# Developing Sustainable Mountain Trail Corridors

## An Overview

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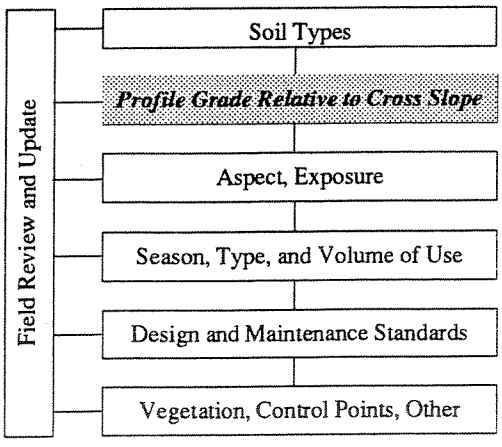
## Introduction

This article introduces the criteria of *maximum profile grade relative to existing cross slope (fall line)* as key to the development of natural surface trail projects that are sustainable. Key trail design concepts excerpted from trail documents are presented in this article. Each of the important documents allude to the suggested criteria and to the concept of sustainability, however no document specifically nor fully develops this particular point of view. The criteria presented in this article will assist planning teams in developing natural surface trail projects that are sustainable.

## Sustainable Criteria

Natural travel surface sustainability criteria include: soil types, *trail profile grade relative to existing cross slope,* aspect, exposure, season of use, type of use, volume of use, trail design and maintenance standards, ecological implications of vegetation, and functional and aesthetic control points. Imported surfacing materials may improve sustainability of specific areas within the overall corridor.




Evaluating sustainable criteria is a process, with a suggested hierarchy shown. The introduction of the criteria *profile grade relative to cross slope* is the focus of this article.

## Corridor Definition

Mountain trails are often treated as a simple linear connection between points of interest, with attention usually given in the literature to just the trail clearing dimensions. Many trail planners realize, however, that there can be influences on the project from beyond the travel surface or clearing limits. The trail corridor is defined as the swath of landscape 10-25 feet on both sides of centerline which contains the travel surface and the aesthetic (viewpoints, wildflower areas, waterfalls) and functional (saddles, switchbacks, stream crossings) control points. Such a definition for the corridor will ensure adequate room for flexibility in the final trail alignment design.

The trail corridor may also include land that must be acquired to protect or buffer the trail from adverse influences, and to protect scenic viewsheds. One purpose of delineating the proposed corridor is to communicate the scope and intent of the project to planning team members and decision makers.

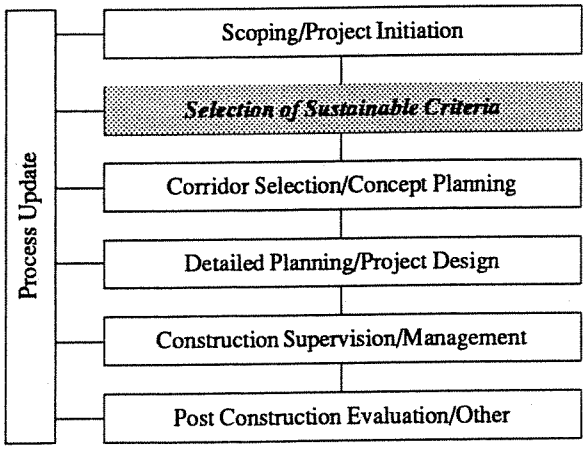
## What is sustainability?

Sustainability of natural surface trail corridors is defined as the characteristic of a travel surface to support currently planned and future uses with minimal impact to the natural systems of the area. Sustainable trails have negligible soil loss or movement while allowing the naturally occurring plant systems to inhabit the area, recognizing required pruning and eventual removal of certain plants over time. Sustainable trails will not adversely affect the naturally occurring fauna. Sustainable trail design will accommodate existing and future uses while only allowing appropriate uses. The sustainable trail will require little rerouting and minimal maintenance over extended periods of time.

## Interdisciplinary Planning Team

For over 50 years, interdisciplinary planning teams have been assigned to trail projects. The National Park Service Construction of Trails and the Parks Canada Trails Manual documents both describe this need. A landscape architect and an engineer have been traditionally included on the team. Other specialists such as a naturalist, field personnel, or consultant can also be included.

Key to project success is the development of a rational and defensible design process by the planning team. Varying by project, the process will include many steps, including: scoping/project initiation, sustainable criteria selection, corridor selection, concept planning, detailed planning, project design, construction supervision, management, and post construction evaluation. Adhering to the established process will ensure that the team will make well informed decisions that will impact natural travel surface sustainability. Developing a review process for interested parties will also be important to individual project success.




The planning process is project specific. Updating the process as new information is presented and new criteria developed is important to sustainability and project success.

## Trailside Vegetation

Understanding the ecological implications of the trailside vegetation within the corridor will assist the planning team in decision making. Response to light and pruning, mature plant size, and invasive or undesirable plants are important factors to consider. The landscape architect can prepare drawings with annotations of anticipated vegetative changes within the corridor for the team.

## Environmental Protection

The Trails Manual recognizes the importance of the protection of the environment for the success of corridor projects. The following excerpts are just a few ideas of many that relate to design which must be considered during the planning process:

*The protection of the environment is (also) of major importance; if environmental quality is seriously affected the very attributes that have made areas attractive for development in the first place may be lost. Effort should be made to ensure that trails fit their environment as harmoniously as possible so that ecological processes and environmental character are not significantly altered. ...The carrying capacity of an area is the amount of use by man that the area can withstand without undue environmental degradation. Carrying capacity is partially determined by man in that it is man who must define the level of change that constitutes the threshold of unacceptable degradation. The task of the [interdisciplinary] development team is to plan, build and manage the trail so that the carrying capacity of its environment is not exceeded.*

*...Detrimental impact of trail use upon the environment is directly affected by type of trail activity and how intensively the trail is used. For example, horses will cause more wear to trail surfaces than hikers, and trails used by experienced outdoors people will usually receive less abuse than those used by the general public, since the experienced hiker is less likely to be careless or destructive.*

## New Uses on Existing Facilities

Realizing that different uses have differing impacts, planning teams must study new uses on existing trails. Addressing pertinent sustainable criteria during the planning process will assist the team in determining the suitability of new uses on existing trails, few of which meet modern standards. Also realizing that design criteria for old roads and railway beds is significantly different than trail criteria, it is necessary to study sustainable criteria when redeveloping these corridors for new uses. Evaluation of projects in the local area can assist the planning team in developing sustainable criteria for the project at hand.

## Field Work

Diligent field work is required to ensure that corridor locations have been identified that will support sustainable travel surfaces. More detailed field work is required in complex areas, the extra work being important to sustainability. Also, scouting an important alternative over several seasons, including a winter, may be required to ensure fitness of the corridor for development.

Planning team members are wise to plan boldly, overlooking social and game trails that have evolved haphazardly. Suggesting new alternatives may be the team's responsibility. Suggesting additional management techniques such as signage and short sections of fencing or planted barriers are the team's responsibility and may be necessary to complete a package to gain management support. Well planned, designed, constructed, and managed corridors will not be improperly used as many suggest, but will be respected by users.

## Slope Ranges and Sidehill Design

As described in many popular trails documents, acceptable cross slope ranges for typical mountain trail construction (without heavy investment) are between 10 and 70%. The acceptable range suggested for maximum profile grade is commonly between 8 and 12%. Combining local topographic study with varying trail profile grades will reduce the erodibility of, and therefore increase the sustainability of, the natural surface trail during the detailed planning and project design steps.

The concept of sidehill trail design is also described in the popular documents. As excerpted from the Appalachian Trail Conference's Trail Design, Construction and Maintenance: *Using a sidehill trail design is the surest way of preventing erosion. ...The grade of the trail can be far less than the grade of the slope itself.* The Appalachian Mountain Club's Trail Building and Maintenance, 2nd Edition, suggests a way to combine trail gain while preventing gullying: *This happy medium can be found with the sidehill trail location, so that running water will cross the trail but not run down [it].* The Trails Manual develops the concept of *diagonal* trails this way: *Location of trails diagonally across slopes slows run-off and reduces erosion.*

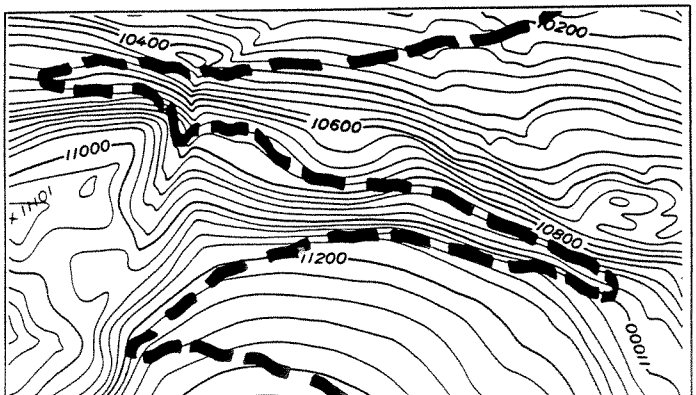
## Profile Grade Relative to Cross Slope

Field experience in the front range near Denver, CO suggests that sustainable travel surfaces not only have good maintenance programs in place, but they also have profile grades (along the trail centerline) that are less than 15%, and that are less than 1/4 the prevailing cross slope (direction of drainage) of the immediate section of trail.

Due to topographic variation, the maximum profile grade along a length of trail should also vary with steeper topography being able to sustain a steeper maximum profile grade. This suggests a 2.5% maximum profile grade in 10% cross slope areas, 5% in 20%, 10% in 40%, and 12% maximum profile grade in 48% cross slope areas or greater.

[Reminder: Natural surface trails in cross slope areas of less than 10% usually require surfacing and drainage improvements if they receive even a moderate amount of use; natural surface trails in cross slope areas between 70 and 90% usually require retaining walls in order to ensure the trail does not mass fail; and natural surface trails simply cannot be built in cross slope areas exceeding 90%.]

Trails with profile grades greater than 15% in any cross slope area are usually prone to erosion. Profile grades exceeding 15% also need to consider the effect of moisture (frost, rain, ice and snow), aspect, season of use, and volume of use on user comfort and safety, and on travel surface sustainability. *Diligent efforts in the scoping and corridor selection planning steps can usually avoid using these profile grades!*




Diligent field work searching out trail profile grades that are less than 1/4 the prevailing cross slope grade will have maximum benefit to natural travel surface sustainability and project success.

## Design Guidelines

Design guidelines are required for each corridor project. A simple outline with supporting sketches describing trail or segment origin, destination, nodes, natural or cultural resource points of interest, landscape architectural design intentions, design standards, and anticipated investment is suggested.

## Estimating/Commitments

Typically, 6 full work days spread out over a year or more are required to prepare each mile of a sustainable trail project for the team leader. This includes project initiation, meetings, scoping, alternative development, preliminary flagging, corridor review with the planning team, design drawings and detailing, supervision of [volunteer or day labor] construction, post construction evaluation, and follow up with the land manager. High quality construction of mountain trails by well organized volunteers usually requires about 175 (6 hour) volunteer days per mile, and contract projects can cost $50,000 per mile for typical construction.

## Maintenance

Maintenance activities are required to restore the original design standard to natural travel surfaces and clearing dimensions at opening and closing each year, and when necessary to restore the original standard. On some trails, routine activities may be required each month during the high use season. All maintenance activities must be designed into the project during the planning stages by the planning team. A typical project may require 10% of the original time and dollar investment each year after construction. Projections can be developed with input from maintenance crews. Monitoring and updating the maintenance schedules season to season and year to year will be required to ensure continued sustainability of natural travel surfaces.

Does your agency have the time and resources to undertake design and maintenance commitments? Planners who communicate time and resource needs to managers, and managers willing to commit to those recommendations will further the interest in developing sustainable travel surfaces. This will ensure a wonderful recreation facility legacy not only to future land managers, but also to future generations of users, and all will be grateful.

## Management

Management of corridor projects by land managers is required to ensure that individual projects complement each other and that they comply with agency, state or federal initiatives. Maintenance activities such as weed control, encroaching or invasive vegetation removal, and bridge deck replacement may be tasks that are managed in a less than annual frequency. From the natural resource point of view, it is wise to monitor access to trails, use patterns and to upgrade individual trail corridor projects to sustainable status before new projects are undertaken.

## Summary

The criteria *maximum profile grade relative to existing cross slope* is key to sustainability for natural surface trails. Trail corridor projects that are developed recognizing this criteria will more effectively meet management goals of exercising a reasonable standard of care for the safety and comfort of users, economy of investment, and will display a commitment to natural resource protection.

## Bibliography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Parks Canada. Trails Manual. Ottawa, Ontario: _____, 1978.

Proudman, Robert D. and Reuben Rajala. AMC Field Guide to Trail Building and Maintenance. Boston, MA: Appalachian Mountain Club, 1981.

The Appalachian Trail Conference. Trail Design, Construction and Maintenance. Harpers Ferry, WV: _____, 1981.

US Forest Service. Trail Construction on The National Forests. Washington, DC: US Government Printing Office, 1923. [While not specifically referenced in this article, this is an important document in a trail planner's library.]


To discuss or exchange ideas on the criteria of profile grade relative to cross slope or the concept of sustainable trails, contact Hugh Duffy at the National Park Service, River and Trail Conservation Assistance Program, 12795 W. Alameda Pkwy, Lakewood, CO 80225-0287. Phone: (303) 969-2781.