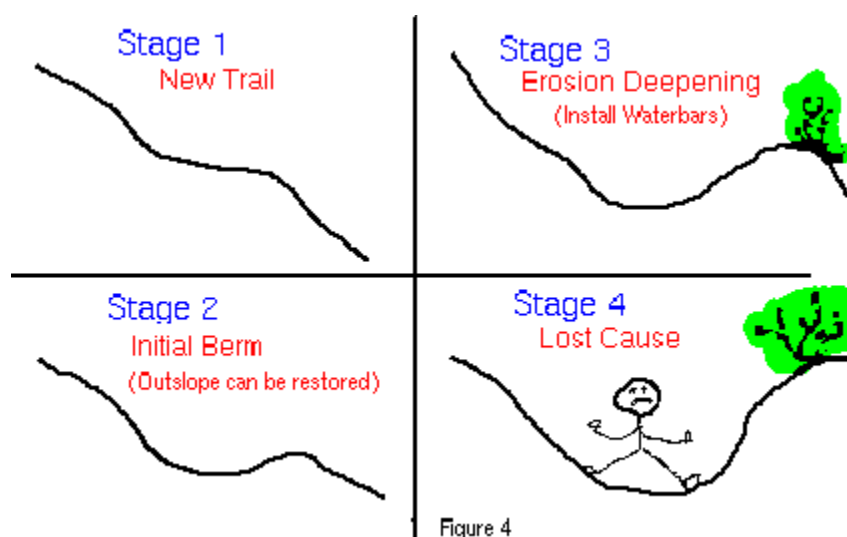
The first step of trail maintenance is to inspect the trail. When erosion problems are evident, the principle questions to ask are, "**Where is the water going and how can I get it off?**"

The following elements represent the primary "tools" to be used in the maintenance of trails. They are generally listed in priority order, but each has its own special application and purpose. Clearly, though, the first 3 (Maintaining the Outslope, Install and Maintain Water Bars, and Maintaining Drainage Dips) are far and away the most important.

Maintaining the Outslope

This is the first order of business in trail maintenance. It is the simplest, but most labor intensive trail maintenance tool.

Normal trail use will build up a berm along the outside (downhill) edge of the trail (Stage 2 of figure 4). If allowed to continue, the berm will grow and prevent water from flowing off the trail, causing gullying down the centerline of the trail (Stage 3). If this centerline gullying is allowed to continue unchecked, the trail will trench deeper and deeper until it is both unusable and unredeemable (Stage 4).



The outslope is maintained at Stage 2 by simply pulling the small 4" - 5" berm back into the trail tread. This unglamorous work must be performed again and again by trail crews, but in many cases, if the outslope is restored on a regular basis, little or no maintenance is needed of any other kind. However, some use patterns (extensive equestrian use), soil conditions (sandy) and climate conditions (high precipitation) combine to minimize the effectiveness of this maintenance tool; it just has to be done too often to make it worthwhile.

Once a trail has reached Stage 3, the berm is too large and overgrown with vegetation to be removed; the outslope cannot be restored and other maintenance approaches must be employed. When a trail deteriorates to Stage 4, the trail is a lost cause, and the best solution is trail abandonment and relocation.

Install and Maintain Water Bars

Water bars divert water off a trail at controlled points along the trail. They can be incorporated in the original construction of a trail, or they can be installed later as a maintenance measure. Done well, a series of water bars can effectively eliminate erosion and stabilize a trail for years. Done poorly, water bars can accentuate trail erosion and become dangerous tripping hazards.

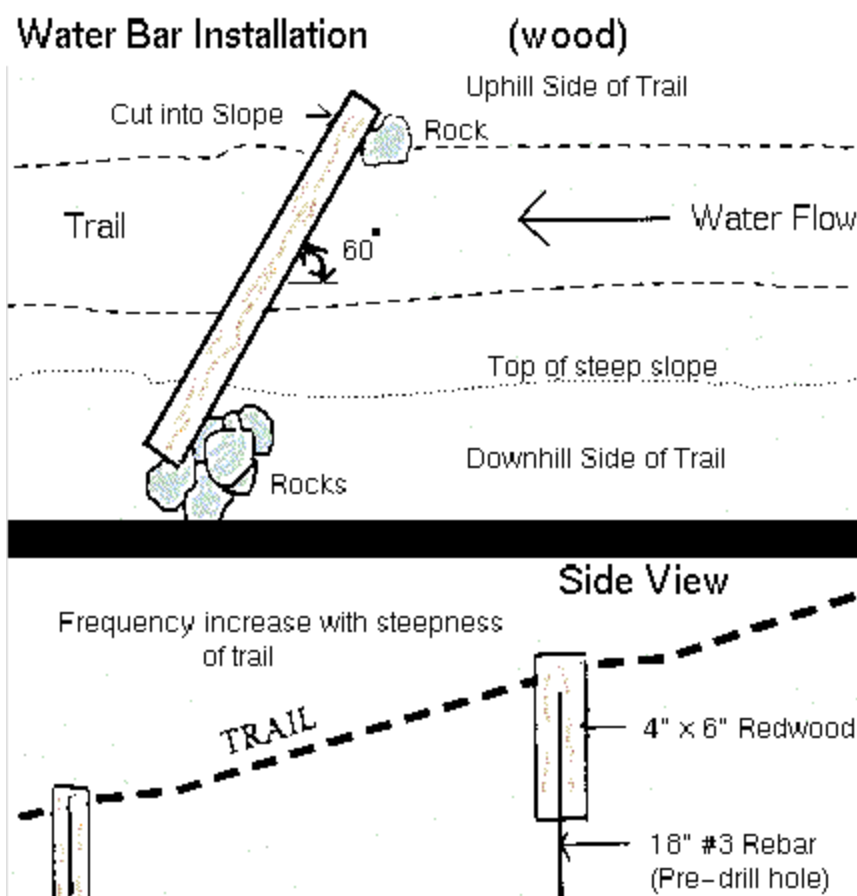
The most permanent water bars are made from native rock obtained on-site. When rock of a suitable size is not available, water bars can be made from 4 x 6 redwood timber, or native logs. Peeler logs or other

landscaping products should not be used because their appearance is foreign to a natural environment. Bicyclists prefer a new product made of black rubber that diverts water, but is flexible enough to allow cyclists to easily cross. However, this too, may be inappropriate for a natural environment.

There are many options about the proper installation of water bars. Three trail handbooks will promote three different approaches. Well, here is one more. The elements of a properly installed water bar are:

1. **Set the water bar at a 60 degree angle** across the trail. A water bar set perpendicular (90 degrees) across the trail will not divert the water off. A water bar set 30 degrees across the trail can be awkward to hike or ride over.
2. **Extend the water bar such that water is carried completely off the trail** to a steep side slope. Otherwise, the water flow will bypass the water bar and erosion will occur.
3. **Provide rock at the downslope end** of the water bar to dissipate the energy of the flowing water, thereby minimizing erosion.
4. **The top of the water bar should be nearly flush with the trail tread** to minimize tripping hazards. On first consideration, it may not make sense to make the top of the bar flush with the tread because there would be nothing to "catch" and divert the water. However, we are not concerned about diverting **all** water flowing down a trail, only that amount of water that causes erosion. With the bar flush, its effectiveness only kicks in when there is enough water to erode away a lip on the uphill side of the water bar, which then allows the bar to divert the water flow.
5. **The boulders used for rock water bars must be huge**, otherwise, they will be kicked out of place by a horse. The rocks should overlap like shingles on a roof to prevent water from flowing between rocks and eroding away the integrity of the water bar. In addition, long boulders with one flat side work best to prevent tripping hazards.

Water bars need regular maintenance. The excess soil and debris that build up at the downslope end of the water bar needs to be periodically graded out to assure that water flows off the trail. **Without regular unplugging, a water bar is useless.**



Maintaining Drainage Dips

A drainage dip is built into the original trail alignment and is a change in gradient (a "dip" in the trail) that dissipates and diverts water flow (it's like a built-in water bar). Like a water bar, it only remains an effective means of erosion prevention as long as regular maintenance keeps it unplugged.

Pruning

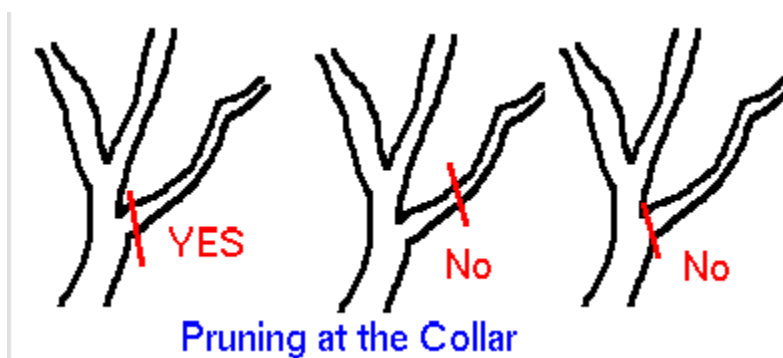
Pruning vegetation is an essential and regular part of trail maintenance, especially in brushy chaparral areas. Multi-use trails should have 10' vertical and 8' horizontal clearance (though there will be exceptions for the sake of protecting a tree or skirting around a large boulder).

Too often, trail pruning is accomplished in the most expeditious manner possible -- a branch intrudes within the walking/riding space of the trail and is quickly lopped-off so that it doesn't intrude and the debris is indiscriminantly tossed aside. However, our goal in trail maintenance is to **maintain a trail in as natural appearance as possible**. A quick pruning job deals only with the function of trail maintenance, not the aesthetics.

There are 6 elements of acceptable pruning in the State Park System. Each of these elements makes pruning a more tedious maintenance task, but results with a trail that is compatible with the natural environment.

1. **Do not toss debris!** Branches that are randomly discarded usually end up hanging in adjacent shrubs or trees. These dead branches are both unsightly and create a fire hazard.

2. **Place debris out of view.** This element requires the extra effort of dragging branches under and around shrubs.
3. **Place the butt (cut) end away from the trail.** This will help disguise the debris.
4. **Each cut branch should be touching the ground to promote decomposition.** This means that brush piles are not appropriate.
5. **Pruning should be done sensitively so that the trail appears natural** and not as if a chain saw just blasted through. Trail users should not be aware that **any** maintenance work has recently been done.
6. **Prune to the collar of any branch stem** for the health of the shrub and a more natural looking result. At the base of any branch there is a wide section that contains a plant's natural healing agents. Any pruning performed away from this collar will expose the plant to a greater risk of infection. A cut at the collar will naturally heal. For large branches over 2" in diameter, cut from the bottom, then cut down from the top. This prevents tearing of the bark, reducing infection.



Signing / Mapping

Adequate signing and mapping keeps trail users on the trail. Uncertainty about which trail is which will lead to new trails being created by trail users. These new trails will become maintenance headaches and will ultimately need to be abolished.

Check Dams

Check dams are a popular, though generally ineffective, instrument of trail maintenance. A wood timber is placed 90 degrees across a trail. In theory, the check dam is intended to slow the velocity of water flowing down the trail, thereby reducing erosion. In reality, nearly all check dams only halt erosion in the 2 to 3 feet immediately behind the check dam, but accelerate erosion immediately below and beside the dam. This is because they never take the water off the trail, they only slow it down momentarily. For check dams to be truly useful in stopping erosion, they need to be spaced 3 feet apart, and this effectively makes a stairway out of the trail.

Check dams should not be used in trail maintenance. However, they may have limited application in restoring abandoned trail alignments to natural conditions.

Import Fill Material

A deeply trenched trail can be restored by importing dirt or decomposed granite, compacting it, and recreating a well-drained outsloped trail. However, in most situations, this approach is usually both cost prohibitive and far too labor intensive.

TRAIL REROUTING

Trail rerouting is beyond the responsibilities of a trail maintenance crew. New trail alignments must be flagged by experienced park staff and then reviewed by resource specialists for compliance with the California Environmental Quality Act. Trail maintenance crews can provide valuable assistance by alerting park staff to those trail routes that may need to be rerouted.

There are two measurements that dictate that a trail relocation is needed:

1. When the maintenance crew is dealing with a poorly designed trail that has deteriorated to the extent that remedial measures will not work or will constantly need repair or replacement, AND
2. A significantly better route is available.



The telltale signs of a trail that needs to be relocated are: deep trenching and a gradient exceeding 20% over about 100 feet of trail.

REFERENCE MATERIAL

This document represents a cursory look at the basic aspects of trail maintenance and only briefly touches on trail construction techniques. There are many valuable references that dive into much greater detail; a few are listed below. Each of them can be obtained by contacting the sponsoring agency.

NPS TRAILS MANAGEMENT HANDBOOK, United States Department of the Interior, National Park Service, Denver Service Center, 1983 (A small, but comprehensive, pocket manual on trails construction and maintenance.)

Trails Coordinator, National Parks Service
P.O. Box 25287, 655 Parfet Street, Denver, CO 80255

A TRAIL MANUAL, East Bay Regional Park District, Oakland CA. 1976

GUIDE FOR MOUNTAIN TRAIL DEVELOPMENT, United States Department of Agriculture, Forest Service, 1984

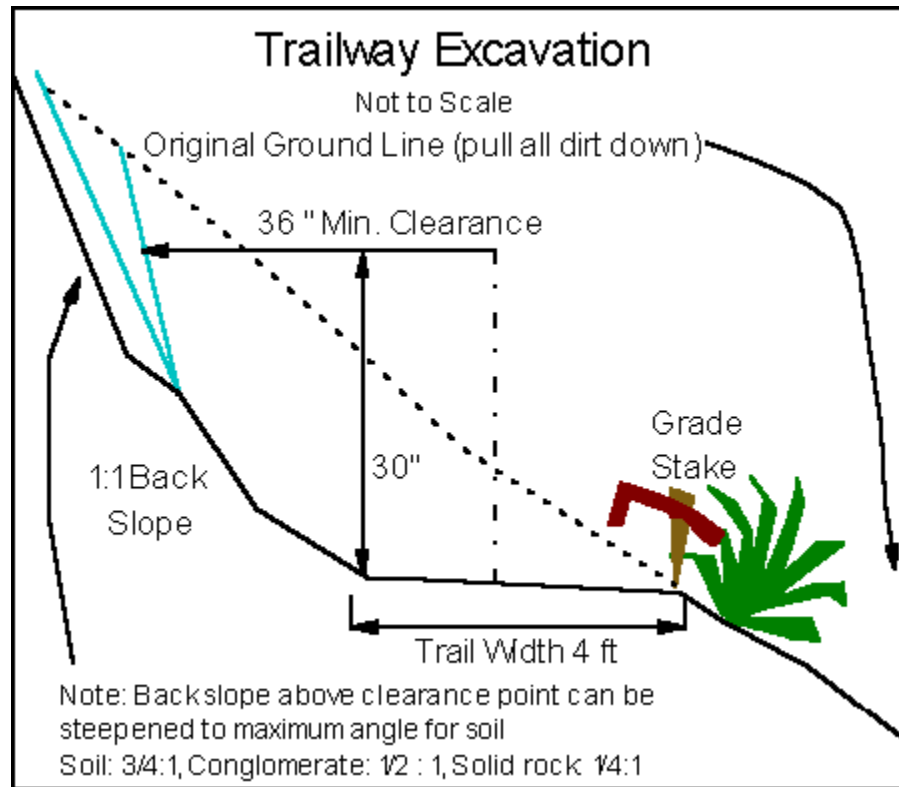
Forest Service - USDA
Engineering Staff - Washington Office, Attn: Publications Specialist
P.O. Box 2417, Washington, D.C. 20013
(703) 235-8198

TRAIL DESIGN, CONSTRUCTION, AND MAINTENANCE, Appalachian Trail Conference, Harper's Ferry, 1981

Appalachian Trail Conference
P.O. Box 236, Harpers Ferry, WV 25425
(304) 535-6331

TRAILS MANUAL, Charles Vogel, 1968

Equestrian Trails, Inc.
10723 Riverside Drive, North Hollywood, CA



[Return to FTA home page](http://www.foothill.net/fta/work/maintnotes.html)