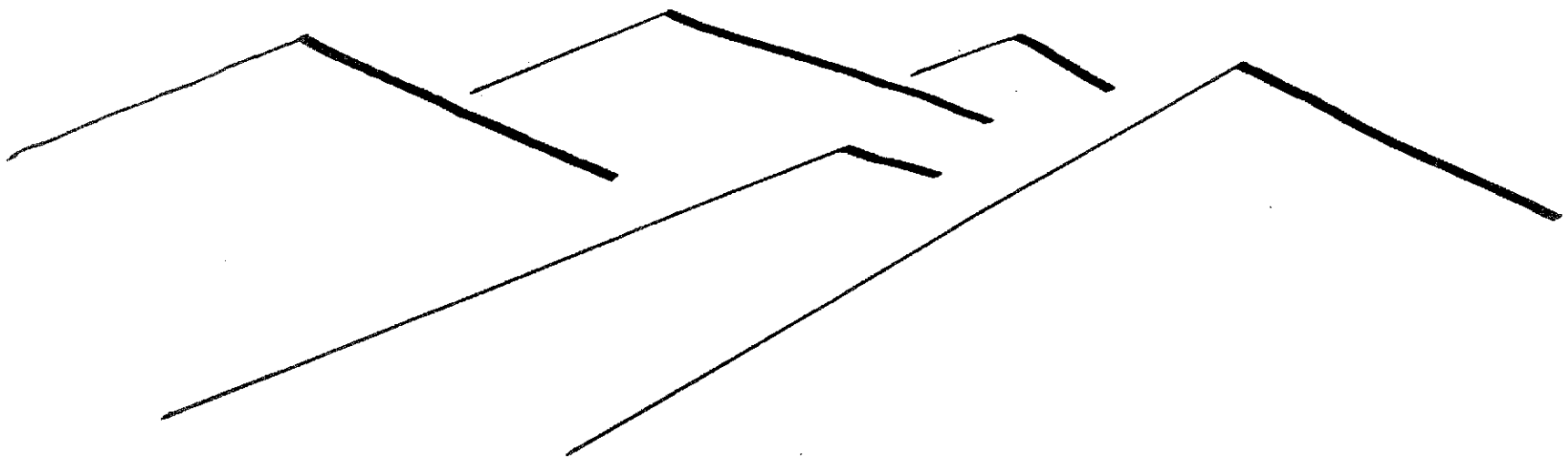


PLEASE RETURN TO HUGH DUFFY

Mountain Trails Management: An Outline



Prepared by the National Park Service with assistance from
The Colorado Division of Parks and Outdoor Recreation

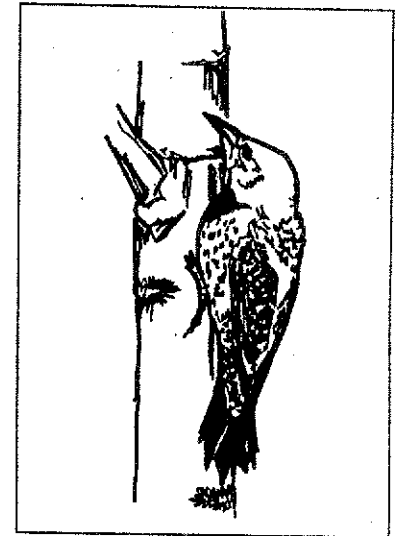


Rivers, Trails and Conservation Assistance Program
National Park Service
Rocky Mountain Region
November, 1992

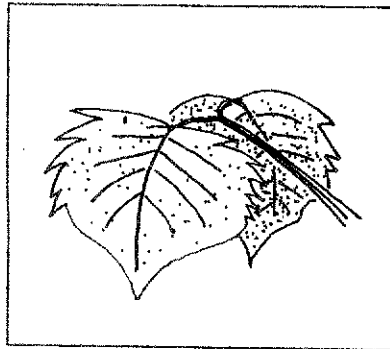
Abstract: Mountain Trails Management: An Outline advocates a comprehensive approach to mountain trails development. Planners and landscape architects are encouraged to investigate the entire spectrum of literature available as well as the specific criteria that affect individual trail development and prescribe solutions that will minimize capital investment and become permanent and sustainable facilities on the landscape. This document summarizes popular literature and information gathered and presented at Roxborough State Park at the Trails Management Forum sponsored by the National Park Service in September of 1989, and contains some new information not available at the time of the forum.

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Flicker



Aspen leaves

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Special thanks for the content of this document are due: Stuart Macdonald, Colorado State Trails Coordinator, for making us aware of the need of this information and helping focus its approach; Susie Trumble, Terry Gimbel and Mary Bonnell from Roxborough State Park; trail planners and participants in the forum which helped fine tune the original recommendations in this outline; Duane Holmes for his editorial work; Kay Salazar, for her insightful comments; and Schelene Harris and Royalene Doyle for their typewriting, proofreading, xeroxing and the general care with which they assisted in the production of Mountain Trails Management: An Outline.

Introduction

Mountain trails and other recreation pathways are playing an ever increasingly important role in modern America. There are many different types of trails in use today as well as many different types of users. There will also be new users and new uses of trails in the future. One important component of the trails spectrum is mountain trails. Mountain trails afford access to remote areas for recreationists of all kinds. Mountain trails, however, have not always been managed properly, and sometimes, not at all. To face the ever growing demands and new challenges that face mountain trails managers, new methodologies and strategies need to be developed to ensure that sustainable trails and related facilities are in place for future generations of trail users.

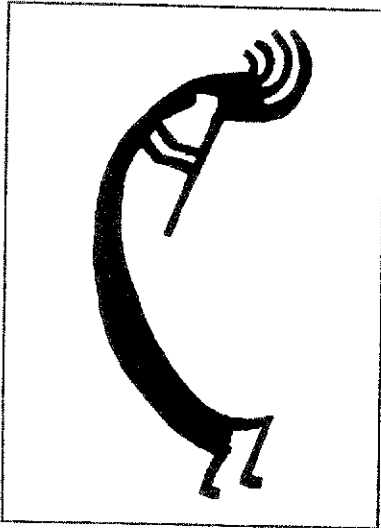
Careful observation of trail activities around the country indicates that there is a great need for developing a comprehensive trail management strategy for mountain trails for each park area or open space unit. Because of varied topography, climatic influences, soil types and trail uses, each strategy should be unique to a particular park unit. It is also imperative that trail designers and managers take a long term view towards all trail projects, and overlook short range solutions.

An increased emphasis on adequate funding for planning, design, construction and management for trails activities would do much to help the overall trails community. In addition, trail management training must be increased and agencies must commit resources and time to these training sessions. A sound trail program will emphasize all aspects of trail management, not just one part.

As trail designers get involved in projects, they would be wise to strive to see the future and how the methodologies presented here can apply to their efforts. Anticipating change in users and use trends is a good insight for trail designers to develop. Trail designers who undertake a leadership role in developing new strategies for trail protection, new methodologies in trail planning, and new ways to quantify trail management concerns will also help the overall trails community. Trail designers are in the best position to do this in that they are generally involved in the entire trails management spectrum. If trail designers will not take on this role, who will?

There is also a need to revisit some of the ideas of the early authors of the significant trails literature, especially the idea of an interdisciplinary team which was developed by the Civilian Conservation Corps in the 1930's. This idea is discussed later. An interdisciplinary approach will yield countless benefits in accurate trail planning and minimize management related expenses over the life of a trail. The trail designer, again, is the best person to undertake a leadership role in this area.

Trails Management Forum Summary



Flute player

This outline was developed for use in conjunction with a forum in trail management co-sponsored by the Rivers, Trails and Conservation Assistance Program, National Park Service, Rocky Mountain Region, and the Colorado Division of Parks and Outdoor Recreation. The forum presented a state-of-the-art viewpoint for developing a trail concept plan for a small park or open space area. Trail planning concepts, trail design criteria, trail construction procedures, and finally trail maintenance and management strategies were discussed. Participants were equipped with the knowledge to begin a rational and comprehensive process to develop parkwide trail plans in mountainous areas. This document summarizes the concepts presented. Future forums may address additional topics.

The forum was held at Roxborough State Park, which is a recent addition to the Colorado State Park system. It is located 25 miles southwest of Denver, Colorado. It protects fragile Fountain (Red Rock) Formations on the Front Range of Colorado. It covers approximately 1600 acres, is varied in topography, home to much wildlife and birdlife, and possesses fantastic views of the front range, the foothills, and to the eastern plains of Colorado.

Roxborough State Park was a good place to host this introductory forum since it is a developing small park which is heavily used. There are a variety of trails through the area including old roads and trails, as well as new trails of varying quality. Possible connections off the park land include a spur to the Colorado Trail, Colorado's cross-state trail. Also, boundary constraints limit trail opportunities, thereby challenging the designer.

Purpose

The purpose of this outline is to offer our best guidance regarding the development of a trails management methodology for a small park or open space unit. It is intended that this document will improve over time into a document covering all aspects of trail management in a more detailed way. You are encouraged to obtain the references mentioned in this document and start your own trails management library for your own area. The concepts presented are firmly based on sound landscape architectural and ecological principles.

We hope this outline, its references and its appendices will heighten your awareness of trail management issues, and show some of the regional, statewide and national implications of your work. We have attempted to combine information presented elsewhere, and refine and update it into a more current point of view. In some cases, new information is presented. Some of the concepts you read about may be new to you, and there may be resistance to accepting them. Field testing them will verify their importance and applicability. Observation of trail projects around the country will also aid in developing a mature perspective on trail management.

Documents mentioned in this outline are considered important resources to the trail planner. These documents are listed in the reference section. Appendices contain information not published elsewhere, but would contribute to the education of a trail planner.

The President's Commission On Americans Outdoors

In 1985, President Reagan asked a special commission to look far ahead into this country's next generation to determine the specific needs of the American republic in terms of outdoor recreation opportunities. The Commission's findings are summarized in The Report and Recommendations to the President of the United States, published in December, 1986.

This important document calls to action all Americans: mayors, state legislators, governors, the Congress, the private sector, and every citizen--to undertake a pro-active approach to improving recreation opportunities for the next generation of Americans. It also pinpoints some specific needs for our future generations, as well as identifying general visions for the future. It is important to point out to trail designers, the broad framework that your trail system fits into so that you can keep a keen vision ahead of you as you develop your projects.

The report identifies very rapid growth in and demand for linear recreation facilities. Local, regional and state agencies alone administer almost 35,000 miles of trails including 776 National Recreation Trails totaling 8,100 miles. There are also 13 designated National Scenic and Historic Trails totaling 23,500 miles. The report also identified the threat to many linear recreation systems, including trails, due to their proximity to private property or public rights-of-way. Finally, identification was made of the problems created when local trail facilities were not expanded in areas of population growth which resulted in overuse. This should be a good lesson for park managers. Trail facilities and their management should keep pace with major trends in the surrounding region.

A strong point of the report was the need identified for a Nationwide greenway system which would include corridors on both private and public lands and waters which will afford open space access to all Americans where they need it most--close to home. Roxborough State Park is an example worth recognizing. There are current plans to tie the Roxborough trail system into the Colorado Trail, the Highline Canal (a major pathway in the Denver metropolitan area), and the Douglas County system of trails. Roxborough's proximity to Denver indicates that serving a large population base is a likely role for the area. With this in mind, trail planners and designers are strongly urged to consider how their park and open space trail systems will fit into the larger picture--the Nationwide Greenway Network.

Trails For All Americans

In 1990, American Trails submitted a report to the National Park Service entitled Trails For All Americans. The report summarizes the National Trails Agenda Project which was initiated to look at issues and develop recommendations to satisfy America's current and future needs for trails. This report is an excellent summary of this projects' findings on trails issues and their subsequent recommendations.

Mountain Trails Background

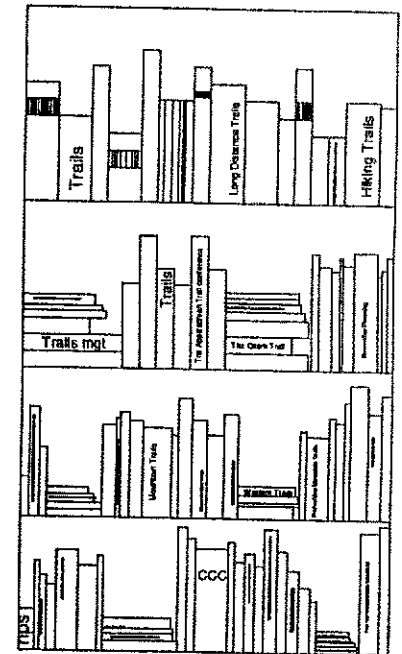
Knowing where we have come from can help us understand where we are and where we need to go. Much of the work done in the past can be built upon. Several ways to do this include reviewing appropriate literature, looking at trails as our pathway to the future, and developing a historical perspective on trails.

Literature Review

Several early documents provide extensive information which was once disseminated throughout the National Park Service (NPS) and the United States Forest Service (USFS) regarding the construction of mountain trails. It is perplexing why so much of this information was not carried over to later documents. Because this information was not carried over, many countless miles of trails have been built inappropriately, which has resulted in many trail users enduring hardships. Unnecessary maintenance and repair expenses have also been incurred. The basic knowledge developed years ago should have been built upon over the years; but was not. As it stands now, some trail organizations are struggling simply to understand the basics of mountain trail planning, design, construction and management which were originally outlined many years ago.

Note the following excerpts from the NPS Civilian Conservation Corps (CCC) Construction of Trails Handbook of 1937, as well as the USFS Trails Construction On The National Forests Handbook of 1915. The NPS/CCC document had been referred to periodically over the years. However, some of the clear insights into cultural practices mentioned in this document which were intended to protect trails after construction have been overlooked in later documents. The NPS/CCC document is the best early trail design and construction document. The text, originally entitled "Recommendations for Trails Construction" was compiled by the landscape and engineering departments of Great Smoky Mountains National Park for all trails within the park area. It was distributed to all CCC camps as an effective outline of good trail construction practices.

These two documents can form the base of knowledge for any modern mountain trail designer. So many new issues have surfaced since their publication that these two documents should now be considered trail basics which must be completely understood before progressing into other areas. Growth and creativity can occur only when the basics are understood.



Office research

Some excerpts from the CCC Construction of Trails Handbook include:

"...Construction should not be started on a trail until the line has been flagged through to its destination [or a definite point of control] and approved...

...(This approval should be from all of the Branches which may have an interest in its construction. These Branches will include the landscape architect who is charged with utilizing the scenic features and blending the trail with the landscape; the engineer who is concerned with the problems of construction; the forester whose duties involve the protection and propagation of natural cover; the geologist who will assist in locating the trail so as to take advantage of geographic and geologic features and protect them from destruction; and the wildlife technician in whose care the zoological and botanical values are entrusted.)...

...No factor in trail construction is more important than proper drainage, and many sections of good trail are damaged and destroyed by erosion which could have been prevented. All drainage should be planned far ahead of construction. The method of carrying surface water off of the trail section should be determined in advance, along with the location, type, size, and construction details of all drainage structures..."

It is particularly noteworthy that this early document described not only an interdisciplinary team approach to trail design and construction, but also some cultural practices that are recommended to ensure sustainability and passibility of the trail over time. This is an outstanding reference document for all mountain trail designers.

The USFS Trail Construction On The National Forests Handbook of 1915 is more construction oriented than the NPS document, yet provides some fresh insights even for modern trail designers. Some excerpts include:

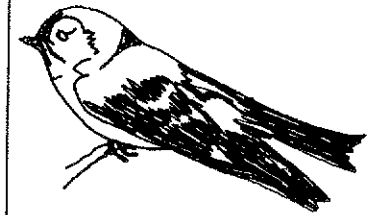
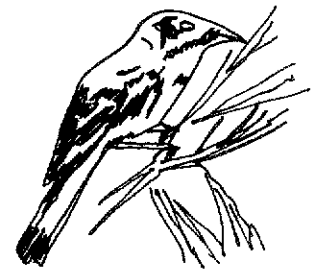
"...The purpose of this handbook is (1) to establish a uniform classification of trails on the National Forests in accordance with their use, (2) to establish standard specifications for each class, (3) to describe approved methods of location, construction, and maintenance, and (4) to furnish reference data useful in preparing estimates and in actual construction work..."

"...Heretofore trails on the National Forests have varied, under similar conditions, all the way from shotgun trails to bicycle paths, in accordance with the exigencies of the situation or point of view of the builder. Economically it is as bad to put too much money into a trail as too little. In the past, standards have been very largely determined by the money available and the necessity for building the first trails. The wrong standard should not be adopted merely because of lack of funds; it is better to stick to the right one, even if several years are required for final completion of the work..."

"...The instruction in this manual should be followed closely. The suggestions are meant merely in the nature of guides. Thorough preliminary work proportionate in amount with the importance of the project, and the adoption of a standard in advance of construction coinciding with the use of the trail, are imperative.....The most important work in connection with the building of trails is the preliminary examination to determine the location. Too much emphasis can not be placed upon its importance. Mistakes in location seldom can be corrected after the trail is constructed. Future generations of men and horses must pay for incompetence or carelessness shown in the preliminary work..."

"...The establishment of the definite line of location must be preceded by a thorough and complete preliminary field examination covering all of the ground which offer possibilities. A general knowledge of the country is not sufficient. In every case where an important trail project is involved, a general reconnaissance of the country should be made with the particular trail project in mind. Even the man who knows "every foot of the country," but who never looked it over for the particular purpose of building a trail through it, will be surprised at the many details previously overlooked. Careful personal investigation is necessary; the opinion of the oldest inhabitant is often in error. Numerous problems will have to be solved in deciding upon the final location. Consideration of but a single factor without its coordinate relation to others is insufficient. Each factor must be balanced against other factors of possibly greater or less weight..."

These statements are as true today as they were in 1915. The challenge to modern trail designers is to build on these sound foundations of the past and apply state-of-the-art planning, design and construction techniques combined with a clearer understanding of ecology, to ensure that the best product possible is provided to the trail user.



Trails Are Our Pathway to the Future



Greenway enthusiast

With increased leisure time, increased funds available to spend on recreation, and increased population pressure, recreation facilities are becoming more and more important. Many documents and studies in the past have identified the need for and the benefits of recreation. Trails can play a unique role in providing quality outdoor recreation experiences in many ways. Discussing questions, such as why people use trails and what benefits users get from trails, help to provide insight into why trails are important to people.

Many primal needs may be satisfied through the use of trails. They include the desire to develop self reliance, the excitement from introducing some spontaneity and surprise in one's life, and the satisfaction derived from the sense of adventure. We as a society require contemplative recreation experiences. We also need to relax and spend time out-of-doors. These appear to be inherent characteristics of all people. Trails help to satisfy these needs in people.

The participation by hikers and horsemen in naturally scenic areas also has a power to influence human beings. Frederick Law Olmsted, in 1865, very eloquently communicated the power of scenery. The following is taken from "The Yosemite Valley and The Mariposa Big Trees, a Preliminary Report of 1865" as quoted from Landscape Architecture Magazine, October of 1952:

"...If we analyze the operation of scenes of beauty upon the mind, and consider the intimate relation of the mind upon the nervous system and the whole physical economy, the action and reaction which constantly occur between bodily and mental conditions, the reinvigoration which results from such scenes is readily comprehended...

...The power of scenery to affect men is, in a large way, proportionate to the degree of their civilization and the degree in which their taste has been cultivated...

...But there is a special reason why reinvigoration of those parts which are stirred into conscious activity by natural scenery is more effective upon the general health than that of any other, which is this: The severe and excessive exercise of the mind which leads to the greatest fatigue and is most wearing upon the whole constitution is almost entirely caused by application or removal of something to be apprehended in the future, or to interests beyond those of the moment, or of the individual...

...In the interest which natural scenery inspires there is the strongest contrast to this. It is for itself the moment is enjoyed. The attention is aroused and the mind occupied without purpose, without a continuation of the common process of relating to present action, thought or perception to some future end...

...the enjoyment of the emotions caused by natural scenery. It therefore results that the enjoyment of scenery employs the mind without fatigue and yet exercises it; tranquilizes it yet enlivens it; and thus, through the influence of mind over the body, gives the effect of refreshing rest and reinvigoration in the whole system..."

Much more literature has been written about the power of scenery and people's contemplative experiences of it. It is refreshing to reread the above passages and simply wonder about the eloquent gift of writing possessed by Olmsted. Although he was writing about lands which would eventually become Yosemite National Park, we too are entrusted with outstanding landscapes to conserve or preserve for all generations. These words can provide an inspiration to us in our required writings for trail projects.

Our roots and our urgings lie in the past. We also need to look to the future and be creative in our problem solving techniques when we develop new trail plans. Trail designers as a group should build on foundations of the past and develop new techniques for meeting the demands of the future. Society as a whole must continuously develop, therefore our creative trail solutions must also develop. As pressure builds on our dwindling natural resources, trail designers must excel in the provision of quality trail experiences and more and better trail facilities. As this is attained, the primal urgings of man can be satisfied, we can continue to grow socially, and society will be better off as a whole. Our future will be more enjoyable if we start planning for it now.

Historic Perspective on Mountain Trails

Man's attitudes towards trails have changed over the years. These attitudes have paralleled attitudes regarding the environment in general. The last 100 years have seen the development of the predominant current attitudes. The original uses of trails in the 20th century were mainly on Forest Service and National Park Service lands. These original trails were for fire and resource protection. The times when trails were built also reflects the attitudes towards them. In the early days, a lot of time and investment was put into trails. Labor was cheap and the work was glamorous. For instance, most of the back country trails of the major national parks were built during the CCC era.

A major increase in trails work occurred in the 'Mission 66' program of the NPS in the 1960's. Emphasis during this time period was placed on providing recreation opportunities for enormous numbers of people to use national park areas. Many of these trails were front country (close-in) trails near visitor centers. Long distance back country trails increased in numbers during the 1970's and early 1980's. Note the popular rise of such trails as the Ozark Highlands Trail in Arkansas and the Colorado Trail during this time period. The 1980's also saw a major growth in urban greenways.

What were trails used for in your area in the past? Where are they headed in the future? (There is always a question as to whether a designer should change the historic location of trails or old roads or, if they should be allowed to continue to develop for future uses in the same location.) If the location is sound, if good basic design and construction principles were applied, it should be allowed to remain. If old roads or trails were located haphazardly, it is probably time to intervene and reset the course of transportation development in your park or open space unit.

Trail designers should take a long term point of view of their projects when considering alternative routes, cost of improvements, and design standards. They must also be wary of individuals who would want to take short cuts to get a project done faster. Short cuts rarely work as planned. This was noted as early as 1915 in the USFS Handbook. A suggestion for trail designers is to plan, design and build a trail properly, and in the long run, the public will have a sustainable product to use and enjoy. Few will look back and remember when the trail was built or think that it should have been done faster. A well designed system will simply be in place, in use, and enjoyed by many.

Twenty Year Viewpoint

A good approach to look at where we are now is to remember that trails will last much longer than our short career at a park or open space agency. A good way to do this is to consider the 'twenty year viewpoint' when developing a trail project. One need only look around at what is going on in the countryside in their area. Is there erosion from overgrazing? Then there is likely to be erosion on your trails. Is there erosion on cut or fill slopes along roads in the area? Then there is likely to be similar erosion on your trails. Many clues which are easy to find will give you an insight into problem solving for your particular trail project. When were areas grazed? When did miners build their roads and when did they stop using them? When trails are planned and designed, they will be used much longer than the tenure of an employee of a particular area. Therefore, plan and design wisely, always considering your successors. Our tenure as stewards is temporary compared to the longevity of our parks or open space areas.

A good suggestion for new trail designers is to envision yourself sitting in a helicopter for those twenty years, day and night, year round, fixed above a trail system. You might call this an aerial perspective view. From this vantage point, you would be in a position to watch everything that goes on, including use, vegetative growth, and erosion. Incremental and cumulative increases in various changes can be readily observed. Erosion is the biggest concern recognizable from this example. You might even see changes in park administration and attitudes towards trails and the environment in general. Consider layout and zoning of trail uses from this viewpoint also.

Now let's look at a long term approach to trails development. If the real satisfaction in a person's life or career can be judged by how much work they did that had a lasting effect on other people's lives, what would future trail designers say about your trail project? It seems that this society takes so much time to educate us and train us for a career. Not many of us have the opportunity to gain national fame for our work. Yet we can all have an impact on the people around us, our communities, our cities, our state or our country. We can leave permanent improvements behind us even if it is simply any job well done, or physical reminders such as buildings or in the case of planners, trails.

We in the recreation field have a great responsibility not only in terms of the protection of the health, safety and welfare of our visitors, but also to use our economic and material resources wisely. We also need to plan and use our time wisely. One area where we can apply these ethics directly is in our trail planning and management. Just a few questions that can be asked when undertaking a trail project include: Am I undertaking a rational and thoughtful trail planning and development process? Are the right people being involved right from the outset? Is an engineer or other professional needed? What other resource concerns should be handled by professionals? Is this trail corridor in the proper location? Is this trail being designed with the correct design standard in mind? Will it be able to support the intended users and uses? How long will this trail last while requiring little or no maintenance? And, is there a maintenance group trained and ready to begin maintenance and management responsibilities?

The reason these questions have been asked is because there have been many trail projects developed around the country that were undertaken prematurely, and unwisely. The answers to these questions should motivate you to learn if you are undertaking the venture in the wisest manner.

Utilizing the aerial perspective view, consider these questions as you undertake a trail project or as you update someone else's work: Will someone in twenty years re-route your work? Will someone identify an obvious, better alternative solution? Why not challenge yourself to do the best you can, to have the greatest impact that you can, to leave your mark on a trail project that no one will second guess?

Trail Renaissance



Many people remember the renaissance as the time period in western Europe when the arts flowered. Webster's New Collegiate Dictionary of 1973 defines renaissance as:

"...a movement or period of vigorous artistic and intellectual activity."

Maturity in trail design takes a long time to develop. Many different trail conditions and project types must be encountered. As a trail designer gets a little experience under his or her belt, standards and criteria can settle deep into the mind. Traveling to different regions of the state or country can also mature a trail designer. There are many techniques of solving problems displayed across the country. Trail designers would be wise to keep their eyes open for good solutions and learn from these as their career develops. There are many great trail projects in Colorado alone that one can look at and learn from. There is an abundance of good CCC trail work in Rocky Mountain National Park. There is also a large volume of literature in the public domain.

Durability, quality and timelessness are attributes that trail designers should strive for. Facilities should be enduring. When choices are made for required trail items such as a waterbar, granitic stone can be imported even long distances. For amenities such as a bench, cedar logs would be the most durable. These choices will indicate your interest in durability. Quality indicates a desire for good design, including form, function and utility. It also means that qualified craftsmen should execute the work. These choices will indicate your interest in quality. Timelessness is the refreshing perspective one has when encountering a trail project completed several years or many decades ago that still retains its uniqueness, is obviously well designed and built, and has stood up to the test of time. How timeless will your projects be?

It is this author's opinion that a renaissance of trails research and information gathering is required in order to help carry appropriate trails development activity into the next century. Prudent trail designers who review the literature and look at good and bad designs can enter a renaissance period of vigorous artistic and intellectual activity.

Sources of Information and Tools

A thorough knowledge of the area where trails are planned, as well as the area surrounding the planning unit including other trails is basic to good design. Combining knowledge of the area with professional decision making skills will further your trail planning activity. Knowledge of soils, drainage, vegetation, and general climatology are required. It is best if there are already trails in the area where you are working so that you can ascertain how different trail solutions are working or not working. Gravel roads local to your area also provide examples of how stable the soils are or if erosion is a problem.

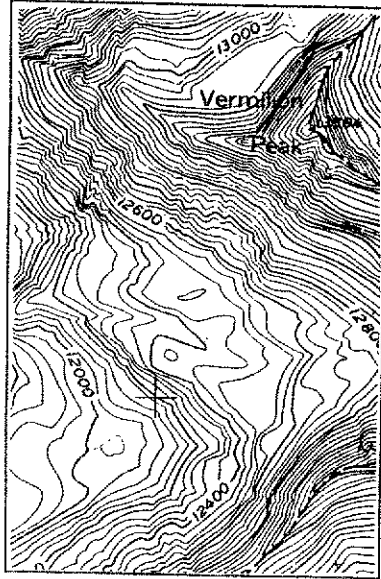
Information

Aside from the basic knowledge of planning and design considerations listed elsewhere in this document, there are two main sources of information available to the trail planner which can assist them during design development: aerial photographs and topographic maps.

Aerial Photographs

In areas of open vegetation, aerial photographs can give a good indication of the type of topography to be encountered on a trail project. Viewing aerial photographs and field checking just a few areas can give a trail designer insight into landform variations, vegetative cover, opportunities, and constraints. Broad scale planning of trail routes and preliminary design can be accomplished by a skilled trail designer using aerial photos.

USGS Topographic Maps



1:24000 USGS map

United States Geological Survey (USGS) topographic quadrangle maps will be a planner's primary source of information on mountain trail projects. Trail designers must know how to use and interpret these if they are going to be successful trail designers. There is an abundance of information on USGS maps that most people are usually unaware of. Begin by getting a free copy of the USGS handbook of symbols.

Scale is a very important component of maps. Most areas of the country are now mapped at 1:24000 scale. The 1:24000 scale is equivalent to 1"=2000'. Also make sure to check the contour interval on these maps! Depending on your region, this can be 10 to 80 feet.

Understanding contour lines is also very important. However, we do not discuss this in depth because of the detail required. Knowing how to scale slopes off of topographic maps, how to develop a slope jig, and how to interpret direction of drainages are map skills required of the trail planner. You are encouraged to pick up a book that will help you understand topography, or take a quick course. Several of each are usually available locally across the country.

Landform and topographic recognition should be combined with topographic map interpretation. Analyzing a topographic map will not be enough if you can not apply your map interpretation to the real world: the ground. Many features identifiable on topographic maps are recognizable on the ground. Many times, fence lines parallel section lines. Section corners and witness trees and other markers are locatable. Roads and trails are easy to locate, as are buildings. Visually adjusting to three dimensional scale conversions for your area may take some practice. Pick a prominent landmark, scale it off on a map, and develop a feel on the ground for the distance.

Other Information

Various agencies might have already gathered or produced other information that can be useful to the trail planner. They include: the United States Forest Service, the Soil Conservation Service, United States Geologic Survey, United States Army Corps of Engineers, various levels of state or local governmental agencies, the NPS and others. Private land owners may have even been involved in studies over the years. Contacting a local, knowledgeable person might also be of great benefit early on in your plan.

Tools Useful to the Trail Designer

Good sources of information, experience, and proper tools can all combine to give the trail designer their best attempt at a trail problem. It is wise to invest in good tools. Some of the items listed here are required for trail planning, design, and construction and therefore should be included in a trail designer's tool kit.

Scale Models

Scale models can be the most powerful trail planning tool. If contours are shown in relief [cardboard or wood cutouts] as opposed to solid [plaster], actual trail planning can take place on the model just as it could on a USGS topographic map. Complex topography is very easily discerned from a scale model. Be sure to get the horizontal and vertical scales as close to actual as possible, or 2x vertical exaggeration. Use trail planning methods based on a model if you can afford the time and/or money. Most landscape topographic models can be made from inexpensive materials. Contact your nature association, local trail group or other non-profit organization for a donation of time or money if your agency funds are short.

Altimeter

Altimeters are very useful tools when working in areas you are unfamiliar with, or in areas that are heavily vegetated. They are useful in planning applications only. An actual field survey with tape and clinometer is necessary for trail design purposes.

When determining suitability of a trail in steep terrain, a known elevation at your point of origin can assist you during the day if there are not large changes in air pressure which would make inaccurate altitude readings. If you pass a known high or low point, you can reset your altimeter. Knowing your elevation in a certain location, you can physically locate yourself on a contour map. Having done that, you can compare your location with your point of origin or intermediate elevation readings and make determinations with your clinometer as to suitability of a route for a trail.

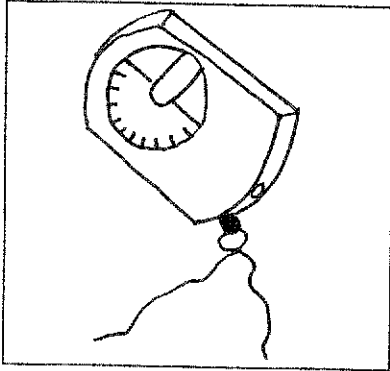
Base Map

A good base map is required for your trail plan. A copy of your base map can be beneficial when making notes of areas studied, or areas to avoid. They are also good for communicating information necessary to other involved persons to make informed decisions. An archaeologist, for example, might need a base map to know where to survey archaeological resources, or an engineer might need to see a bridge location to determine design criteria. **Appendix A** contains a base map with a trail concept plan example.

Compass

A compass, combined with USGS topographic map interpretation will give you most of the information you need to locate prominent landmarks. In trail planning, you can determine approximate bearings for suggested trail corridors from known features. In addition to placing flags or stakes in the field, a 'metes and bounds' type of note keeping can be employed to record planning alternatives and decisions.

Clinometer



Clinometers are required equipment for trail designers. Some trail designers still use an Abney Level, but this takes two hands to use. Clinometers come in many variations. Choose one that fits your needs and experience level. If you are planning trails and using guidelines in percent, use a clinometer that gives readings in percent.

Several rules apply to the use of clinometer. The first rule is to make readings on something at your own eye level for consistency. Either work with someone your own height, or hang flags at your eye level. The second rule is that clinometers actually measure grades over any distance, not just one hundred feet, which is commonly assumed. Finally, clinometers give readings of the grade between the two points viewed. If there are landform variations in between, these must be accounted for. The best way to do this is to take readings from high point to low point, regardless of the distance. This will ensure accurate readings.

Tape/Scales

A standard 100 foot surveyors tape [or rope] is also required equipment for trail planners. With a tape, estimations can be made as to length of improvement required, and preliminary estimates can be drawn up in the field. A fiberglass tape, off the reel is preferred by many. A drafting scale can be used to draw up design sketches. A map or aerial photo scale can be used to help you navigate in the field.

Notes/Notebook

Annotated notes made in the field, complete with sketches and maps are very important. Notes form the benchmark of information for planning decisions, design calculations, and direction of the work in the field. A surveyor's field notebook is very handy to use for note keeping. Weatherproof paper is suggested. Several styles of notebooks are available; experiment to see what is best for you. A book with a sketch page on the left and note page on the right is preferred by many.

Design Process

It is very important to develop and stick to a valid design process as you develop your trails program. This applies to trail planning, design, construction, and management activities. Often people get involved in decision making based upon assumed facts or input from others. Later in the decision process, earlier criteria change, or are no longer valid. It is important to point out that in a valid design process, changed criteria are revisited and reevaluated and changed as necessary. Maintaining a defensible and rational design process throughout your project will ensure maximum success.

When trail planners do not revisit earlier decisions, mistakes are sometimes made. Trail designers must constantly strive to develop the best design process and therefore the best trail facilities that we can, with the least expenditure of time and resources. Reevaluating earlier criteria or decisions can greatly assist in this. **Appendix B** contains Design Process Flow Chart information.

In trail planning, developing a valid design process means that the trail concept, preliminary design criteria, corridor locations, bridge locations, and design guidelines will be thoughtfully and carefully studied and coordinated. If a change is made in one, other aspects of the plan need to be revisited. Maybe an assumption is made that a certain trail width standard is necessary for a trail route. A corridor is then chosen. If, at a later point, a wider standard of trail is adopted, then the trail corridor must be reviewed to ensure that it can handle the wider trail. If it can, no changes are required. If not, a new corridor study must take place.

In trail design, the same process applies to the design of the trail cross section, drainage structures, and the development of specifications. If a switchback can not work nicely with either leg of the trail, the trail legs need to be adjusted within the established trail corridor. Adjustments like this will contribute to trail refinement. Mature trail designers know that adhering to a valid design process assists in construction and management activities. How does this concept affect you where you are, and your park area?



Oak leaves

Planning Considerations

There are many diverse aspects of trail planning that collectively contribute to what may appear to be a maze of obstacles for the trail designer to get through in order to see their project to completion. The following discussion is presented to motivate you to see the larger picture, and to try to streamline some of the planning aspects of trail design. Trail design, associated compliance procedures, and new constraints all contribute to a sometimes difficult process for trail designers to follow. However, by focusing on the larger picture and satisfactorily completing each intermediate step, the final result will come out very well. You must also be patient. Years from now, you will look back on your trail project or trail system, and you probably will not remember if it was completed in 1989 or 1990, or if you finished a phase of a project in May or August of a particular year. Taking this kind of an approach can keep you looking past the apparent obstacles and forward to your goal: providing well planned trail opportunities for your visitors!

Keys To a Successful Project

Keys to a successful project will be known to the good trail designer, the most important of which is ability to plan boldly. The city planner Lewis Mumford described the need to plan boldly in order to accomplish a great plan. Several parts of a successful, bold plan include: flexibility and ability to grow over time; accommodation of increased usage; planned accommodation of additional spurs and loops; accommodation of key viewpoints and other scenic/cultural attractions; hazardous, unacceptable areas avoided from the outset; consideration given to proximate uses; consideration given to ecological changes over time; 97-99% accurate location; planned for permanence and sustainability; and establishment of an accurate design theme and high quality construction ethic from the outset.

Budgets

Early in your planning process, planning for budgeting of dollars, staff time, equipment, and training must be done to ensure that as trail plans develop, money and people will be available and well equipped to do the job. Budgeting is a tricky business sometimes, and those that are successful are those who are creative. Successful trail implementers are those that understand their agency budget cycles and process.

Sustainability

The concept of sustainability should guide trails development philosophies. Developing Sustainable Mountain Trails Corridors (Appendix C) defines sustainability of natural surface trail corridors 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."

Environmental Compliance

Prior to undertaking any management activity or trail project on your agency's lands, you will have to go through an environmental compliance procedure. Procedures vary widely across agencies. Resources that are typically reviewed before undertaking any project include historic and cultural resources, soils, water quality, plants and animals. Plants and animals are usually compared to lists of known threatened, endangered, or otherwise rare species. Air quality may be a concern on some projects. Public involvement may also be solicited and considered during an agency's compliance procedures.

It is important to point out that review and compliance are required because what you as a trail designer may consider to be a common plant may actually be rare in a larger context. What you may think is a picturesque mine structure might be a safety hazard. What you may think is a minimal impact on a stream side environment may actually be a big impact. Find out what your particular agency's policies are and adhere to them.

Access, in the context of this document, is defined as the accommodation for all persons in the essential spaces or features of a building, site, or park area. All persons must be able to approach, enter, and use these spaces that are defined as accessible. Today's park facilities planner should consult with trail designers and access specialists to ensure that legally defined access is provided for all persons. Planning and location of all new or renovated park facilities and structures should ensure that access is afforded to all essential features.

One only need visit an established park area anywhere across the United States to see that use has constantly gone up since a facility's construction. Facilities were usually under-designed or designed to outdated standards, and accessible facilities in park areas are at a shortage. This indicates the need to strive to provide increased opportunities for unique and complete recreation resource experiences for all persons. The National Park Service Policy, as quoted from Special Directive 83-3, is to provide representative resource experiences to all visitors. Specifically, it states:

"In the planning, construction, and renovation of buildings and facilities and in the provision of programs and services to the public and employees, it is the policy of the NPS to provide the highest level of accessibility possible and feasible for persons with visual, hearing, mobility, and mental impairments, consistent with the nature of the area and program and consistent with the obligation to conserve park resources and preserve the quality of the park experience for everyone. This policy is based on the commitment of the NPS to provide access in our programs and facilities to a broad cross section of the visiting public."

If actual physical access cannot be provided, media can be developed as an alternative to the actual trail experience. These may include slides, videos, and brochures. All parks and open space areas should consider the provision of alternative media so that all persons can enjoy our natural resources.

Does your park or area have a policy on providing this type of experience? For the purposes of trails, consideration should be given to locating and designing all park improvements within a certain distance of a key park facility within access guidelines to maximize opportunities for all persons.

The Americans With Disabilities Act of 1991 covers both the legal aspects of providing access to persons of all abilities, as well as the design criteria for carrying out the legal aspects of this law.

Property Ownership/Boundary Constraints

Trail projects should only be started with an accurate boundary and property survey in hand, especially if your unit adjoins private land. A property survey might yield some insights into your problem and expose some opportunities for easements or other creative solutions. Undertaking a trail project without an accurate survey can create legal problems. If you are unsure about land ownership status, consult a licensed surveyor. If property ownership issues are a real constraint causing much investment or extra work, waiting may be better than carrying out a trail project.

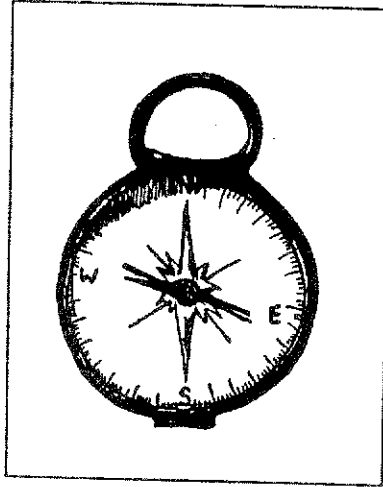
Easement Opportunities

Obtaining an easement across private land within your park boundary, or negotiating with an adjacent landowner for an easement is a preferred way of assembling trail corridors. Large expense can sometimes be avoided when using this method of trail planning. Easements should be determined and negotiated by experienced professionals. Mention is simply given here to identify the possibility to trail designers.

Vegetation

Each landscape area has an established characteristic landscape which is indicated by common types of plants and topographic features. Plant associations should be considered when planning trails to ensure the accommodation of the trail in the various associations encountered. Large trees, small trees, shrubs and grasses should all be studied for each area to determine their potential impact on trail corridors.

Design Criteria and Standards



Compass

Design criteria and standards are measures by which decisions can be made regarding planning or design alternatives. Criteria are usually applied to volumes and types of use, and standards apply to sizes and shapes of improvements. A strong background in these as they apply to trails is recommended for trail designers to ensure that trails which are planned can actually be designed and constructed.

A process should be established for each park area to outline design criteria and standards as part of the planning process. For instance, a 3 foot wide standard width might be selected based on the criteria to serve an expected number of both pedestrians and mountain bicyclists. Then that standard must be applied to the ground to ensure that it can be designed and eventually built. The same is true for horse or ski trail standards. If preliminary standards are not developed, it is uncertain whether or not proper design and construction can take place.

It is also necessary to develop and apply preliminary design criteria and standards to trails or old roads that are being considered for a change in types of use, season, or even volume of use. A good example is the possibility of converting lightly used old roads to mountain bike trails. If the old roads exceed 10% in grade, or do not obliquely cross contours, they are probably poor choices for heavily used mountain bike trails. Another bad sign is erosion on the cut banks that has not healed in a long period of time. Potential problems in change of use can also occur when allowing horses to use trails designed for pedestrians. Horses have requirements for geometry and grades that are different than those for pedestrians. A large investment is usually required to upgrade a pedestrian trail to horse trail standards if it is possible at all. Complete redesign or choosing an alternate location is usually required. Knowledge of design criteria and standards in advance is a good tool to employ to ensure wise decisions are made in a timely way.

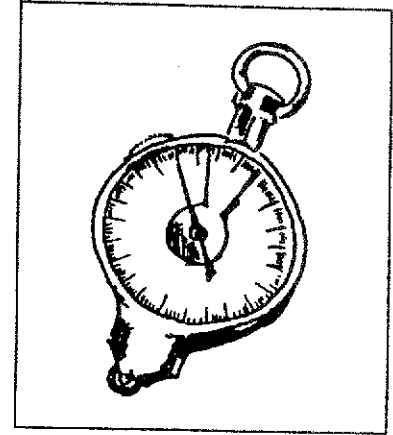
Corridor Choice

After complying with the legal and major functional requirements of trail corridors, the trail designer is faced with the question of corridor choice. **The highest quality corridor choice must be made.** The objective for the trail should be considered. This would include whether or not the trail is a nature trail, a front country trail, or a long distance trail. In this context, corridor means the swath of landscape approximately 10-20 feet wide. Grades, location, turns, scenic viewpoints, and switchbacks are all very critical within the chosen corridor. Trade offs usually have to occur to mitigate some adverse conditions along the trail grade. However, designers should still strive to pick the best corridor considering all factors.

For example, in a given corridor, unstable areas might have to be improved. A stone wall support for the unstable area is a possible solution. The corridor choice may still be the best one if more expensive improvements are required in alternative corridors. Spending enough time to pick the best overall corridor is better in the long run than picking an easy location now and having to re-route or do other improvements later. If it was hard to drum up money for the trail now, think about how hard it will be in five years when extensive rehabilitation is required! Pick the best route considering all the constraints and opportunities. Then design in all needed improvements. Later, small adjustments within the trail corridor can be made over time to improve small areas that require a little extra work. Minor changes over time in a trail corridor should be expected and are acceptable.

Pick your corridor and strive to achieve a very low re-route or improvement rate, for instance: less than 3% re-route or significant improvements in first 3 years. This is quite low considering that little wet spots, holes, or erosion are likely to happen in all trail projects. Strive for less than 150 feet improvement per mile of new trail. If budgets are tight, the trail designer can make choices regarding phasing of sections if desired. Testing out a small solution is all right. You might be surprised. These should be part of the 3% recommendation for improvements within 3 years. If you are uncertain how extensive areas of trail will hold up or work out, you should probably go back to the drawing board and start over.

Does your agency mandate charge you with conserving resources forever? What does forever mean? In terms of improvements to a chosen corridor, commercially available treated wood lasts 30 years, stone walls can confidently be expected to stand for about 50 years, and vegetation cycles along the front range of Colorado vary to upwards of 150 years or so. So what does forever mean? Twenty to thirty years is actually long enough to consider for the longevity of trailside improvements. The corridor choice, however, should be permanent. Consider the routes of the interstate highway system, the development of urban streetscapes and transportation systems, and the location of railroad corridors.



Mapwheel



The interstate highway system is a system of high speed multi-lane highways that was often superimposed onto existing state and local highways. These systems have enormous amounts of money invested in them, and great care was given to corridor choice to minimize land acquisition, development, operation and maintenance costs. These corridors will not be changing soon. Many urban streetscapes have buildings that conform in shape to the street pattern. These systems also have enormous investment in them and resist change. And finally, the great railroad corridors are an example of transportation facilities that require such heavy investment in time and money that appropriate planning and design had to take place well in advance of construction. Many times, railroads paid large amounts of money for property, rights-of-way, and easements. Notice the accommodation of existing railroads into rights-of-way adjacent to this nation's interstate highway system and adjacent to private development. These large investments indicate that these systems are not going to be changed easily, and that their location is permanent.

The amount of investment in each of these systems indicates their priority in our society and our desire to have these types of facilities permanently located. The anticipated benefits of trails activities for the participant and the importance of trail corridors to our society are reasons enough for trail designers to strive equally as hard as other transportation officials to choose permanent trail corridors. Future generations will appreciate that extra little bit of work put into trail projects to ensure their permanence and sustainability!

Differentiating Types of Use/Zoning

Trails must be zoned as part of the planning process. Zoning is the separation of different uses in different portions of a corridor. Some obvious recommendations come to mind. Road bikers do not mix well with horses, therefore a parallel horse track should be provided adjacent to a paved bike trail if both uses are to be served. Snowmobiles and skiers usually conflict also. Provision should be made for these alternate uses.

Beyond the simple zoning issues, diverse trail opportunities should be provided so that a wide spectrum of opportunities are provided to users of an area, yet not necessarily in one particular park or open space unit. Most park areas have the need for a simple nature trail, and other trails. These should be located nearest the parking and visitor facility areas. Incorporate access to these front country trails and if possible, segregate these from long distance trail opportunities to reduce conflicts with strollers and vehicles.

As distance increases from these areas, the more difficult and self-reliant trail opportunities can be developed. Strive to plan an entire system logically, so that it is easily recognizable, there is a minimum of conflict, and that maximum benefits may be derived from your system.

Off-Site Connections

Off-site connections can be key to the development of a trail program. Many times, conservation units are located adjacent to other conservation, preservation or open space areas. Caution must be given to differences in regulations. This may limit the amount and types of cross boundary use. At a minimum, clear signs at trailhead locations must be installed and maintained properly. Trail users crossing administrative boundaries or private land must be warned at trailheads and boundary lines. Consideration should be given to instituting a permit process, especially in heavily used areas.

The opportunities to tie into an adjacent piece of ground owned or managed by others can greatly expand your area's resources and accommodation of trail users. Adjacent lands may also infringe on your trail program depending on their uses and management strategies. For instance, hunting may be a management activity that is allowed on your land that is not allowed on adjacent land. Determinations must also be made as to the number and types of users and their origins and destinations. If a large percentage of trailhead users are going across your land to get to someone else's, your trailhead parking area may need to be expanded.

Consideration should also be given to the regulations of the adjacent lands. In addition to hunting activities which will vary across differing management agencies, some agencies may have regulations regarding picnicking, year-round use and special use permit requirements. Coordination with adjacent agencies is therefore required!

Analyzing Your Park or Agency Mission

Your district or agency should have a mission, and must have comparable and compatible trails management objectives. You should not have the best search and rescue team, and yet have a poor trails program. Invest in your programs equally. If your mission is to preserve a unique ecological area for all generations, your trails management objectives should match that objective. If you are to preserve a wet meadow, trails across it will not assist you in mission attainment, unless it is a well designed boardwalk.

This is a major key to the understanding of trails management in your park, community or state. If you understand your mission, you will be able to understand parallel objectives for your trails. Also consider the framework of resources that you have to offer your visitors. Your park or open space unit probably has legislation that indicates what resources you have and how they should be managed. In the case of Roxborough State Park, the management direction is to preserve the fragile Fountain Formation rock outcrops. In addition, there are diverse opportunities for short distance, medium distance, and even long distance hiking. The abundant geologic formations of the front range of Colorado are all evident at Roxborough, and all are being taken advantage of in terms of trail use and interpretation.

Park Interpretive Theme Coordination

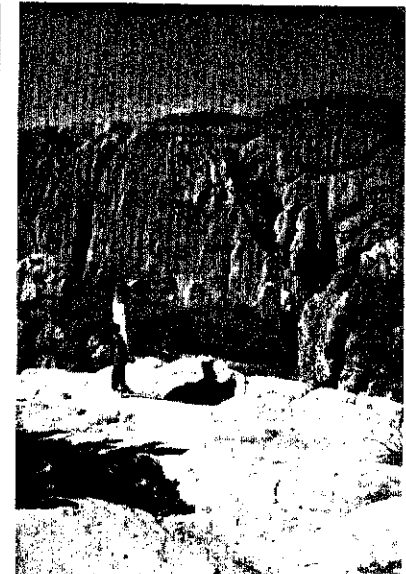
A park interpretive theme which addresses the major environmental, ecological, and natural history highlights of the area should be developed before undertaking a parkwide comprehensive plan. The comprehensive trails plan will then complement the interpretive theme plan. An experienced interpretive planner should develop the interpretive plan. Park managers should be aware of the education, research, transportation, conservation, preservation, cultural, and inspiration opportunities of an area when working with an interpretive planner. Several good questions to ask oneself when assisting during the development of an interpretive plan include:

Why is this park set aside for conservation?

What makes this place special?

Why do, or why would people come to this park or to use this trail?

What can be accented or highlighted in this area to optimize the trail user's experience in this landscape?



Old Roads, Rail Beds and Game Trails

Two-track roads and abandoned rail beds can sometimes serve as lightly used mountain trails. The trail manager must be aware of increased use and drainage problems that can develop. **Appendix D** contains sketches of cross section conditions common on abandoned rail beds and old roads. If conditions permit use of an old road as a trail, proceed. Otherwise, starting with a clean slate when beginning trail plans will improve the sustainability of a finished trail. It is important to point out that if old roads or game trails exist on your piece of ground, they should not automatically be included in a trail plan. Realizing this may expand your point of view on trail opportunities and not restrict you to old roads or rail beds.

Game trails are usually very minor impacts on the natural landscape. Imposing a designed trail onto a game trail usually completely obliterates it. Game typically follow a route around vegetation, and sometimes up steep grades. This is not usually the route a designed trail should follow. Also, protection of wildlife habitat and use areas should be a priority in natural areas. Game may actually be displaced by trails. For these reasons, game trails should generally be avoided as corridors for developed trails.

Control Points

Control points are locations which either restrict or allow trail uses. It may be required that a trail go through a mountain pass. The pass is therefore a control point. An archaeological site may need to be avoided and therefore is a control point. Control points can be studied when planning trails to assist in the development of a logical plan. Functional and aesthetic control points are also usually considered. An experienced trail designer will map out these control points on their base map to assist in the formulation of a trail concept.

Functional control points are things such as impenetrable rock outcrops, stream crossings, or archaeological sites where entry is not permitted. Aesthetic control points are areas where the trail designer would like to see the trail go if possible. These include overlook areas, high points, interesting water features or an ecological zone of interest. Consideration must be given to trail configurations and logical layouts. Not all aesthetic controls points make it into trail plans!

Bridge Planning

Bridges commonly represent the largest investment in a section of trail. Because of the anticipated high cost and the potential for structural failure in floods or storms, bridges should be planned and designed by qualified engineers. Footbridges in The Countryside. Design and Construction is an authoritative publication regarding bridges for pathway use.

A basic consideration for bridge planning includes the axiom that if your destination is across a particular drainage, you will need either one or three or five bridges. This is very important for planning and cost purposes. Typically, finding one suitable location for a bridge is difficult. Finding two crossing locations gets increasingly more difficult and three may be impossible. Generally, if you want to cross a creek, cross it once.

Bridges and their properly planned and designed locations might be worth a large investment in terms of trail length and construction cost to ensure that it is located in the correct place. If a bridge design and construction is going to cost your agency \$5000 it is worth building several hundred feet of extra trail to it on both sides to put it in the correct place. Carefully consider your bridge locations at least as a functional control point, and maybe even as an aesthetic one. Consider bridge approaches and their characteristics, as well as suitability for trails adjacent to bridges. Invest wisely in bridges.

When planning bridges; soil analyses and related structural determinations should be made. It is prudent to consult with a licensed bridge engineer or soils testing laboratory to assist you. Program necessary funds and line up necessary personnel well in advance of your need.

A final consideration in bridge planning activities for creek crossings is to determine how high above a creek a bridge should be designed. A design for a given frequency of flood event must be considered and documented. For instance, a 100 year flood event is often set as a minimum design standard. If flood information is not available, examine the streambed carefully to determine flood levels and check for the elevation of past debris to estimate how high above the actual flood level the bridge needs to be to pass the flood. Bridges which are designed to swing aside during large floods may also be considered.



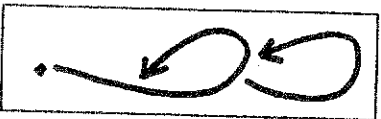
Mountain Trail Configurations



Linear



Loop



Stacked loop

The Trails Manual from Parks Canada and Non-Motorized Trails/An Introduction to Planning and Development are two documents that adequately cover trails planning methodologies and configurations.

Several basic configurations are available to the trail designer. Careful study is required to determine which type of trail or combination of types is appropriate for an area. The Trails Manual summarizes trail configurations available to the planner. They include the linear form, the loop form, the stacked loop form, the satellite form, spoked wheel form, and the maze.

The linear trail is the simplest form of trail. This trail will leave its place of origin and proceed to a destination. This is commonly used for long distance trails, or where a certain destination is desired. Areas that are topographically confined also commonly support linear trails.

The loop trail at some point turns back on itself and can accommodate more participants because conflict is reduced by encouraging only one direction of use. More interest is provided by not requiring the participant to retrace steps. A narrower trail standard can be used in one-way trails.

A stacked loop trail system is a series of loops and is sometimes better than the loop system, as long as too much complexity is not introduced into the system. A high level of variety can be designed into this type of system. Various travel distances and terrain conditions can usually be designed into the system.

The satellite form (not common) is a combination of loops and linear spurs and can expand on the stacked loop concept by introducing areas for contemplative trail uses, as well as further increasing distance and terrain variety in trail designs.

The spoked wheel (not common) focuses emphasis in a central area. If you have a feature you wish to accent, this might be a good system to consider. This system also offers a wide variety of travel distances and terrain features to participants.

The maze form is a complex form of trail layout and is generally not suggested because of management problems associated with it. However, if this type is chosen for use, expect maximum opportunities for distance and terrain variations, as well as possibilities for confusion. Accurate signs are required.

Developing a Comprehensive Trails Plan for a Small Park

A comprehensive trails plan should be developed by an interdisciplinary team of resource and design professionals for each park, open space area, or division of a conservation unit. The plan will identify where and when trail activities will occur and what uses will be allowed. The plan will also identify training needs, tool and equipment needs, and will also identify budgetary concerns. Plans can be developed for a definite period of time (for instance 5 years), and can be updated towards the end of that original planning period. The plan may include both short range (up to 5 years) and long range goals (up to 10 years). Updates to plans can address the long range goals identified in the original plan. A good trail planning process will involve the public, appropriate professionals having an interest in the plan, and neighboring land management agencies.

The purpose of a comprehensive trails plan is to provide the land manager with a tool to be used in the coordination of existing and proposed trail systems. It will also be a policy document to be used in the maintenance and expansion of the system area. The plan serves as a guide for land managers in their decisions regarding the location, funding, and construction of trails under their jurisdiction. The intent should be to standardize and systematize the development and management of trails in a given area. Plans can be used for the coordination of trail projects across agency boundaries where neighboring agencies have mutual goals.

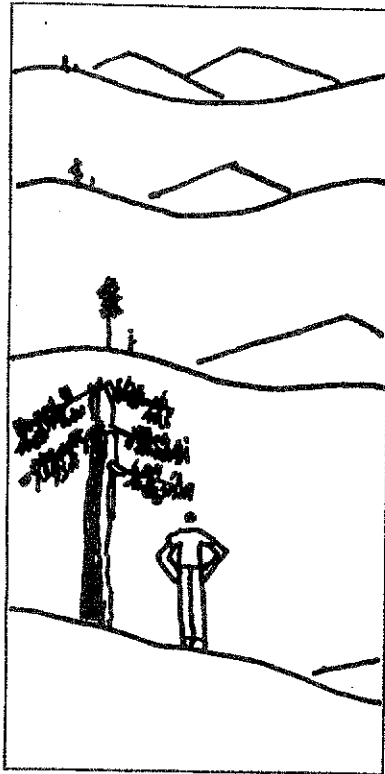
During the planning and public involvement process, many issues will come up and be addressed by the team which can adequately respond to situations as they arise. The land manager is then presented with a complete and professional plan which addresses most of the issues that will face the development team.

Most damage to existing trails has occurred because of poor siting in the original trail plan, if in fact a trail was planned. Comprehensive plans should include an inventory of existing trails and their condition as well as their fitness for continued inclusion in the trail system in their current condition. Maintenance and management needs can be identified, prioritized, and programmed in this process.

Basic Design for Mountain Trails

There are some general design philosophies and discussions that form the background information for the trail designer. A few good books or courses in human physiology, human responses to the environment, and basic ecology can benefit the trail designer. A key to accomplishing good trail design is understanding how people perceive the environment, and how they participate in the landscape.

Participation in the Landscape



Trail designers who consider trail users, on each kind of trail, as *participants* in the landscape will promote a mature concept of trail use. Participation in the landscape goes well beyond simply hiking, biking, riding, or skiing a trail. There are many stimuli that affect a trail user during the course of an experience. The designer must respond to them, and incorporate them into the trail experience.

Consideration must be given to environmental as well as cultural factors. The goal of considering these factors is to respond to them as much as possible and accentuate those that are desirable through location or opening views. Trail designers must also mitigate adverse influences. Care should be given where ever possible to preserve all possible natural remnants, provide a smooth, safe trail corridor that affords comfortable ingress and egress, one that is easily recognizable, as well one that a user can participate in and not just use.

Participation in the landscape should address ecological factors such as water (passive and active, large and small areas, meandering and straight waterways, fishing and non-fishing areas, active and passive involvement areas); vegetation (small and large, coniferous and deciduous, grasses and flowers, agricultural and natural, pioneer and mature species, thorny and soft, berries and flowery); soils (talus areas, stable areas, differing types or colors); rocks (cobbles and boulders, scree, outcrops); and wildlife (micro organisms, invertebrates, rodents, song birds and game birds, snakes, predators and prey, large and small mammals, livestock and pack animals). Participation extends to cultural factors such as mining history, archaeological remains, and historical features. Finally, participation should be extended to maximizing interchanges and, therefore, participation in and with environmental factors such as solar exposure (constant or filtered); glare (periodic or frequent); radiation (hot or cold); and wind (whether intermittent or heavy).

Trail designers must ensure that both the grand and the subtle elements in these ecological, cultural, and other environmental factors in the trail corridor are captured for participation in, with, and by the user. When doing this, put yourself in the shoes of a participant and envision what they will be experiencing.

Consideration should also be given to how the trail is viewed or experienced from points off the trail. Is the trail viewed from roads or highways or from residences or park facilities? A two-way line of sight therefore exists and you must be careful to avoid visual impacts from key areas. Remember to consider the aerial perspective as well. Is your plan organized logically? How does or will it function as a whole? Are conflicts minimized?

Roxborough State Park is blessed with unique scenery and natural resources of the front range of Colorado. It is the duty of trail designers to assist in the organization and presentation of these resources in as natural a way as possible to maximize the trail experience for the participant. The Olmsted Report, one of the earlier reports concerning the organization and presentation of natural resources for public enjoyment concerns the power of scenery on human emotions and the management of areas which would become part of Yosemite National Park. If we can apply the principles of this report to this concept of participation, present our information, and discuss our point of view as eloquently as Olmsted, we will be doing the public a great service.

National Forest Landscape Management, Volume 1 contains very good information regarding the visual aspects of landscapes that affect perception of and, therefore, participation in the landscape.

Physiology of Use

Trail designers must be aware of the physiology of use for the different types of trail users whether they be hikers, mountain bikers, cross country skiers, or equestrians. Horses, for instance, have a tendency to drift to the outside edge of a trail if there are no barriers to prevent this. Human physiology of use is also important to understand when designing trails. Hikers have varying gaits and habits when they use front country or back country areas. Ski trail geometry is very precise and must be understood to design effective trails. As trail designers travel and use various trails, they would be wise to observe how trails are being used, problems that are developing, and make note of good solutions they find.

Extent of Impact

It is important to realize the implications of your proposed trail route especially if you are working in areas where substantial cut and fill will be required or if you are working with large structures such as bridges or switchbacks. Simple geometric calculations are applied. Indiana Trails, Construction and Maintenance contains good information on helping you determine the extent of impact for proposed trail routes.

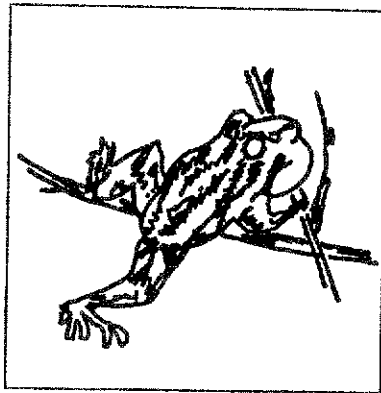
Design Guidelines

Design guidelines should be established for each area of a trail system to ensure that the development of the trail corridor and related amenities development proceeds properly. The role of the guidelines is to maintain the visual quality of the individual trail, system of trails, or park unit itself.

Items to consider when developing design guidelines include the character of existing sustainable trails in the area (trail visual quality, sinuosity of alignment, durability of existing improvements); the ecological character (the visually dominant topographic or vegetative characteristics as expressed by line, form, color and texture); and architectural character (the visually dominant qualities of man made improvements also expressed by line, form, color and texture) of the trail segment, trail route, or area being considered.

Design guidelines should be established to provide a framework for informed decisions by designers and managers when selecting or making improvements to trail corridors. Some ideas for design guidelines for mountain trail projects are that mountain trails should: be non-intrusive on the environment; be simplistic and restrained in design; be respectful of past traditions worth preserving; use indigenous materials; retain natural site character; and be sensitive to site ability to absorb modifications. Designers may also consider the development of experiential design guidelines that discuss how the participant will use, perceive and enjoy the trail or system of trails.

Ecology



Frog

Webster's New Collegiate Dictionary of 1973 defines ecology as:

"... the branch of science concerned with the interrelationship of organisms and their environment, and 2) the totality or pattern of relations between organisms and their environment."

Having a basic understanding of the landscape ecology in your park unit will further a trail designer's efforts to develop a trail system in harmony with the environment. Ecology and its interpretation should guide the formation of your trail system. If you are in a new conservation unit, how your unit contrasts or is similar to the immediate area around you, and how it fits into the larger regional, national and global ecosystem should be the theme of your park's focus for a trail plan. If you are in an established unit, compare your existing trail system with the framework of your education program. Some adjustments may need to be made to either your trail system or education program to ensure they complement each other.

Mountain Trail Design

Once all of the planning considerations have been studied and a trail plan developed and approved, trail design for a portion of the plan can proceed. Design is a very creative venture, especially in mountain trail projects. Design involves the processes of identifying and determining the fitness of alternative solutions on the ground to ensure that they are buildable. It also involves the process of specifically determining what trail experience is intended for the trail user. Experience is the best way to accumulate good design skills.

Design Criteria and Standards

Very specific criteria and standards must be applied during the design phase. Many design criteria and standards apply only to specific types of trails. A mature trail designer will seek advice from several sources and filter all the information to arrive at a concise point of view for the particular situation in hand. A mature trail designer will also seldom exceed any standard recommendation, and then, only wisely. Pedestrian mountain trail standards for profile grade, for instance, vary across the literature from a maximum sustained grade of 8 to 12%, with a single reference suggesting up to 18%. Designers suggesting grades beyond about 12% should use caution, and then, only with great experience.

One common aspect of trail profile grades for typical mountain trail projects that is not mentioned in the available literature is the aspect of trail profiles relative to the cross slope (or fall line). Field experience shows that as trail profile grades exceed $\frac{1}{4}$ the cross slope grade, excessive erosion takes place. For instance, trails that ascend at 10% profile grade should be built on 30% cross slope to minimize erosion. Trails that ascend at 10% profile grade on 10% cross slope are going straight up hill. A gully will result. Therefore, tailor your theoretical profile grades to the exact condition that you are dealing with. Exceeding the $\frac{1}{4}$ cross slope recommendation will require heavy investment in erosion control structures which may not even work.

Appendix E contains a general pathway design standards comparison matrix.

Pedestrian Mountain Trails

The AMC Field Guide to Trail Building and Maintenance, and the ATC Trail Design, Construction and Maintenance are the best reference documents for pedestrian mountain trails projects.



Horse Trails

| The Trails Manual by Vogel is the most important reference for mountain horse trail projects.

Mountain Bike Trails

| No standards currently exist for recreational mountain bike trails. Some literature indicates that ski trail geometry is adequate for mountain bikes. Some ski trails, however, do not have tread cut nor are they surfaced. Old logging roads may be suitable for mountain bike trails in terms of typical horizontal and vertical geometry. However, the relationship of the profile to the prevailing cross slope will need to be evaluated. Two concerns seem to be uniquely pertinent to mountain bike trails. These are the clearance of the chainwheel over obstacles and the turning radius. Bikecentennial's document Mountain Bike Trails: Techniques for Design, Construction and Maintenance, and Keller's document Mountain Bikes on Public Lands: A Manager's Guide to the State of the Practice are the best currently available resources for mountain bike trail developers.

Cross Country Ski Trails

| Cross Country Ski Trails by Alberta Recreation and Parks and Wisconsin Tourism's Cross Country Ski Trail Development Guidelines are outstanding references for ski trail developers.

Nature Trails

| Trail Planning and Layout by Ashbaugh is still the best nature trail planning document, although there are others of some interest.

Access Trails

| Accessible Trails, a Case Study At Malibu Creek State Park, and David C. Park's publications Access 2, 3, and 4 in Design are the best references for accessible trails resources.

Individual Project Design

| Each individual trail project should be designed within the context of the park's comprehensive trail plan. As each trail is inventoried and/or designed, slight adjustments can be made to the connections and nodes identified in the plan. Cost estimates and other related information should also be updated in the plan as new information arises.

Mountain Trails Project Implementation

Implementing trail projects is a very rich and rewarding experience for trail designers. Knowledge regarding the compilation of annotated notes, plan and profile drawings, specifications, and cost estimates are required. The methods and detail you use will vary with the method of construction. Methods of construction range from construction by contract to construction by volunteers. In either case, the same field work and calculations will be required. The actual presentation of the information will vary from a contract with construction drawings and specifications to annotated notes and a trail handbook for volunteers. Supervision of a contract or volunteer crews is also required.

Annotated Notes

Annotated notes, which are either xerox copies of field notes or rewritten field notes, are required on any trail project. Accurate design and construction drawings as well as material, time, and cost estimates can be made from the notes. **Appendix F** contains field note examples, project notes, and plan and profile drawings for the South Rim Trail at Roxborough State Park. Careful note taking skills are required. A skilled note keeper will actually perform running calculations in the field to keep the trail designer on track.

Annotated notes should minimally describe length of trail, clearing standards, tread type and width, any required improvements, and any other information needed to carry out the project.

Design and Construction Drawings

Design drawings can be done in the field or in the office from field notes to make a record of or to communicate field situations to interested parties. Quick concept sketches can also be used. The audience for design drawings is typically the client or a professional peer. Tailor your presentation accordingly.

Construction drawings are very detailed, precise drawings, required to actually build an item in the field. The drafting of custom construction drawings should be reserved for experienced trail designers. Many standards already exist for the inexperienced designer. Fitness of each proposed solution should be judged and ensured by the drafter. Thoroughly review each situation individually with standard drawings in hand before deciding to use them. The audience for construction drawings is the builder. Tailor your presentation accordingly. **Appendix G** contains sample trail design and construction drawings.

Specifications

Specifications are required on trail contracts to ensure that the design intent of the trail is achieved. This applies to both materials delivered and the finished quality of the work. You may also need them on day labor projects if your employees will be purchasing materials. On volunteer projects, it is advisable to purchase and provide all required materials and then to supervise construction yourself. The U.S. Forest Service's Standard Specifications for Trails is an excellent reference for the trail specifier.

The goal of specification writing is to communicate, as precisely as possible, the character, shape, and/or size of the results desired. Specifications are typically broken into divisions and sections according to the nature of the work and then into parts for each type of work. Many agencies have standard specifications from which an experienced designer can work. As with construction drawings, each specification must be exactly tailored to a specific situation to meet the needs of the current project. Experienced professionals usually prepare new specifications with great caution. Consult your contracting officer for advice about your agency's policy and be very careful. Estimates of material, measurement of quantities, and payment for work provided are areas where mistakes commonly occur. **Appendix H** contains sample trail specifications from the National Park Service and U.S. Forest Service. Many products on the market can be incorporated into trail projects. Most recreation equipment suppliers will supply their own specifications. All you usually need to do is custom tailor the specification to your agency's format.

Estimating Procedures

Developing cost, labor, materials, and training estimates are crucial to the success of a trail design project. All projects should have an estimate developed to within 10% accuracy. These estimates are required whether a contractor, day labor, or volunteers especially, are used to complete a trail construction project. Please do not overlook this need. Volunteers are special individuals, and if you give them a two day project that takes them 5 days, they will not be happy about the situation.

The best way to develop estimates is to use historical data as a baseline to start from in terms of dollars, days, or equipment needed. The best source of reliable data is a recently completed trail project in your area. You must be warned, however, that contractors, day labor employees, and volunteers all vary widely as to the amount and quality of work that they can do. Also realize that last year's contractor who built a mile of trail for \$15,000 might want \$20,000 for the same mile this year. The same is true for last year's day labor work force, or last year's volunteer group. If you have not had a project in your area recently, every required task should be itemized and broken down into component parts on a form or in a spreadsheet to arrive at an adequate estimate.

Comprehensive Mountain Trails Programming

There are several keys to a comprehensive and complete trails development program. They include a parallel planning process that prioritizes and schedules planning, design, construction, maintenance, and management tasks of various trail sections over an extended period, such as five years. Additionally, parallel planning should occur for public involvement, for developing a volunteer or leader program, for fund-raising activities, planning for tool acquisition, and for the development of education and information programs.

Schedule new trail construction when volunteer development opportunities or increased budgets are adequate to allow for trails maintenance and management concerns. Also, do not build new trails before you can take care of what you already have.

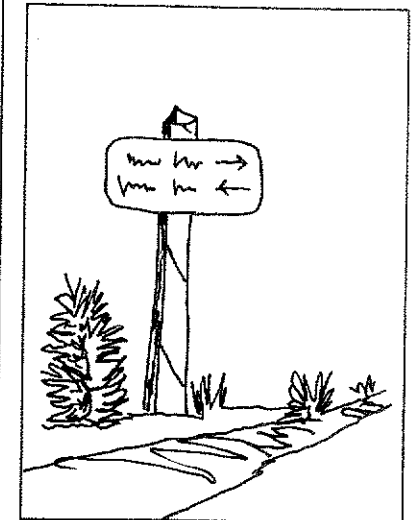
Developing a plan with short-term and long-term goals each year will give your agency staff enough time to plan for the budgetary items required, to schedule required professional services, and to coordinate the trails plan with other agency plans. Revising the plan keeps your staff, adjacent agency staff, and interested parties up to date on what your agency or park's trail plans are. As priorities change, so can your plan.

Signs

Signs can help you manage your trails program by providing general information, regulations, and interpretive information, as well as warnings where they are needed. Signs can be of assistance to trail managers, but judgement should be used to avoid installing too many signs. A complete sign plan and inventory can assist you in ensuring that just the right amount of signs are installed.

It is important to point out that sign standards are required for the different types of signs. Front country and highway signs can identify trail head and trail opportunity locations. Back country signs can provide information regarding destinations and facilities to users. Interpretive signs provide information regarding ecology, cultural values, or other items of interest. Warning signs provide information regarding hazardous situations and possible weather conditions peculiar to an area.

Standards should be developed in advance for different types of signs. They should be consistent with information style and presentation format, so that the message presented is quickly understood by park users. Each park should determine the best style of sign for each type required. Signs, Trails, and Wayside Exhibits-Connecting People and Places and the National Park Service Sign System Manual are excellent resources for sign information.



When developing a sign plan, consideration should be given to what the visitor needs to know about the area, the interpretive focus for the area, the numbers and types of trail users, the location of the needed message, how the message should be presented, as well as installation and maintenance requirements.

Trail Marking/Blazing

Trail marking and blazing can be controversial. Many different methodologies have been used. Basic considerations to be made include your agency's management strategy for an area, the amount and type of use you want to encourage, what conditions will influence perceptions of the marks or blazes, and what materials are locally available and vandal resistant. The AMC Field Guide to Trail Building and Maintenance, and the ATC Trail Design, Construction and Maintenance contain the best information marking and blazing trails.

Trails Maintenance and Management



Pulaski trail tool

The following is part of the trail management plan developed for Roxborough State Park by its staff. It is a very sound outline for undertaking a trails management program.

Good stewardship by trail managers promotes good stewardship on the part of trail users. The trail user's impression of management's concerns for the trail system are directly related to the trail's quality of design, construction, and maintenance. Trail maintenance and the management of it become an integral part of an overall park management plan. A trail maintenance management program is a method of planning, scheduling, performing, and evaluating trail maintenance activities that are necessary to ensure the trail user's safety and enjoyment, as well as to protect, administer, and promote appropriate use of a trail system.

The first step in establishing a trail maintenance management program is to perform a parkwide inventory of the trail system. The trail inventory's primary purpose is to establish the location of the trail, its distance, the amount and kind of visitor use it sustains, what kind of soils and vegetation the trail traverses, and any special considerations regarding that trail, such as proximity to archaeological sites. The trail inventory will provide a brief overlook of the entire trail system. In order to record certain data for the inventory, visitor uses may need to be surveyed, actual measurement of trail distances made, and information on soils, vegetation, and special considerations relating to the area or the park gathered. A park or unit inventory needs to be completed each year because use level and other considerations can change.

After a trail inventory has been completed, the staff person supervising trail maintenance will need to complete a condition report. This is the most important part of a trail maintenance program. A trail condition report provides current information on the status of all trails within an area. The data gathered and

decisions made during a condition survey provide information needed for further decisions regarding the scheduling and reporting of trail work. This information identifies all deficiencies within the trail system and any corrective measures necessary for planning maintenance or reconstruction projects.

Segment trails into easily identifiable sections for the condition survey preferably using landmarks to designate the beginning and end of each section. The following conditions need to be reported by section:

1. Tread maintenance. This includes loose rock removal, rock and root removal, slough and berm removal, and of trail tread outslope, and tread width.
2. Drainage maintenance. This includes routine cleaning out of ditches and clearing of brush and debris impeding water flow, maintenance of water bars, drains and culverts, and maintenance of stream fords, gully crossings, and drainage dips.
3. Trailway maintenance. This includes brush clearing, tree removal, litter pickup, and slope revegetation.
4. Structures. This category includes maintenance of rock and log barriers, walls, turnpikes, fences and gates, bridges, signs, benches, steps and cairns.
5. General. This category includes type of terrain, ground cover, slope, grade, switchbacks, climbing turns, intersections and vistas.

Upon completion of the condition report, and using the inventory report, the trail maintenance supervisor can prioritize the trails for maintenance according to their use, degree of deterioration, and erosion or hazardous conditions that may exist. The resulting data from the reports helps direct trail maintenance planning and scheduling as well as the implementation of any required trail restrictions (barricades, closures, revegetation programs, or restricted winter use) and/or any required rerouting. When priorities have been set and a determination of what maintenance measures will be required is made, the supervisor should estimate what amount of time and manpower, and what kind of tools will be required to do the jobs.

Maintenance scheduling can be accomplished by assigning each trail crew a specific section of trail as a weekly goal. Detailed notes, along with the condition report, and/or a walk-through with the crew leaders, will provide the necessary information to complete the maintenance tasks required for each assigned section. Numbered stakes or flags may also be placed along the trail to correspond to the stations indicated on the condition report.

The crew leader should record all work completed on each day worked, and the number of work hours required to do the job. The completed weekly work assignment notes should be returned to the supervisor at the end of the week for review. In this way, all tasks being completed as well as overall maintenance achievements can be monitored. The supervisor should inspect the trails and the work progress on a regular basis so that they will be able to pass on to the crew leader and crew a compliment, or a reminder of any conditions that still require corrective action.



Completion of an annual trail maintenance management plan is necessary to project future maintenance needs and recommendations. This plan is based on historical maintenance requirements, the most current condition report, knowledge of projected use of the trails, and an evaluation of need for certain trails. The plan will summarize actual requirements for the past year and projected requirements for the upcoming year.

Recommendations for maintaining the trail system at desired standards and/or design specifications, problem areas, and the consideration of any re-routes and/or closures of trails will be listed in the annual report. Trail requirements can be prioritized by the following criteria:

- 1. Correction of unsafe conditions.*
- 2. Minimization of unacceptable resource and trail damage.*
- 3. Restoration of trails to design standards.*

Beyond the physical maintenance and management of the easily measurable qualities along a trail corridor, a trail vegetation management plan should be developed for each trail area to ensure a long term management approach to trail corridors which will accommodate changes in vegetation. For instance, oak seedlings are much more important to clear in a timely fashion than fir seedlings. This is due to the speed with which the oak grows and its ecological response to disturbance. Fir seedlings can be monitored and removed in several years when they start impacting trail use while Gambel Oak must be removed several times a year. Strive to develop a specific maintenance plan for each trail area based on its unique ecology. Consider what the major plant species are, their ecology, their potential impact on the trail corridor, and methods to mitigate impacts.

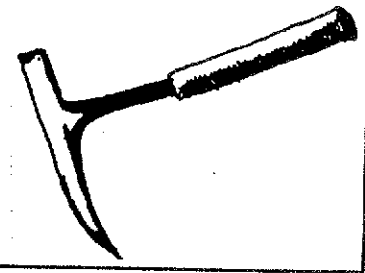
Trail Transects

Permanent trail transects can be set up to monitor trail tread migration and change over long periods of time. Vegetation can also be monitored. Information gathered can provide a unique and objective point of view of how things are changing in trail corridors. Consideration should be given in each park area to setting up transects. Each trail route at a minimum should have one transect, and maybe several. Different geology or soil types can indicate the need for additional transects, as can different types of trail use. Photo monitoring can also be instituted to accurately record changes in trail corridors.

Trail Education

Education should be a large part of each conservation unit's agenda for meeting the public's curiosity and need to learn about their environment. How can the education of others about trail related issues help your program? By involving local schools, clubs, and other organizations, you can use your park as an outdoor learning laboratory for everyone to stretch their imagination. If children become interested in a subject when they are young, they may be truly inspired and develop a life long interest in the subject. Parents and teachers can also learn, so make sure that you include them also, and you may even want to tell the public about rehabilitation of disturbed landscapes if they have occurred in your park area.

The development of an education program about trail ethics and the management of trails will do much to further your efforts to preserve and conserve trail corridors. Some suggestions include the development of handouts, flyers to post on bulletin boards, an information newsletter, a slide show, or maybe a video documenting improvements made to date, as well as threats to trails if problems are left unchecked.



Geologist's tools

Trail Interpretation

Interpretation can aid your overall trails program by making users aware of not only ecological values, but also trail opportunities, constraints, and existing conditions. Wise trail managers should study ways that information can be presented to interested staff as well as the public, to assist in achieving their goals. Another suggestion is to develop your trails program in a process parallel to your interpretive program themes. Strive to gain insights into how interpretation can complement your trails program.

Trail Brochures

Trail brochures say a lot about your trails and trail program. Investing in a good brochure indicates your level of commitment to communicating needed information to the potential participants in your trail system. You might have to develop a series of brochures describing different aspects of your program if you have a complex system of trails. Contact a naturalist or interpreter in your agency for assistance in developing brochures for your trail program.

Volunteer Programs

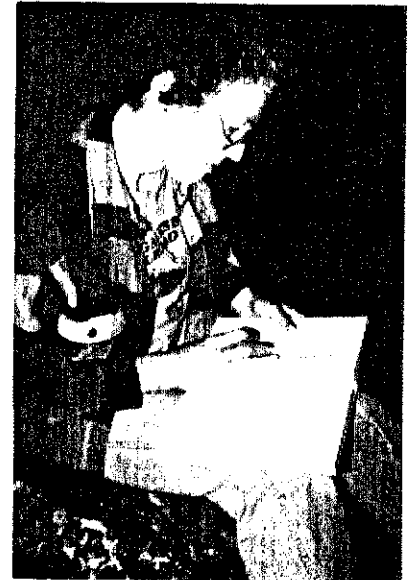
Five major aspects of your program should be studied when choosing volunteers for projects. They include: Organizational Development, Project Development, Crew Leader Development, Volunteer Development, and Recognition. If you decide to develop your own volunteer program, consider doing it as you develop your trail project. Much training is required and a lot of time. As you begin to plan your trails, develop a slide show and an orientation package for your volunteers. Do not wait until your trail is ready to be built to go out and recruit volunteers. An excellent document to help you develop your volunteer program is Extending Your Reach - A Guide for Agencies Working with Volunteers published by Volunteers for Outdoor Colorado (VOC). **Appendix I** contains Optimizing Your Return From Volunteers. **Appendix J** contains Quality Ensures Project Success. These two documents emphasize the philosophical side of developing volunteer projects.

Organizational Development

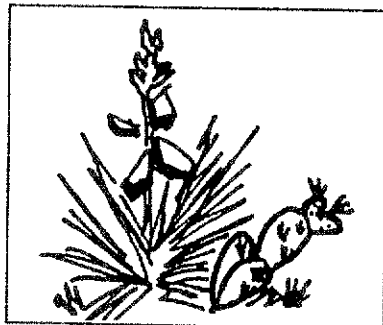
If you are going to start your own nonprofit organization, make sure you have experience in recruiting, placing, and training volunteers. You will also need legal advice if you are going to incorporate your own organization. If you want assistance from other nonprofit agencies, make sure that you know the agency's mission, its philosophy, its short and long term goals, and its technique for carrying out those goals.

If you are going to use an existing organization, get some background information on the organization, make some preliminary contacts, and begin working with them. Find out what their mission is. VOC is a major nonprofit agency in the Denver area. Their mission is to: "instill in Coloradans a sense of responsibility for the stewardship of outdoor public lands..." Typically, VOC carries out large volunteer construction projects to help carry out this mission. Usually a barbecue is provided to reward the volunteers. VOC's publication Agencies and Volunteers - Conducting Your Own Volunteer Projects and the Tahoe Rim Trail Association's Tahoe Rim Trail Volunteer Handbook are both excellent resources for those wishing to develop volunteer programs for trail projects.

Other local and national organizations that can help you include REI (Recreation Equipment, Incorporated), the Student Conservation Association, the Sierra Club, the Colorado Mountain Club, the Colorado Trail Foundation, the American Hiking Society, the Boy Scouts of America, the Telephone Pioneers, and various church groups. Several law enforcement agencies also can supply community service individuals or groups to help you with your program.



Project Development



Project development needs to take place over an extended period of time. Many factors will influence the development of your project. They include your agency's budget cycle and availability of funds, availability of manpower and equipment necessary to prepare the project, seasonal variations or closures, and availability of contract or volunteer labor.

Just as a mature trail designers will look at a trails development program in a multi-year fashion (planning of an areawide or parkwide trail concept one year, a series of trail designs another year, and construction in subsequent years) parallel development of the volunteer program will ensure the availability of properly trained leaders and volunteers when trails are ready for construction. Fun hikes, orientation slideshows and training sessions can be carried out during the design process to help you develop your volunteer program. If you are going to construct trail by volunteers, be advised that the best volunteer organizations require project submittals one year in advance of construction.

Crew Leader Development

Volunteer crew leaders can be an integral part of your trail program. By adequately training crew leaders, you, as a park trails specialist, can dedicate more of your time towards enhancing your program. The time required for leader training is extensive, but worth it. It is wise to have an established training program in place when you start recruiting leaders. It is also important to have a written summary of training requirements and commitments in advance so leaders know what to expect. Thorough training is required to ensure that new leaders can transfer agency expectations of standards and craftsmanship to the volunteer crew. **Appendix K** contains crew leader development information.

Volunteer Development and Recognition

There is much literature available about how to recruit, select, train, and place volunteers. State-of-the-art training is important for all volunteer work. Make sure that you invest wisely in training materials, and that volunteers know what to expect in advance. You will reap the benefits in your trail program. Also set aside time to recognize volunteers and to celebrate occasionally! Your local library is a good source of information on volunteer development.

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The following publications are referenced in this document. These are key documents which, as a group, make up a mature mountain trail planner's library. These documents are widely available through inter-library loan (through your local library), or directly from the appropriate agency.

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Appendices

Appendices contain information that display examples of concepts mentioned in the text of this document. Miscellaneous Appendices contain literature that will be useful to most trail advocates.

Appendix **A** Base Map and Example Concept Plan

Appendix **B** Design Process Flow Chart

Appendix **C** Sustainability

Appendix **D** Typical Cross Sections of Old Roads and Rail Beds

Appendix **E** Pathway Design Standards Comparison Matrix

Appendix **F** Field Notes, Project Notes and Plan/ Profile Sheets

Appendix **G** Sample Trail Design and Construction Drawings

Appendix **H** Sample Trail Specifications

Appendix **I** Optimizing Your Return From Volunteers

Appendix **J** Quality Ensures Project Success

Appendix **K** Crew Leader Development Guidelines

Miscellaneous Appendices

Miscellaneous Appendix **AA** Sketches

Miscellaneous Appendix **BB** Legislation

Miscellaneous Appendix **CC** Sources of Equipment and Supplies

Miscellaneous Appendix **DD** Combined Glossary of Trail Terms

Miscellaneous Appendix **EE** Role of the Trail Designer and Other Positions

Miscellaneous Appendix **FF** Job Descriptions

Miscellaneous Appendix **GG** NPS-77 Chapter 3 Backcountry Management

Miscellaneous Appendix **HH** Annotated Bibliography

Miscellaneous Appendix **II** Liability Bibliography